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# THE IMPACT OF THE COGNITIVE CODE APPROACH ON LANGUAGE PROFICIENCE IN ENGLISH LANGUAGE LEARNERS

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***Abstract:*** This paper explores the benefits of utilizing the cognitive code approach in second language instruction. Originating in the 1970s, this method prioritizes engaging mental processes over habit formation, aiming to foster a deep understanding of language through personal experiences. By improving comprehension of grammar, structure, and expression, cognitive learning enhances student motivation in language acquisition. The main goal is to advocate for the incorporation of the cognitive approach in language classrooms, underscoring its effectiveness in motivating students. By showcasing its advantages, the article aims to encourage teachers to integrate cognitive strategies into their teaching methods, recognizing its potential to boost student engagement and enthusiasm, thereby optimizing language learning outcomes.

**Keywords:** Cognitive code approach, Second Language Instruction, Phraseology, Language acquisition, Learning outcomes, Student Engagement.

## INTRODUCTION

The task of teaching a foreign language can be extremely difficult. Educators must have a thorough understanding of the cognitive processes involved in language learning. The advantages and effects of using a cognitive approach in language classes will be discussed in this article. Mayer (2011) defines cognitive learning as an alteration in knowledge resulting from experience. Three essential elements are included in this definition: first, learning entails a change; second, the change takes place inside the learner's knowledge; and third, the learner's experience is the primary source of this change.

This article's goal is to persuade teachers to implement the cognitive method in language classes, which has the power to completely change the dynamics of the classroom. In the modern world, the cognitive learning theory is crucial since it acknowledges that every person thinks differently depending on their specific memories, experiences, and pertinent information they have learned in the historical period. The classical behaviorism approach has been surpassed by the cognitive approach as one of the most prominent approaches in modern psychology.

### I Historical Background

A theory of teaching and learning second languages, the cognitive code approach first surfaced in the 1960s and was supported by cognitive psychologists and applied linguists such as J.B. Carroll and K. Chastain. It emerged as a counter to the audiolingual approach, which was primarily focused on the development of habits. The cognitive code approach, in contrast to the audiolingual method, emphasizes the importance of viewing a language as a body of rules and information. It can be viewed as a contemporary version of the grammar-translation approach in this way. The cognitive coding technique gives students the means to efficiently understand grammatical structures. Additionally, it makes meaningful language practice and application easier, which fosters a deeper comprehension and application of language abilities.

The process of identifying and gaining knowledge is referred to as cognitive processes. Perception, intuition, and reasoning are only a few of the internal processes that are formed by the mental processes examined by the cognitive development hypothesis (dictionary.com, 2012). The development of cognitive theory was vigorously pursued in the middle of the 20th century, even though it gained substantial traction in the 1970s. Language acquisition and data processing, according to Noam Chomsky and B.F. Skinner,

are not random processes. They suggest that, in contrast to other mammals that do not have this ability, humans are born with a Language Acquisition Device (LAD).

**II Cognitive Development Theory**

Cognitive science, focusing on how individuals perceive, comprehend, evaluate, and think about information, has gained attention since the mid-20th century. Cognitive psychology suggests the mind functions as an information processor, receiving and transmitting information. The cognitive-code approach, applied to language learning, emphasizes active mental engagement through five phases: engagement, exploration, explanation, elaboration, and evaluation.

Certainly, cognition plays a pivotal role in comprehending and actualizing mental processes, particularly evident in language learning through the Cognitive Code Approach. This method is structured around five key phases—engagement, exploration, explanation, elaboration, and evaluation and prioritizes active mental involvement, nurturing deeper understanding.

2.1 In this approach, the teacher harbors several goals to foster effective learning:

1. **Building on previous knowledge:** Establishing connections between new information and students' existing experiences to foster a richer understanding.
2. **Developing problem-solving skills:** Encouraging critical analysis and application of knowledge in real-world contexts.
3. **Promoting higher-order thinking:** Cultivating analytical, synthetic, and evaluative thinking to engage students in complex cognitive processes.
4. **Enhancing language proficiency:** Improving grammar, vocabulary, and language structure proficiency to enhance communication and comprehension.
5. **Providing purposeful practice:** Engaging students in activities that actively reinforce language skills, ensuring proficiency through active application.

Through these objectives, teachers not only support students' language development but also cultivate critical thinking, autonomy, and confidence in their language skills.

**2.2 In the Cognitive Code Approach, the interaction between students and teachers is characterized by:**

1. **Teacher as facilitator:** Taking on the role of a facilitator, guiding and supporting students in their learning journey by creating an environment conducive to active participation and critical thinking. Teachers provide resources, guidance, and feedback to aid students in actively processing information and constructing understanding.

2. **Individualized learning experiences:** Recognizing and respecting the unique needs and learning styles of each student, teachers tailor learning experiences to address individual strengths and areas for growth, providing opportunities for personalized learning.

3. **Student responsibility**: Encouraging students to take ownership of their learning process, actively engaging in seeking resources, asking questions, and monitoring their progress. Teachers empower students to become independent learners who are self-motivated and self-directed.

4. **Consideration of learner's emotions and cognitive abilities:** Creating a supportive and positive learning environment that nurtures students' emotional well-being, while encouraging reflection on their cognitive abilities. Students are guided to recognize their strengths and areas for improvement, enabling them to optimize their learning strategies and enhance their learning experience.

5. **Learning from mistakes:** Fostering a culture where mistakes are viewed as valuable learning opportunities, teachers create a safe space where students feel comfortable making and learning from errors. Mistakes are embraced as a natural part of the learning process, prompting reflection, identification of areas for improvement, and application of corrective measures.

Overall, the interaction between student and teacher in the cognitive code approach emphasizes a supportive and personalized approach, fostering active engagement, responsibility, self-reflection, and continuous growth.

**2.3 To nurture healthy cognitive growth in students, educators can implement the following strategies:**

1. **Engage students in discussions:** Create an atmosphere conducive to open discussions on various topics, encouraging students to share their perspectives and ideas. This cultivates critical thinking and the ability to consider diverse viewpoints.

2. **Foster idea sharing**: Encourage active participation in class by prompting students to share their thoughts with both peers and teachers. Incorporate collaborative activities and group discussions to promote engagement and the exchange of ideas.

3. **Promote independent thinking:** Empower students to think independently by providing opportunities to explore different perspectives, analyze information critically, and form opinions based on evidence and reasoning. Guide them in constructing logical arguments and supporting their ideas.

4. **Encourage goal setting:** Assist students in setting specific, achievable goals for their learning and personal development. Support them in monitoring their progress, fostering self-reflection, motivation, and a sense of purpose in their cognitive growth.

5. **Recognize good decision-making:** Acknowledge and praise students when they demonstrate effective decision-making skills, emphasizing instances where critical thinking and thoughtful choices were employed. Positive reinforcement encourages continued practice and refinement of these skills.

6. **Support re-evaluation of poor decisions:** Provide guidance and support to students when they make mistakes or poor decisions, helping them understand consequences and learn from their experiences. Encourage self-reflection and offer opportunities for students to reconsider their decisions, explore alternative approaches, and develop improvement strategies.

By integrating these strategies into the learning environment, educators can foster a culture that promotes healthy cognitive growth, empowering students to think independently, critically analyze information, make effective decisions, and continually develop personally and academically.

## III. CONCLUSION

In conclusion, the cognitive code approach, particularly through Cognitive Code Language Teaching (CCLT), emerges as a potent methodology for language instruction. By prioritizing active student engagement and cognitive processing, CCLT not only facilitates language acquisition but also cultivates crucial cognitive skills like problem-solving and decision-making. Through techniques such as meaningful discussions, idea sharing, and independent thinking promotion, educators can foster a rich learning environment that nurtures cognitive growth and enhances critical thinking abilities. Additionally, by emphasizing goal-setting and recognizing positive decision-making, teachers bolster student motivation and self-reflection, preparing them for success beyond language learning.

Overall, the cognitive code approach offers multifaceted benefits to language learners. It equips them with language proficiency while concurrently developing essential cognitive competencies applicable across various life domains. Through the integration of CCLT, educators can create an enriching educational setting that fosters cognitive advancement, empowering students to thrive in their academic pursuits and beyond.

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# CULTURAL ALIENATION IN UPAMANYU CHATTERJEE'S ENGLISH, AUGUST: AN INDIAN STORY

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## Abstract

The theme of exile and alienation is prevalent throughout twentieth-century writing, to the extent that it is often referred to as the literature of exile. This text reflects the overall sense of disappointment, challenges, and profound spiritual isolation experienced by individuals in the post-war generations. It highlights the feeling of being insignificant and alienated in the vast cosmos. Upamanyu Chatterjee's novel "English, August: An Indian Story" explores identity in a postmodern culture. It complicates this topic by involving the protagonist in a complex network of conflicting and contradictory experiences and behaviors. Chatterjee presents a nuanced perspective on post-colonial society, where exile and alienation appear to be unavoidable aspects of human behavior.

**Keywords:** Alienation, Torment, Tribal,Culture.Displacement

The concept of Alienation is prevalent in much of modern literature, with one of its central focuses being the exploration of potential harmony between individuals and their circumstances. This issue is of immediate importance in all post-colonial literature, as they are the product of an unequal interaction between a violent and exploitative imperialistic culture. This dynamic has led to significant displacement, dispossession, and dislocation in contemporary societies. These effects are observed in various social, cultural, linguistic, and geographical domains. Consequently, a crisis of identity has emerged, accompanied by a pervasive sense of Alienation.

The main character in English, August and The Mammaries of Welfare State, experiences an unavoidable feeling of isolation caused by a strong recognition of his colonial heritage. Agastya Sen is experiencing a sense of estrangement due to his displacement and dislocation in Madna. He is socially isolated in his community. Upamanyu Chatterjee portrays Agastya Sen as an estranged hero to illustrate the challenges he faces due to his isolation. Hence, there is a strategy to investigate and elucidate Agastya's psychograph to determine the factors behind his feeling of estrangement. The main character in the novels English, August, and The Mammaries of Welfare State experiences an unavoidable feeling of Alienation caused by his profound understanding of

his colonial heritage. Agastya Sen is experiencing a sense of estrangement due to his displacement and dislocation in Madna. He is socially isolated in his community.

Upamanyu Chatterjee portrays Agastya Sen as an estranged hero to illustrate the challenges he faces due to his isolation. Hence, there is a strategy to investigate and elucidate Agastya's psychograph to determine the factors behind his feeling of estrangement. Agastya is an unconventional bureaucrat who makes no effort to conform to the norm. The trainee is bewildered by anything he does. Nevertheless, he is eager to discover significance and attain a clear purpose in his life. Individuals have yet to embrace their uniqueness successfully and instead desire to be a fusion of Western culture. The novel English, August is narrated in a seriocomic manner, with situational humor stemming from absurdity and disorientation. Upamanyu Chatterjee adeptly blends elements of absurdity with the character's emotional experiences in the narrative. Although he displays affection, he is uncompromising in his portrayal of modern India. Agastya and his companions are both attracted to and concerned about the increasing prevalence of Western culture. However, while working as a trainee in Madna, Agastya starts to discern what holds significance and captivates his attention. There are no definitive truths or certainties, but there is a rising recognition of the importance of being true to oneself, establishing a solid foundation, and ultimately striving for happiness. As a trainee at Madna, Agastya engages in sexual fantasies, appreciates music and literature, enjoys wine and marijuana, and practices masturbation. An Indian Administrative Service (IAS) officer is an essential and integral part of the bureaucratic system, playing a crucial role in serving the nation. Prioritizing preserving the Indian Administrative Service's integrity and dignity takes precedence over all other matters.

But Agastya feels apathy for it and misses his vocation completely. On the very first day in Madna he feels being fucked like the fallen Adam. The filthy food and mosquito-infested atmosphere at the Rest House suffocate him, as if these factors contaminate his psyche as much as excrement does. Agastya is now unmarried, however, he falsely claims to be married when interacting with people. When questioned by Deputy Collector Mr. Agarwal regarding his spouse, Agastya responds :"She is in England She's English, anyway, but she's gone there for a cancer operation. She has cancer of breast" (13). In addition, he informs the District Inspector of Land Records that his spouse is a Norwegian Muslim. He unabashedly boasts about his parents' involvement in the inaugural Indian mission to Antarctica without any sense of shame.

Agastya derides and belittles everyone and everything in his vicinity. His westernized influence frequently disrupts his superiors, subordinates, and colleagues, indicating a strong aversion to his work. He disregards regulations and violates cultural norms by making offensive and explicit remarks of a sexual nature. Occasionally, he has feelings of sadness, deep thought, and fluctuating emotions. In Madna, he encounters a feeling of surrealism and displacement. Deep in

contemplation, Agastya asks himself, "I don't look like a bureaucrat, what am I doing here. I should have been a photographer, or a makes of ad films, something like that, shallow and urban" (EA 13). He considers himself alien living in a misfit world, and does not enjoy the role he has earned for himself by virtue of his competitive qualification.

The circumstances surrounding him evoke a profound sense of displacement in Madna. He experiences unease and doubt at his incapacity to integrate into village life, which becomes apparent on his train travel from Delhi to Madna. Agastya Sen, born to a father of Bengali Hindu descent and a mother of Goanese Christian descent, symbolizes the infiltration of Western civilization into the local Indian society. Cultural hybridization denotes the process of blending or merging different cultural elements:

> The ways in which forms become separated from existing practices and recombine with new forms in new practices…… a reflexive relationship between the local and global produces the hybrid. The identities are not assimilated or altered independently, but instead elements of cultures are incorporated to create a new hybrid culture. (3)

Agastya lacks both physical strength and ambition, making him not a superhero. During a school composition, he expressed his aspiration that he wants "to be a domesticated male stray dog because they lived the best life. They were assured of food. . . . A stray dog was free; he slept a lot, barked unexpectedly and only when he wanted to and got a lot of sex" (EA 35). He remembers it from his time in Madna as a solution to his disordered thoughts. Agastya's inclination towards becoming a dog reveals his irrational mindset. His existence in Madna is disconnected from his origins, depriving him of the opportunity to indulge in a continuous cycle of excessive drinking, drug use, and sexual activities in Delhi. However, this does not alleviate his feeling of being in exile, a general feeling of discontentment and disconnection. His senses are overwhelmed by dislocation. Upon entering the Indian Administrative Service, he aspires to discover significance and direction in his life. Dr. Upadhyay his college professor says "I'm happy for you Agastya you're leaving for a more meaningful context" (24). But life in Madna is alienated and misplaced, feeling empty and lonely.

Agastya's feelings of loneliness and misery seem insignificant, impolite, and empty in comparison to Dhrubo's portrayal of boredom.: "All those expense accounts, and false-accented secretaries, and talk of New York and head office, and our man in Hong Kong, it's just not real, it's an imitation of something elsewhere" (EA 153). The novel English August explores the generational anguish of various characters, including Agastya, Madan, Dubey, Mohan, and Bhatia. Madan provides an eccentric description of his boredom, while his sister is captivated by the characteristics associated with English culture. Agastya is reluctant to confide his distress to his pals due to his sensitivity in recognizing that it is not particularly rare or entirely exceptional.

Similarly, many individuals in his vicinity also experience a comparable degree of incompetence in discovering purpose in life, and it is plausible that this inability is a prevalent characteristic among humans in contemporary society. Agastya's existential agony is not "a routine gesture of conformity to modern cynicism", as M.K. Naik points out in his comments on the novel. The genuineness of Agastya's delicate immobility within a confined and airtight environment evokes a genuine and identifiable character and sensitivity. Despite feeling dislocated and overwhelmed, Agastya manages to overcome his inertia and confront his anguish and lack of purpose. During moments of seriousness, he visits Multani's clinic. He observes the doctor's satisfaction and ambition, inspiring him to connect his life's struggles with concrete plans and a clear future.

While traveling to Baba Ramanna's Rehabilitation Home, he is greatly struck by the nobility and magnitude of the latter's dedication, which is evident in his remarkable accomplishment. He is captivated by the immense capacity of human potential energy and the ability to transform human vision into tangible achievements via careful planning and unwavering determination. The author observes the intense focus and dedication of Shankaran Karanth, also knownas Baba Ramanna, who has abandoned his profitable medical career in Bangalore and relocated to a remote area to provide medical treatment to impoverished lepers. Significantly, Baba's trip has a beneficial impact on Agastya: "Later, mulling over his visit, Agastya envied Baba Ramanna most of all for knowing, when he had been merely Shankaran Karanth, how to master his future" (EA 237). Yet the reflection doesn't trigger a tremendous turn in him. As Murari Prasad states in his article "Reading Upamanyu Chatterjee's English, August"as

> Contrary to Pranjape's point, by implication,nothing in Chatterjee's book suggest a "negative" attitude to India. It is a pity that Paranjape tars many Indo- Anglian novels with the same brush, ergo he contracts "the western disease" which he seeks to combat in his argument: the disease "to encapsulate the whole of Indian reality ". (89)

Agastya becomes cognizant of the destitution, suffering, oppression, and lack of necessities experienced by the tribal population. He ceases his procrastination and idleness. He resolves to cultivate empathy for the impoverished villagers. The beneficiaries find his effort to be encouraging and instill confidence. Nevertheless, he has become more earnest in his work and continues progressing. Agastya's initial display of resolute intent after being assigned as Assistant Collector in Koltanga quickly transitions back to his usual tendency to downplay and delight in petty matters. Meenakshi Raykar in an article "The Intellectual in a state of 'Anomy'" analyses:

> Chinua Achebe's No longer at Ease and English, August point out that both the protagonists and their respective periods suffer from a state of 'anomy' –reminiscent of

> Wole Soyinka's The Season of Anomy. 'Anomy', a word resurrected by the French sociologist Emile Durkheim from the Greek, denotes the condition of society which results from the disintegration of commonly accepted normative codes. (111)

Somewhat similar to the idea of alienation, it refers to a condition when an individual loses his traditional moorings and is prone to disorientation. Rukun Advani points from the book *The Fiction of St. Stephen's* as: "Agastya is quintessentially the Stephanian graduate extricating himself from the existential dilemmas that made thinking people clench their teeth when faced with the dreariness and mindlessness of the Indian bureaucracy" (12). Agastya saw himself as an outsider in the transaction governed by excessive greed. However, rather than dealing with the problem, Agastya and Obi absolve themselves of responsibility; both withdraw from their commitment and become introspective, as their education needs to provide them with the necessary guidance. Agastya is fully aware of his state of estrangement and actively struggles between his anglicized colonial self-image and his more profound native impulses. In any case, the text is ultimately reduced to an expression of conventional male anxiety. In order to achieve this objective, the narrative is extensively adorned with expressions that depict the predicaments faced by a disillusioned and confused young man. The main character lacks power and faces difficulties accepting his new experiences to discover a more cohesive identity. Agastya develops a fixation on exercising: "His exercise was something he felt he must hold on to, some anchor of stability, without it the day would slip into anarchy. And only after its completion was he was ready for anything, for any act of illogic and unreason" (EA 120).

Physical exercise provides him with a temporary but meaningful sense of self. It can be considered as his altruistic act for the day. On occasion, he attempts to address or bypass his feelings of isolation by expressing his dissatisfaction through the use of offensive language and references to bodily functions. The use of taboo words becomes a potent tool in his possession. It might be inferred that this is merely one of the methods through which Agastya demonstrates his authority or dominance over the incomprehensible world surrounding him. During the concluding stage of the novel, Agastya has the opportunity to visit Baba Ramanna's Rehabilitation Home for Lepers. This visit deeply affects Agastya in a way that surpasses any previous experience. "Initially, to him, Baba Ramanna had seemed pleasantly mad and completely remote, a do-gooder out of a book of legends for children, a small time Ishwar Chandra Vidhyasagar or a male Mother Teresa" (EA 235). However, at a later time, this man appeared to be more than human at brief and disturbing moments, as he witnessed the vastness of the accomplishments made from a state of barrenness. Agastya is experiencing genuine emotions for the first time due to a human endeavor.

## Conclusion:

He is not only wonderstruck by the immensity of ambition but also by "its nobility and virtue... the limitlessness of the potential of human endeavour" (EA 235- 36). This is a pivotal moment for Agastya, leading him to recognize that human beings are not entirely devoid of value. Along with his pals, Agastya begins to challenge the foundations of Western metaphysics, the fundamental perspective that has shaped his identity. This perspective generates a feeling of being disconnected from everyday life, resulting in unfamiliarity. Regarding the impact of Western upbringing and education,it is a sense of dislocation prevails and it is acutely experienced because 'the real' is what is thought to be apprehended through English education, that belief itself being rudely contradicted in everyday interactions.

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# Use Of Debates To Develop Argumentative Paragraph Writing Skills Of Engineering Students

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**ABSTRACT**
This study probes into the connection between debate and its effect on developing argumentative paragraph writing skills. Paragraph writing is a basic form of writing that every student should master to communicate well both in academic and professional settings. This paper expounds how debates can help students enrich their argumentative paragraph writing skills. After a thirty-period intervention program using debates to trigger their ideas for better argumentative paragraph writing skills through process approach, it has been understood that students have demonstrated a marked improvement in their argumentative paragraph writing skills.

**Keywords:** Paragraph writing, Debate, Process Approach, English Language Teaching

## 1.Introduction

English has become genuinely a global language and it has been used in every industry and every domain of study as a medium of communication. Crystal (1997:79) has estimated that 85 percent of international organizations use English as one of their working languages. Undoubtedly, English is the most widely spoken and written language in the world. In the Indian context, English is not only an associate official language with reference to business, commerce, government, and higher education but also it is regarded as a second language.

On account of this, there has been consistently a growing need in recent times to learn English for academic and professional purposes. In the academic arena, it is the most preferred medium of instruction because higher education in any discipline is offered in English. Every student is expected to gain proficiency in English language skills i.e. listening, speaking, reading and writing skills to excel in their academics. Out of the four language skills, writing is generally considered the toughest skill by the students. But effective writing skills will give an edge over others if the students master them.

Hyland (2003: viii) says, "Learning how to write in a second language is one of the most challenging aspects of second language learning. Perhaps this is not surprising in view of the fact that even for those who speak English as a first language, the ability to write effectively is something that requires extensive and specialized instruction." If any student wants to write well, he needs to understand and learn different sub-skills of the writing to gain competence in writing. For this study, the researcher has chosen debates to be conducted before the students attempt argumentative paragraph writing as it is hypothesized that if students are participated in debates, the process helps the students get equipped with many relevant ideas for effective argumentative paragraph writing.

### 1.1. Objectives of the Study

The present study is driven by two objectives:

- To know what extent debates can help students enrich their argumentative paragraph writing.
- To understand the effectiveness of the process approach to writing.

### 1.2. Research Questions

- Do the students writer better argumentative paragraph after their participation in debates?
- Does the process approach really help them write the argumentative paragraph effectively?

### 1.3. Hypothesis

The hypothesis of the study is:

If debates are conducted before instructing the students to write argumentative paragraphs, the students can write better argumentative paragraphs.

**2. Literature Review**

Writing skills are of paramount importance to every student irrespective of their field of study as they need to communicate well in written mode frequently in their academic and professional settings. Generally, every student considers that developing good writing skills is both difficult and time-consuming. Students need to master the sub-skills of writing and get sensitized with nuances of formal writing in due course of time. For any form of writing, paragraph is the basis. Zemach, Dorothy E and Rumisek, Lisa A (2005:11) define that "a paragraph is a group of sentences about a single topic. Together, the sentences of the paragraph explain the writer's main idea about the topic". If students understand what constitutes a good paragraph and have sufficient and relevant ideas at their disposal, they can produce a well –developed paragraph. If the students understand the different components of a paragraph like topic sentence, supportive sentence, concluding sentence, connecting these sentences both coherently and cohesively, they can produce a good paragraph. Argumentative paragraph is one of the important types of paragraphs which students feel a bit difficult to write. Raman, Meenakshi and Sharma, Sangeeta (2011: 369) explain that "an argumentative paragraph is used when we want to express an opinion and convince the readers using facts to substantiate our stand."

Oxford dictionary (2020) defines the word "debate" as "a formal discussion of an issue at a public meeting or in a parliament". So, it is understood that debate is a basically a discussion. Johnson (2009:12) defines that "a debate is a contest of the arguments used to prove or disprove the motion." It is hypothesized by the researcher that if debates are conducted as pre-task before writing argumentative paragraph, the students will get sufficient and relevant ideas to write the argumentative paragraph effectively. The researcher has used the process approach predominantly to help the students learn argumentative paragraph writing. Harmer, Jeremy (2004:4) defines the process approach as "the stages a writer goes through in order to produce something in its final written form. The process may be affected by the content of the writing, the type of writing, and the medium it is written in." Zemach, Dorothy E and Ghulldu, Lisa A (2011) say that "process approach to writing is where students work on invention, peer response, editing, and writing multiple drafts with a pragmatic approach to learning the basics of writing." Hence, the researcher has used both debates and process approach to writing to develop the argumentative paragraph writing skills of the first year engineering students in this study.

**3. Research Methodology**

Qualitative research methodology has been used in this study.

**3.1. Research Tools**

The research tools used in this study are pre-test, post-test and interviews with teachers.

**3.2. Research Sample**

Thirty-first-year engineering students were chosen for this study using simple random sampling technique.

**3.3. Intervention**

A group of thirty-first-year engineering students have been selected for this study. Firstly, a pre-test has been conducted to understand their ability to write argumentative paragraph and to know their awareness of the basics of the paragraph writing skills. The pre-test scripts were evaluated qualitatively. Secondly, ten teachers were interviewed. Next, the students have been sensitized with basics of debate and its procedure for correct and effective participation. The students have been given a thirty-hour intervention for fifteen days. Every day, the students have involved in the intervention for two hours i.e. from 1 pm to 3 pm. The students have been divided into three ten member groups and they were monitored by three teachers. The everyday session plan has been that students, firstly, were given twenty-minute preparation time to make sure all were ready. Secondly, they were involved in debate for 20 or 30 minutes. Immediately after the debate, they were asked to jot down the points they expressed in the debate in groups. Last, they were asked to write the first draft of the argumentative paragraph and then asked to revise three to four times using process approach principles to produce the final version. A post-test has been conducted to understand the effectiveness of the intervention the program.

**3.4. Data analysis and interpretation**

Qualitative approach techniques have been used to analyse and interpret the data. Firstly, after evaluating the students' Pre-test answer scripts, it was found that the following problems had been identified. Some of them are: no paragraph structure, no sufficient and relevant ideas, and both coherence and cohesion were affected. After the intervention, a post-test was conducted and the answer scripts were evaluated qualitatively. It has been observed that the students' writing has shown a good improvement in terms of paragraph structure, sufficient information, cohesion, coherence, etc. Thirdly, opinions from the ten English teachers involved in the intervention were collected through interviews to know their opinion on this study and its effectiveness.

**Some of the opinions of the teachers are given below:**

- Paragraph writing is a basic form of writing which students must learn to excel in it.
- Activities like debates equip students with a set of ideas so that it enhances their confidence level to write paragraph effectively
- Process approach should be used in every writing class irrespective of the age of the students to achieve effectiveness in writing.
- More periods should be allotted to teach writing skills

**4. Discussion**

This study proved that if students had the right and sufficient inputs to write, they would write well. Students, who showed some problems to produce a good length paragraph, showed a marked improvement in their argumentative paragraph writing. In addition to that, they wrote coherently because of the process approach procedures. The students were able to write the topic sentence correctly which was well supported by the supporting sentences.

**5. Conclusion and Recommendations**

Based on the understanding of the intervention program in this study, the following conclusions/suggestions have been specified.

1.Speaking activities like debates trigger a lot of ideas in students and other participants' contribution help the students with sufficient ideas for any writing tasks. The more the speaking activities, the better for the students for the development of proficiency in writing.

2. Students must be encouraged to develop consistent reading habits to enhance their writing skills.

3. More intensive testing practice should be given to understand the efficacy of speaking activities to enhance students' writing skills

**6. Limitations**

Firstly, one of the limitations of the study is the small sample size and thirty period intervention program. Secondly, the teacher has developed the assessment parameters based his understanding and requirements.

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# ENGLISH PRAXIS COURSE-I: A BRIDGE GAPING COURSE AND A GENTLE PUSH INTO HIGHER EDUCATION

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**ABSTRACT:**
Students have emerged into a paradigm shift from a closed framework of Intermediate Education to a flexible Choice Based Credit System(CBCS) existing in the general undergraduate courses(B.Sc/B.A/B.Com/B.B.A), being offered by the Andhra Pradesh State Council for Higher Education (APSCHE). So they need to be offered knowledge along with 'practicing skills'. The revised syllabus for English, which is implemented as 'English Praxis Course' (in three parts) offers specific skills that are needed to impart to the students at each part of the English Praxis Course during the three semesters. Praxis Course implies a course that always undergoes the formula of 'theory into practice'. Significantly, the syllabus for 'English Praxis course-I: A Course in Communication Skills' seems to have been framed as a bridge-gaping course between Intermediate Education and Higher Education. This paper primarily aims to discuss the following.

a. The Implementation of Praxis Course-I in a sensible and practical approach.
b. Its challenges of making a student leap forward to embrace Higher Education
c. Pragmatic Strategies for creating a vital teaching and learning environment.

**KEYWORDS:**
Praxis Course, Paradigm shift, Hours allotted, Methods, Preparedness, CBCS, Bridge-gaping course

**INTRODUCTION:**
We are aware that the syllabus for General U.G courses (B.Sc/B.A/B.Com/B.B.A) in Degree Colleges has been revised under the Choice Based Credit System (CBCS) across Andhra Pradesh with effect from the academic year of 2020-21. This syllabus revision of English has become a prominent action as English medium became mandatory in all Degree Colleges across A.P w.e.f the academic year of 2021-22. It's become an arduous task for many students pursuing primary studies in the medium of Telugu. They are unable to simply adapt the new course to study in other mediums at the level of higher education. So, it would be rather practicable when the students are sent to undergo a bridge gaping course during the first semester. Moreover, a bridge course is needed for the transition of a student's 'level of study' from the lower stage to the upper stage. A bridge course

should not be confined to conducting a program for one week or ten days. It will be beneficial when it's extended in a complete semester. English Praxis Course-I consists of certain attributes that let them be accustomed to pursuing studies in higher education. However, the confinement of instructional hours allotted to English (four per week) prevents the students' enthusiasm towards language skills into practice. Also, the teachers using various methods for the same topic wouldn't be helpful for the existence of a revised course which necessitates a certain orientation offered by the Department of Higher Education.

**A. Syllabus Design:**

As Breen mentioned in 1984, "Any syllabus will express_however indirectly_certain assumptions about language, the psychological process of learning and the pedagogic and social processes within a classroom." The syllabus design of a course is usually ignored by the concerned authorities. The content of the course should be designed by the people who are dwelling in the field of teaching. The design of the course should reflect the needs and interests of the students from all regions. It is not supposed to confine to something which fulfils a person's requirements. Designing the syllabus can dictate the prospect of the forthcoming generation. So, it's essential to take the stakeholders' feedback on a course and to be reviewed by the experts' team. As well, following a meticulous approach in determining objectives and specifications for each topic would be a fundamental obligation of syllabus makers. During the Preparation of the English curriculum, one should keep in mind whether the language proficiency of teachers, learning resources, the time bound for syllabus completion, and standardized testing tools are conceivable in the institutions or not. If it is not possible, we should focus on how to make it customized to our institution in accordance with the adaptability of the syllabus. Candlin suggests that curricula are concerned with general statements about language learning, learning purpose and experience, evaluation, and the role of relationships between teachers and learners. When you are part of the syllabus design for the freshers at UG level into Higher Education, we should carry out a few things like selecting suitable materials, stating the objective of the course, listing grammatical and functional components, and formulating a teaching-learning act.

As the title of the course suggested, the Praxis course recommends the practice of exercises rather than mugging the vocabulary and grammatical rules. The syllabus must be knitted with the scope for using authentic learning material and suggesting various methods and activities during the teaching-learning process in order to touch the distinctive paths of the syllabus. Every college should be equipped with an English Language Lab to deal with topics from II Unit (speaking skills) like Sounds of English, Stress, and Intonation. The teaching methodology has to be suggested in the syllabus design for dealing with new topics like Soft Skills. Finally, a Continuous Comprehensive Evaluation has to be executed to assess the constant progress of the student across all aspects mentioned in the syllabus of English Praxis Course-I.

**B. Choice-Based Credit System (CBCS):**

The University Grants Commission (UGC) has initiated several steps to bring equity, efficiency, and academic excellence to the National Higher Education System. The important ones include innovation and improvement in the course- curricula, the introduction of a paradigm shift in learning and teaching pedagogy, examination, and the education system. Choice-based credit system (CBCS) offers opportunities to address students' educational needs and aspirations of a student. This choice-based credit system in higher education provides flexibility in preparing the curriculum and granting credits based on the course intensity and teaching hours. This helps students to pursue courses of their choice, study at their own pace, learn extra lessons, and acquire more than the required credits. The framework of CBCS emphasizes group discussions, assignments, class activities, and internal examinations which creates an environment that is appropriate for English Language Learning. According to the guidelines issued by UGC on the CBCS framework, the student is supposed to take the Praxis Course, the Language Course which is given with 3 credits and 4 hours in each semester. (Ref.2). As conducting the activities of the English Language Lab is also part of implementing the English Praxis Course,

allotted hours (4 per week) are scarcely enough to conduct other language activities. So, it necessitates extending two more instructional hours per week.

**C. English Bridge Course:**

English has been considered the lingua franca which gives the scope for exploring global knowledge. Nehru and other like-minded leaders agreed that English should be allowed to continue as the official and link language in the country until Hindi was accepted and spoken fluently by the non-Hindi-speaking people in the country. The Teaching of English at the UG level plays a vital role in the level of achievement of students ensuring they acquire the English language skills for application at various levels. The Bridge Course, when conducted as a sustained system of language input and acquisition of a student's undergraduate program will yield the best results. However this, according to the teacher's feedback, is not practically feasible due to time and space constraints in the regular curriculum in colleges. The English Language Program is specifically designed to assist a student with initial English proficiency to attend college courses in the English Medium and to develop English Language Skills. The English Bridge Course is designed to give a rapid revision and training of the language skills namely Listening, Speaking, Reading, and Writing. Language learning is complete only through the acquisition of Language skills with appropriate Grammar and Vocabulary skills. Hence, it is vital to evaluate any English Bridge Course material concerning its coverage of lessons including exercises and activities in Language, Grammar, and Vocabulary skills. When we look into the syllabus of English Praxis Course-I which is meant to be designed for students preferring higher education in degree colleges, the following features may turn it out as a bridge course for the beginner of higher education.

1. **Exclusion of Literary section:** It is the most astonishing feature of the English Praxis Course-I which can be evidently endowed as a bridge course for a beginner of Higher Education. As we are aware no English course was designed so far at the level of Higher Education unaccompanied by a literary section. However, English Praxis Course-I has been mapped out in consideration of accustoming a beginner to the new environment of Higher Education. Also, something goes under discussion that English Praxis Course-I doesn't make room for creativity at the exclusion of the literary section.

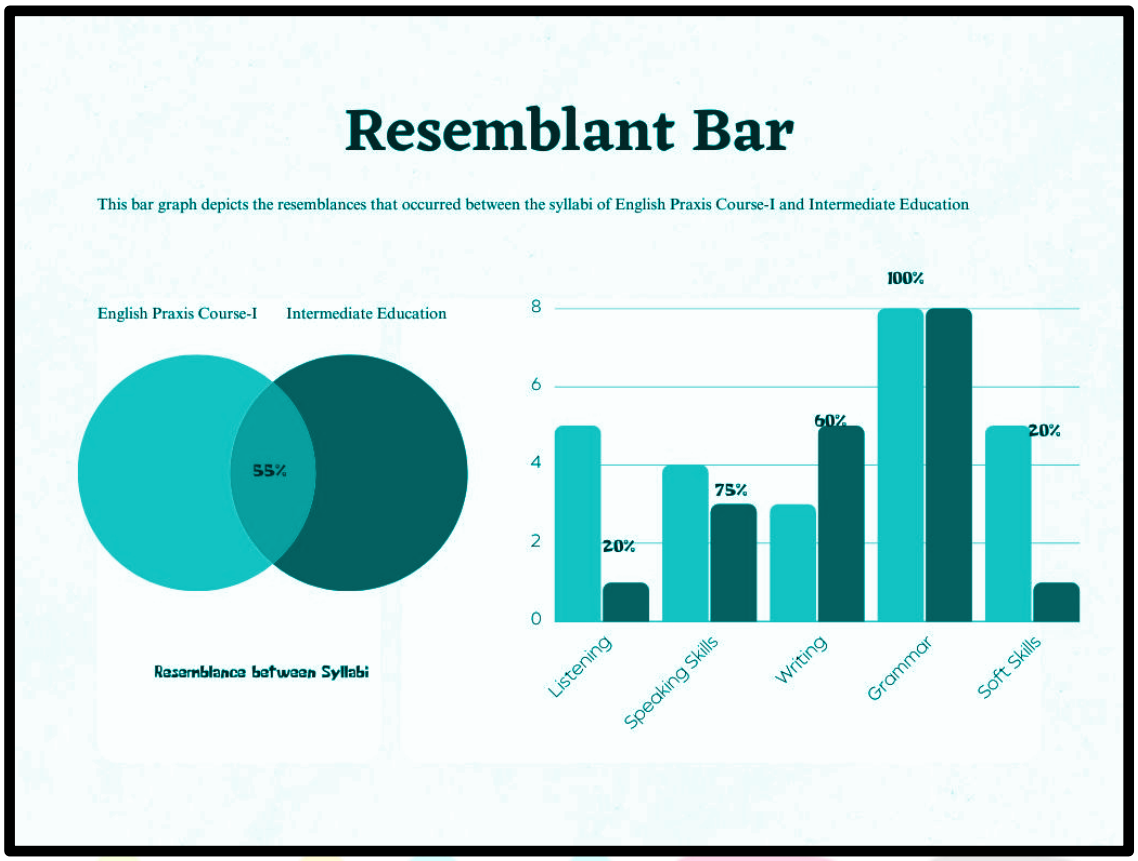
2. **Prominence to Listening skills:** Listening-skill which is commonly ignored among the four skills of language acquisition, differs from hearing and is contemplated as an amalgamation of Receiving, Understanding, Remembering, Evaluating, and Responding. English Praxis Course begins with an introduction to listening skills which includes the importance of Listening, the differences between Listening and Hearing, the stages involved in the Listening Process, Barriers, and Strategies for effective listening. The weightage identified for Listening skills is rather high among other aspects that existed in English Praxis Course-I. As the students are familiar with note-taking exercises at the intermediate level, they can apply them for the acquisition of listening skills.

3. **Likelihood of syllabi:** A significant feature of English Praxis Course-I which made it envisaged as a bridge course is to extract the syllabus of grammar, speaking, and writing skills from the syllabus of the Intermediate course which students had been already familiar with, by the time they blended in higher education. It will surely support the students to embrace the undaunted sphere of higher education. All the segments of the grammar section from the Intermediate syllabus have been astonishingly repeated in English Praxis Course-I. Except for the topic of Intonation, each topic has been readdressed in this new one.

The major resemblances between the syllabi of Intermediate and English Praxis Course-I shown in the table would make it embodied as a Bridge Gaping Course.

| S.No | Unit | Segment of Syllabus | Topic included in the syllabus of 'English Praxis Course-I(Sem-I)' | Whether it is covered in the syllabus of "Intermediate' |
|---|---|---|---|---|
| 1 | I | Listening skills | 1. Importance of Listening<br>2. Types of Listening<br>3. Barriers to Listening<br>4. Strategies for Effective Listening | Yes, this section is addressed to a certain extent in the form of comprehension passages which can assess the listening and reading skills. |
| 2 | II | Speaking skills | 1. Sounds of English: Vowels and Consonants<br>2. Syllable division<br>3. Word accent<br>4. Intonation | Yes, Except for the topic on Intonation, students are well-acquainted with the rest of 3. |
| 3 | IIII | Grammar | Concord: Agreement of Subject and Verb | Yes, students are familiar with every grammatical segment at the Intermediate level. |
| | | | Modal Auxiliaries | |
| | | | Tenses | |
| | | | Articles | |
| | | | Prepositions | |
| | | | Question Tags | |
| | | | Sentence Transformation (Voice, Speech, Degrees of Comparison) | |
| | | | Error Correction | |
| 4 | IV | Writing | 1. Punctuation | Yes |
| | | | 2. Spelling | |
| | | | 3. Paragraph Writing | |
| 5 | V | Soft skills | 1. SWOC | Yes, this section is |

| | | | | |
|---|---|---|---|---|
| | | | 2. Attitude | addressed to a certain extent through literature topics though they are not provided as specific segments. |
| | | | 3. Emotional Intelligence | |
| | | | 4. Telephone Etiquette | |
| | | | 5. Interpersonal Skills | |




So, this study reveals that 55% of the syllabus from Intermediate (Previous Class) has been revisited by the syllabus designers of 'English Praxis Course-I (Sem-I)' for the students of I-B.A/B.Com/B.Sc. They might have contemplated making the beginners accustomed to the new syllabus. It justifies that 'English Praxis Course-I (Sem-I)' can act as a bridge-gaping course that can give a gentle push towards higher education.

**D. Introduction to Soft skills:**

'Soft skills' is an umbrella term that comprises personality traits, social graces, and a facility with language that marks people to varying degrees. We witness that students don't even hesitate to take their lives when they are unable to bear the stress and conflict they face in daily life. The student with soft skills can effortlessly manage turbulent times during the course of life. Students do not come across the segment of soft skills at the level of Intermediate Education. When students take up higher education, they must be provided with certain soft skills that are essential to growing up as adults. The maturity that is acquired by learning soft skills makes the students balance success and failure on the same terms. They choose career paths effortlessly by moving forward despite facing failures and can determine the course of action for the next attempt.

**Findings & Suggestions:**

1. **Adapting experience-based approach**: The praxis course can adapt the experience-based approach that links theory and practice and allows students to participate in real-life situations instead of regular class sessions. Unlike the other subjects, English Language acquisition demands an interactive approach among pairs and groups. Much of the class time should undergo collaborative learning that includes JAM sessions, Group discussions, and role plays instead of being encouraged to learn grammar and spelling rules by heart. The experience-based approach may bring out the students from their comfort zone of expression. It leads to evolving themselves for exposure to the language. Though Reading skills are not addressed in the syllabus of English Praxis Course-I, teachers can facilitate the students to explore comprehension passages for preparing summaries and analyses. As well, the creation of opportunities to participate in Word-building games will enhance students' enthusiasm for learning Vocabulary.

2. **Preference to Functional Grammar:** As we can see, students learn more grammatical patterns at the level of Intermediate Education than in the English Praxis Course-I from semester -I of B.A/B.Com/B.Sc Courses. They might be given much emphasis on practicing exercises by the time they join Higher Education. So, teachers would better encourage them to participate in real-life situations in order to acquire grammar organically. In the English Praxis Course-I, much emphasis is given to functional grammar which lets the students make use of appropriate grammatical patterns in the various discourses.

3. **Computer-assisted Language Learning (CALL):** It is a well-known fact that the coronavirus pandemic has altered the world's perspective of language learning. It made us experience global learning through a single window of technology. Using computers for language learning began in the 1960s. During the age of technology, all learners dwell in the world of machine learning. So, it would be recommended to adopt technological platforms for effective language learning instead of discouraging them from keeping away from technology. Computer-assisted Language Learning (CALL) is identified as a cross-disciplinary science that emerged between 1960 and 1970. Computer-assisted Language Learning (CALL) has recently grown up to make use of various applications and virtual learning platforms. In addition, learning becomes more personalized when CALL has been modulated portable with the usage of mobile phones. It is known as Mobile Assisted language learning which brings global learning into the palm of learners. The platforms like National Digital Library, Swayam Platforms, and Amazon Kindle throw opportunities for learning. With the aid of CALL and MALL, students are offered to listen to Podcasts and watch video discussions in order to enhance their listening and speaking skills.

4. **Adapting 360-degree evaluation to assess soft skills:**
Attitude, SWOC Analysis, Emotional Intelligence, Telephone Etiquette, and Interpersonal skills are the five soft skills which are included in the syllabus of 'English Praxis Course-I(Sem-I)' By only providing experiential learning opportunities through hands-on practice in communication, collaboration, and problem-solving, a teacher can manage to accomplish the objective of instructing soft skills though it's a strenuous exercise for the teachers'. However, the evaluation of soft skills is such a challenging task it is transcendental to draw the results by conducting paper-pen examinations. Some Interviews and personality tests should be conducted to measure students' perspectives toward a problem or a situation. Sometimes they may not bear full-fledged results. So, adapting 360-degree evaluation will make the assessment non-subjective and comprehensive. It will provide a holistic view of assessing students' soft skills. Having feedback from multiple sources under 360-degree evaluation, the teacher can identify the strengths and weaknesses of students in certain areas of performance. Peer feedback plays a pivotal role in 360-degree evaluation for evaluating students' soft skills. In addition, extracting feedback from all the stakeholders will grant us fair and accurate results.

5. **Four Quadrant Generation of Learning Management System (LMS):**
   Based on the application of MALL (Mobile Assisted Language Learning), the Andhra Pradesh Department of Higher Education has come up with an amazing initiative of a Learning Management System (LMS) that brings an ICT classroom to students' mobile phones. Unlike the Department of School Education, they don't entertain corporate companies like BYJU's. Under LMS content generation, many lecturers who are adept and experienced have sorted out to act as master trainers. They are offered training classes in the utilization of various technical platforms like OBS (Open Broadcast Software). Every lecturer has to be part of the LMS content generation in 4 quadrants as claimed by the APCCE.
   1. E-Notes
   2. Presentation (PPT)
   3. Video class
   4. Assessment (Objective)

   Each topic has been formed into the above 4 quadrants, made available in the portal of APCCE (Andhra Pradesh Commissioner of Collegiate Education). The student is supposed to log in using credentials provided by the Department of Higher Education.

**Conclusion:**

As discussed in this paper, the syllabus of English Praxis Course-I plays a prominent role in shaping the learning experiences of students. 'Introduction to English medium', as a mandatory policy was implemented in degree colleges across Andhra Pradesh. Primarily, this study focused on how English Praxis Course-I can act as a bridge course for beginners who have to be accustomed to performing effectively at the level of higher education. This paper explored the various aspects to be adapted to the syllabus for English Praxis Course-I. Computer Assisted Language Learning (CALL), Experience-based approach, and four-quadrant content generation will support the pragmatic implementation of English Praxis Course-I. As well, this paper suggested 360-degree evaluation which is an appropriate technique for the assessment of soft skills. I hope this paper has accommodated precious insights into the best initiatives that have to be adapted by syllabus designers.

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Cover Page

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# FLIPPED CLASSROOM IN ENGLISH LANGUAGE TEACHING AND LEARNING

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**Abstract**
Ever since the dawn of Pedagogy, the process of learning has been done by the Traditional Teacher-Centred System through the age-old lecture method. Educationalists in the modern age opine that students can no longer be just passive recipients of information from the textbooks instead they must be made active learners in the classroom through new educational techniques. It can be noted that the traditional classroom lectures are becoming out fashioned and less interesting. One can observe that the students in modern times have access to the online classes, video tutorials and well-prepared study material and for this reason, the traditional classroom lectures are becoming outdated in the New Age Education Scenario. Today, the educational institutions are expected to provide new learning ambience for developing student's all-round personality. In the light of such emerging trends in the field of education, this paper examines the feasibility of introducing an updated learning activity in the modern classroom scenario called Flipped Classroom Method. The FCM is a new method of reversing the traditional model of classroom in which a student is asked to take part in teaching activity. If the students are engrossed in the discourses and discussions on prescribed syllabus, they can learn the difficult subjects easily. In general, the FCM provides all students an opportunity to use technology at home to explore, analyse, evaluate the assigned topics, then discuss and present the same in the classroom. In particular, this paper attempts to explicate how such flipped classroom can provide a platform for the students of English Language to develop their Communication Skills through practical involvement in teaching activity and also strengthen their personality through Peer Group Interactions. Finally, the paper shows how a sage like teacher on the stage can help students to free themselves from the cage of classroom and engage themselves in delightful and Positive Learning Activity.

**Keywords:** Pedagogy, Traditional Classroom, New Age Education, Flipped Class Room, Discourses, Practical Involvement, Personality and Positive Learning Activity.

The learning and proficiency in English for engineering students is extremely important if they want to pursue their career aspirations globally. To impart English language skills, teachers prefer student centric teaching methods to teacher centred methods for various reasons. First, Student Centred Learning encourages students with diverse learning needs, and it augments their retention of knowledge and skills (Baeten et al., 2013; Thanh, 2010).Student-centred approach allows the learners to explore knowledge across a wide range of disciplines, use creative and critical problem-solving skills, express themselves confidently, and learn how to work both independently and in collaboration with their peers. In student-centred learning, the teacher is still the classroom but functions as a facilitator and the students embrace a more active and collaborative role in their own learning. In the classroom, students are expected to make every effort to make sense of what they are learning by linking it to prior knowledge and by discussing it with the peers. (Brophy ,1999)

In the present scenario, the teacher's role is shifting with the changing trends in modern day technologies. The students today have access to the online classes, audio video lectures and authentic materials and so the traditional classroom lectures are becoming out fashioned, less interesting, and ineffective. Moreover, the role of the teacher is becoming even more challenging to teach employability skills to students with which they can strive up to the expectations of the new age employers. In order to disseminate knowledge in the modern classroom, several innovative teaching practices have come into existence.

In the light of such innovative ideas, this paper, in general, presents the feasibility of introducing an updated teaching and learning activity in the modern classroom scenario. Particularly, it discusses the feasibility of flipped classroom method in the field of English language teaching (ELT). The paper further discusses how the modern pedagogic model can provide

Cover Page

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an opportunity to gain exposure to the new ideas and concepts outside the classroom via e-journals, online lectures, subject manuals, video tutorials, power point presentations and focused reviews.

**The Evolution of Flipped Class Model**

Despite distinct methods of teaching were created by the researchers in the field of education, the modern students are seemingly less enthusiastic in traditional model of classroom pedagogy. The teacher, using the lecture-style, acts as the sole disseminator of knowledge and the student remains as passive observer. In a traditional classroom, it is not certain whether all the students comprehend the lessons properly and equally. Conversely, the modern teaching-method namely the flipped classroom, deliberately transforms the classrooms as the centres of community learning and offers new learning prospects. The learners generally have a more active role and ultimate responsibility for their understanding (Gallagher, 2009).

A new technological movement in education, flipped class opens opportunities for free flow of information and this innovative style of imparting knowledge is gaining special attention among academic circles. This new pedagogical strategy overturns the conventional type of learning ambience by providing teaching content often online, outside the school or college. The learners, with the guidance of mentors, watch the online lectures, participate in online discussions, or embark on research projects at their homes and also involve in discussions and debates for gaining the conceptual clarity in their respective subjects. This shift in focus to the provision of student cantered learning, coupled with the pervasiveness of technology, has suggested a change in the role of the teacher from a 'knowledge provider' to a 'knowledge resource' due to "self-access to information", a key feature of technology (Trebbi, 2011).

**The significance of Flipped Classroom**

The primary objective of education system is to expand the horizons of the knowledge of students and motivate them to create innovative ideas. It is through which the learner modifies his/her behavior as a result of practice or experience. In order to materialize such ideals, the Flipped Classroom has come into existence as a new experiment in teaching which is totally unique from the centuries-old classroom teaching. Besides freedom in learning, the students master the skills with peer interactions in this model. The researchers found the method more advantageous to promote teaching and learning. Research in this area informs that students cannot reach their full potential by passively listening to the teacher. They must actively participate themselves in higher-order thinking tasks like analysis, synthesis, and evaluation. Such active participation is only possible though flipped classroom method. Flipped Learning Network established four pillars of flipped learning that represent key practices in this model of teaching.

The acronym "FLIP" gives an overview of these elements:
F: Flexible Environment
L: Learning Culture Shift
I: Intentional Content
P: Professional Educators
(Hamdan, McKnight, McKnight, & Arfstrom, 2014)

Flipped Classroom Model was first popularized in USA by experienced teachers namely Aaron Sams and Jon Bergman. According to their model, the lessons are delivered by video recordings to provide free time to students to take part in knowledge explorative activities. The students are engaged in problem solving debates and active learning process. These modern-day students wish to educate themselves by means of audio/video lectures and take part in intellectual discourses to avoid the fatigue generally found in classroom learning. The pre-recorded lectures incorporated in video recordings are given to students for their learning activity at home. As certain learning activities cannot be automated or computerized, they are instructed to take part in interactive sessions. One can also observe that this flipped classroom ideology is being promoted by several websites. Instructors recommend flipped model as it helps to utilize the time effectively (Cole, 2009).

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Besides active participation, it also facilitates more active learning opportunities for students (Gannod, Berg & Helmick, 2008). It also makes the student responsible for learning (Overmyer, 2012).

**Conceptual Framework of FCM**

The process design and the conceptual framework of FCM depicted here under are practicable in the reformation of the existing style of pedagogy. The process design of learning in a flipped classroom helps to gain new knowledge and ideas in an atmosphere of academic freedom.

- Teachers prepare the learning materials and post them.
- Students watch and later clarifies in the classroom.
- Students take instructions to complete the activities and tasks.
- Teacher monitors and facilitates.

The new educational technique re-orders classroom and at-home activities and engages the students in group learning activities inside the classroom and personal computer based individual learning at one's own residence. The traditional teaching method in classrooms turns upside down delivering instruction online outside the class and shifting the homework into the classroom. In order to reap better results through this model the teacher has to identify the needs and aptitude of students and make them ready for receiving knowledge. Then they must be engaged in either Project-Based Learning (PBL) or Game-Based Learning (GBL). Effective and appropriate technology must be used for yielding good results through this method. The students' opinions and reflections should be taken into consideration for understanding the effectiveness of this new teaching scheme. Taking different individual learning styles into consideration, proper strategies should be formulated.

The flipped classroom method in ELT has been gaining popularity in recent times. Normally in ELT, speaking and writing abilities are the most commonly studied language skills. As the flipped classroom optimizes student-teacher interactions, every ELT teacher strives for making use of such effective method. The methods of enriching learning vocabulary, improving the knowledge of syntax and manner of pronouncing the words in RP can be learnt online. Communicative activities such as pair and group work can be more efficient in flipped model than done through self-study in the class which is not flipped. Through this model, the difficult concepts such as Voice of Verb or Reported Speech can be taught easily through video lessons even to the slow learners.

Owing to a flexible and autonomous learning atmosphere, the flipped classroom is very suitable for language classes. Because the teacher can spend the class time in the interactive activities namely, dialogues, demonstrations, and deliberations. English Language Teachers can prepare the students by providing the self-guided grammar tutorials and graphical presentations of the intricacies of language learning. Some of the innovative language learning models are presented here for authenticating the contention that English language learning is easier in flipped class. The Classification of English Studies, various categories of English Language and the important elements of Literature can be learnt conveniently with help of the following figures shown through audio- visual aids

Among the myriad of benefits related to the use of the flipped classroom method in English as a foreign language (EFL) classroom is the learners become responsible students with improved learning capabilities. Further, learners work collaboratively to achieve a common goal. They discuss and comprehend the concepts with ease. Student in flipped learning becomes an autonomous learner. The method also helps the learners to think critically to solve the problems effectively. During this journey, learners develop teamwork, team spirit and intrapersonal skills.

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**Prospects of Flipped Classroom**

Now-a-days, employers are emphasizing on writing skills along with the listening, speaking and reading skills in English language. In the job selection process, the writing abilities of the students are tested. Thus, the aspirants to be thorough in precis writing, summary writing and report writing. During the job recruitment process, the students may be asked to develop an argument, write an analysis, compare and contrast or to present a report.

To accomplish these tasks the student should practice and master various sentence structures in English language. Besides the basic skills like conciseness, clarity, courtesy, correctness, other writing devices like coherence, usage of cohesive devices plays a significant role in writing.

The teacher can impart such skills to the learner through flipped classroom method. The teacher can present various lectures on simple, complex, and compound sentences and its role in precis and summary writing. The learner can access to the lectures on linkers- coordinate, subordinate conjunctions, adverbial connectives before writing an argumentative essay or in analytical writing. The online lectures on active and passive voice, sequence of tenses, direct and indirect speech, and their relation to write an article or to prepare a report helps the students either to acquire knowledge or to master the writing skills.

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# ~Contents~



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# Exploring English Teacher Identity in Andhra Pradesh's Single Major Degree Honors Programs: Insights from Online Forums

Sulochana B, Radha Devi V & Mercy Miriam P

**Abstract**

This research investigates the potential impact of implementing single-major degree Honors programs within Andhra Pradesh's Degree Colleges on the identity of English teachers. The limitation of General English instruction to two semesters raises concerns about potential identity erosion. Through focused observation of an exclusive online forum dedicated to English teachers engaged in teaching General English at Andhra Pradesh's Degree colleges, this qualitative study unveils nuanced perspectives on the impending changes. Thematic analysis underscores apprehensions about professionalism and adaptability, while also spotlighting prospects for innovation and interdisciplinary collaboration. This research enriches the discourse surrounding teacher identity in the context of evolving educational paradigms, providing valuable guidance for policymakers and educational institutions. A comprehensive understanding of these dynamics holds paramount importance in upholding educational quality and ensuring the well-being of educators amidst curriculum transformations.

**Keywords:** English teacher identity, Single Major Degree Honors programs, Andhra Pradesh, qualitative research, thematic analysis.

## Introduction

### Teacher Identity in Higher Education

Teacher identity is a multifaceted construct shaped by various factors, including pedagogical practices, curriculum design, and institutional contexts. Research by Beijaard et al. (2004) underscores the dynamic nature of teacher identity and its susceptibility to influence from external factors, including instructional time constraints. Additionally, Flores (2019) highlights those teachers' perceptions of their roles can undergo transformation when confronted with shifts in the curriculum.

### National Education Policy (NEP) 2020 and Single Major Degree Programs

The education landscape is undergoing a transformative phase driven by the mandates set forth in the National Education Policy (NEP) 2020. This policy shift encompasses various aspects of higher education, including the introduction of single-major degree Honors programs in degree colleges. This paradigmatic change not only redefines the academic structure but also presents novel opportunities and challenges for educators, students, and institutions alike. A cornerstone of the NEP 2020 is the introduction of single-major degree Honors programs. These programs bear the distinctive mark of embracing multiple exits and

entries, enabling students to navigate their academic journey at their own pace. This progressive approach is rooted in the recognition of diverse learning pathways and the acknowledgment that one-size-fits-all models no longer cater to the multifaceted aspirations of learners. Integral to the re-imagined education landscape is the prioritization of skill development.

These single-major degree programs are designed to elevate students' skill sets, ensuring they emerge not only as subject-matter experts but also as well-rounded individuals prepared for a dynamic global workforce. Moreover, the incorporation of multidisciplinary subjects underscores the importance of fostering holistic and adaptable perspectives in students. While the NEP's reforms bring forth a wave of optimism, they also pose certain challenges. The implementation of such comprehensive changes demands the active involvement of educators, necessitating adaptations in teaching methodologies and curriculum design. Simultaneously, these reforms open avenues for innovative pedagogies, interdisciplinary collaboration, and the cultivation of student agency.

**Scope of the Study**

Amidst this educational transformation from the academic year of 2023-24, this study aims to dig into the perspectives of English teachers within the context of Andhra Pradesh's Single Major Degree Honors programs. By exploring how these changes may impact teacher identity and instructional practices, the research seeks to contribute to the discourse on education's evolving landscape.

In essence, the introduction of Single Major Degree Honors programs in accordance with the NEP 2020 signifies a progressive shift toward learner-centric education. This change not only introduces new academic frameworks but also necessitates a revaluation of pedagogical approaches and educational philosophies. Through a thorough examination of these changes and their implications, educators and institutions can effectively navigate the evolving landscape and contribute to the holistic development of students. This structure integrates the key points you provided into a coherent introduction that sets the stage for the rest of your research paper. It establishes the context, introduces the changes brought about by the NEP, highlights the significance of skill development and interdisciplinary education, and outlines the scope and objectives of your study.

**Contribution and Significance of the Study**

This research study, undertaken in anticipation of the implementation of Single Major Degree Honors programs, assured to make a pioneering contribution by exploring an uncharted territory. As the first endeavor of its kind in the specific context of the new academic framework in Andhra Pradesh, this study holds the potential to inform educators and institutions about the challenges and opportunities that lie ahead. Its insights can facilitate educators in adapting to the changes while preserving the essence of their professional identity. Additionally, the study's findings will serve as a foundation for future research endeavors, laying the groundwork for a deeper understanding of teacher identity in an era of transformative educational paradigms.

## Methodology

This qualitative study adopts a focused observation approach to gather insights from an exclusive online forum dedicated to English teachers engaged in teaching General English at Degree colleges of Andhra Pradesh. Focused observation allows for an in-depth exploration of participants' discussions, capturing their perspectives on the potential impact of Single Major Degree Honors programs on their identity. Forum discussions, comprising threads related to the implementation of Single Major Degree Honors programs, General English instruction, and teacher identity, serve as the primary data source. Relevant discussions, comments, and interactions are documented through screenshots, ensuring a comprehensive representation of viewpoints. Participants in the online forum are English teachers currently teaching General English at Andhra Pradesh's Degree colleges. A union of Language educators put forth a memorandum regarding the language teacher's identity, prompted by the implementation of Single Major Degree Programs. This document was communicated through the English Teachers' Online Forum, a platform fostering discussions. The core issue revolved around the proposal to restrict General English instruction to the initial two semesters. The memorandum stressed that such a restriction obstructs students from pursuing postgraduate studies in languages, curbing their prospects for language-focused research. This limitation bears the risk of negatively impacting the very essence of language teacher identity. Consequently, the union rallied all English educators to unite in advocating for the continuous integration of language studies throughout the entirety of the four-year degree program.

Ten (10) English teachers took part in the conversation, sharing their diverse viewpoints and underscoring the perspectives shared within the broader language forum. This discourse illuminated the complex interplay between instructional choices, language education, and the fundamental components of 'English Teacher Identity'. It also showcased the significance of collaborative efforts in shaping the educational landscape. It is interpreted in the table below

| S No | Participant | Comment through an English Forum |
|---|---|---|
| 1 | A | Takes it as a serious issue. |
| 2 | B | B is concerned about the plight of language in higher education. |
| 3 | C | Emphasized the above comment |
| 4 | D | Asserted to raise voices as mentioned in memorandum |
| 5 | E | Recalled that the UGC document contemplates continuing languages for two years in 4 semesters and questioned A.P Council for Higher Education for ignoring the UGC DOCUMENT. Also confining English instruction will be the reason for incapable of written communication which is necessary to attempt the high level exams like Group-I and Civil Services. Participant E was also concerned about becoming the producers of waiters and servants of the West instead of producing authors and poets. |

| | | |
|---|---|---|
| 6 | F | Emphasized the words of participant 'E' and the importance of Communication Skills. |
| 7 | G | Participant G suggested a venue to meet and discuss the issue. He said we would strongly recommend adding English in the two more semesters. |
| 8 | H | Emphasized the words of participant 'G' |
| 9 | I | Participant I recalled that there was English instruction in 4 semesters. Then it was reduced to three. Now in the single major degree honours, it is reduced to two. |
| 10 | J | Participant J who belongs to Acharya Nagarjuna University said they have General English instruction till 2021 in the affiliated colleges of Acharya Nagarjuna University. Participant K emphasized the opinion of Participant J. |

**Findings & Discussions**

This thematic analysis delves into an online forum conversation regarding the proposed changes in English instruction within Andhra Pradesh's Single Major Degree Honors Programs. The analysis specifically focuses on the potential impact of these changes on English teacher identity, as expressed by participants in their discourse. It has been initiated on the opinions of English teachers for the Educators' Union Memorandum on English Teacher Identity in Andhra Pradesh's Single Major Degree Honors Programs via an Online Forum. The present thematic analysis delves into a memorandum issued by a union of language educators, addressing the intricate theme of teacher identity in the context of the introduction of Single Major Degree Programs in Andhra Pradesh. The memorandum was disseminated through the platform of the English Teachers' Online Forum, which facilitated an extensive discussion among English educators. The central concern of the memorandum was the proposition to restrict the teaching of General English solely to the first two semesters, which, according to the union, could potentially have far-reaching consequences on both language education and the identity of language teachers.

**Theme 1: Recognition of Seriousness and Importance**

Participant A's initial comment and the subsequent agreements from Participants B and C reflect the recognition of the seriousness of the issue at hand. The theme emphasizes that the proposed changes in English instruction hold significant implications, sparking collective concern among participants.

**Theme 2: Challenge to Established Norms and Ignoring UGC Guidelines**

Participant E's elaboration highlights the theme of challenging established norms and guidelines. The mention of the UGC document and the question raised about the A.P. Council's adherence to it emphasizes the potential discord between official guidelines and proposed changes. This theme reflects participants' concerns about the integrity of the educational framework and its impact on English teacher identity.

**Theme 3: Communication Skills and Professional Preparedness**

Participant E's apprehensions about compromised written communication skills, particularly for exams like Group I and Civil Services, shape this theme. The notion that restricted English instruction might hinder students' ability to excel in professional assessments is tied to the concept of teacher identity. The theme underscores the relationship between educational changes and teachers' role in preparing students for their futures.

**Theme 4: Shaping Societal Roles and Identity:**

Participant E's concerns about producing "waiters and servants" rather than authors and poets speak to the theme of societal roles and identity. This theme underscores the broader impact of educational changes on students' prospects and, consequently, how English teachers perceive their role in shaping these prospects.

**Theme 5: Emphasis on Communication Skills and Collaborative Action:**

Participant F's alignment with Participant E's perspective reinforces the theme of communication skills. The importance of fostering effective communication aligns with the core responsibilities of English teachers. Additionally, Participant G's suggestion for a collaborative meeting and advocacy emphasizes the theme of collective action in preserving English teacher identity amidst proposed changes.

**Theme 6: Evolution of Curriculum and Institutional Legacy:**

The recall by Participants I and J regarding the evolution of English instruction in the curriculum and its continuity within specific institutions highlights the theme of curriculum evolution and institutional legacy. This theme reflects how changes in instructional content over time can impact English teacher identity and the traditions associated with their teaching.

## Conclusion

This thematic analysis emphasizes how the proposed changes in English instruction within Andhra Pradesh's Single Major Degree Honors Programs have implications beyond the academic realm. The discussion reveals concerns about the erosion of English teacher identity due to potential shifts in curriculum focus and societal roles. The themes collectively highlight how changes in educational paradigms can impact English teachers' perception of their roles, the skills they aim to impart, and their connection to broader educational frameworks.

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# EXPANDING HORIZONS: ENGLISH MEDIUM EDUCATION IN THE GENERAL U.G PROGRAMMES OF ANDHRA PRADESH

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**ABSTRACT**__This study investigates the effects of the Government of Andhra Pradesh's implementation of mandatory English medium education in General Undergraduate Courses. Through a quantitative survey conducted among multi-disciplinary educators working in Government Degree colleges, the strengths and weaknesses of this policy are examined. The shift from the National Policy of Education-2020, which prioritizes mother tongue instruction, has triggered discussions among educationalists. Utilizing a Google Form survey, insights are gathered regarding the perceived advantages and drawbacks of the participating educators. The findings contribute to an understanding of the implications of compulsory English medium education on equipping students with global competencies for their future careers. This research informs policymakers and stakeholders in making informed decisions regarding language policies in higher education.

**KEYWORDS**__English Medium Education, Andhra Pradesh, Transition, Undergraduate Courses, Training Programs

## 1. Introduction

According to Brown (1990), "Language is the road map of a culture. It tells you where its people come from and where they are going" (p. 123). A notable recent development in Andhra Pradesh's educational sphere is the implementation of a compulsory English medium education policy for General Undergraduate Programmes of B. A, BCom, B.B.A and B.Sc., taking effect from the academic year 2021-22.". In the Degree Colleges of A.P., 65,989 students were admitted out of 2.62 lakh students in Telugu Medium in the Academic Year of 2020-21.

### 1.1. Background of the Study:

During the academic year of 2020-21, Andhra Pradesh witnessed a remarkable enrolment of 2.62 lakh students in Degree Colleges, out of which a noteworthy 65,989 students opted for instruction in Telugu Medium. Surprisingly, despite the absence of a compulsory requirement, a significant 75% of students voluntarily chose English Medium education. Recognizing this prevailing preference, the Andhra Pradesh State Council of Higher Education (APSCHE) promptly introduced the mandatory adoption of English Medium education in general Undergraduate (U.G) programs offered by Degree Colleges. This perspective considers the progressive nature of language acquisition and acknowledges the potential complexities that arise when switching educational mediums at an advanced stage. By advocating for English medium education in core subjects and facilitating a gradual transition,

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particularly during intermediate and degree programs, the government aims to facilitate greater linguistic competence and better equip students for academic and professional success.

**1.2. Recommendations of National Policy of Education-2020:**

In line with the National Education Policy 2020 (NPE-2020), the suggestion to embrace the mother tongue, local language, or regional language as a medium of instruction has been put forth. This recommendation stems from the understanding that children naturally begin their educational journey in their native language, a concept not limited to our country alone.

However, taking into consideration the demands of global competitiveness, the Government of Andhra Pradesh has taken a proactive stance by implementing mandatory English medium education. This decision follows the recent introduction of compulsory English medium education at the school level, which was initiated just a year ago. To address the challenges associated with the implementation of mandatory English medium education, the Commissioner of Collegiate Education in Andhra Pradesh took a significant step in April 2023. A comprehensive Training of Trainers (TOT) program was conducted for 100 lecturers with English Proficiency from various disciplines across the state. This two-week training initiative carried out in collaboration with the English & Foreign Languages University (EFLU) in Hyderabad, aimed to equip the lecturers with the necessary skills. Subsequently, these trained lecturers, acting as master trainers, assumed the responsibility of conducting training programs for content lecturers at 18 Nodal Resource Centres (NRCs) across Andhra Pradesh.

This comprehensive endeavor seeks to address concerns and facilitate the successful implementation of mandatory English medium education. By providing specialized training and support to lecturers, the government aims to create an environment conducive to effective English language instruction while acknowledging the need for a balanced approach that values the importance of regional languages.

**1.3. Purpose of study:**

This study holds the promise of providing profound insights into the effective implementation of English Medium Education. By examining the strengths and weaknesses of this educational policy in Andhra Pradesh, it has the potential to shed light on the key factors influencing its success and impact. By delving into the experiences and perspectives of multi-disciplinary educators in Government Degree colleges, the study can offer valuable insights into the challenges, benefits, and implications of mandatory English medium education.

**2. Review of Literature:**

As Naoko Taguchi (2014) stated that the goal of English -medium education is to broaden students' general and specialized knowledge in academic subjects and to promote professional expertise in English that enables students to take leadership in the international community. In such a context, English is viewed as a tool for academic study, not as the subject itself.

Guang Wei (2019) mentioned the popular strategy of internationalizing higher education is to provide English Medium Instruction in Higher Educational Institutions.

The implementation of mandatory English medium education in the General U.G. programs of Andhra Pradesh has sparked significant debates and discussions among educators, policymakers, and researchers. This literature review aims to explore the existing research and scholarly discourse surrounding this topic, shedding light on the various perspectives, challenges, and implications associated with this policy shift.

3. **Methodology**

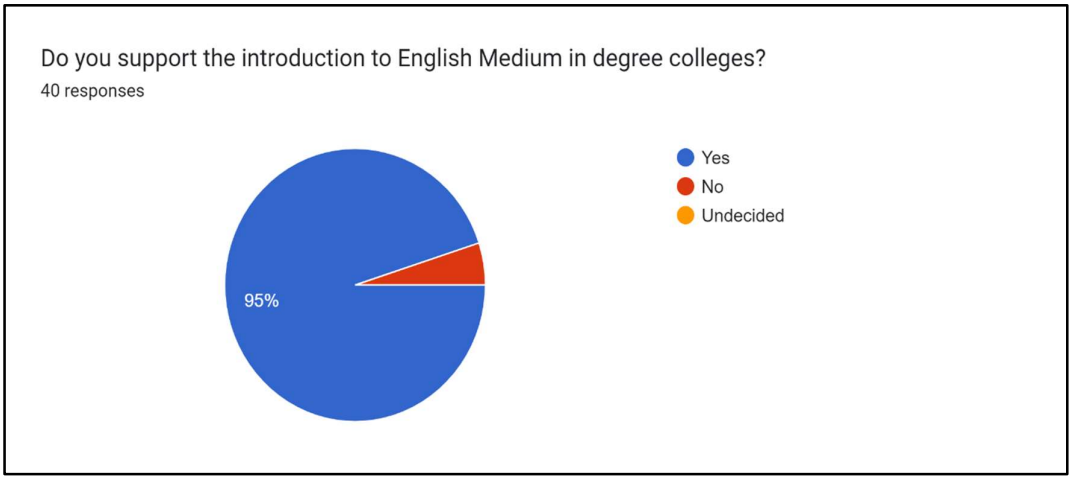
A cohort comprising 40 lecturers from diverse disciplinary backgrounds actively participated in a comprehensive questionnaire administered through a Google Form. The questionnaire was thoughtfully

ISSN: 2173-0695

designed, encompassing 4 meticulously crafted questions that aimed to elicit genuine and insightful feedback. This strategic approach ensured that all dimensions of opinions from these key stakeholders were effectively captured, allowing for a nuanced exploration of their viewpoints.

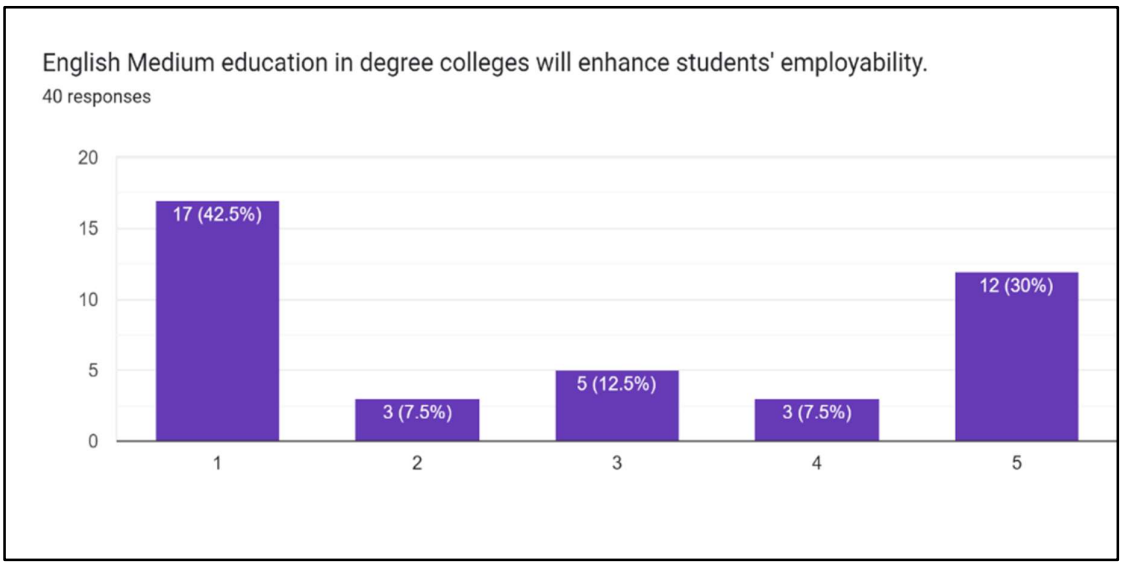
## 4. Findings & Analysis

**Q. No:1**




The data from the questionnaire reveals a significant level of support among lecturers, with 95% expressing their endorsement of English medium education in degree colleges of Andhra Pradesh. This overwhelming support suggests a consensus among the surveyed lecturers regarding adopting English as the primary medium of instruction. The high level of support could be attributed to the recognition of English as a global language of communication and its perceived significance in equipping students with the necessary skills for future career opportunities. However, it is important to conduct further analysis that considers additional factors such as discipline, teaching experience, and other demographic variables to gain a more comprehensive understanding of the lecturers' perspectives and the underlying motivations behind their support for English medium education.

**Q. No:2**




According to the survey results, 42.5% of respondents strongly agreed that English Medium education in degree colleges will enhance students' employability. This finding highlights the perception among a significant portion of participants that proficiency in English, as imparted through the medium of

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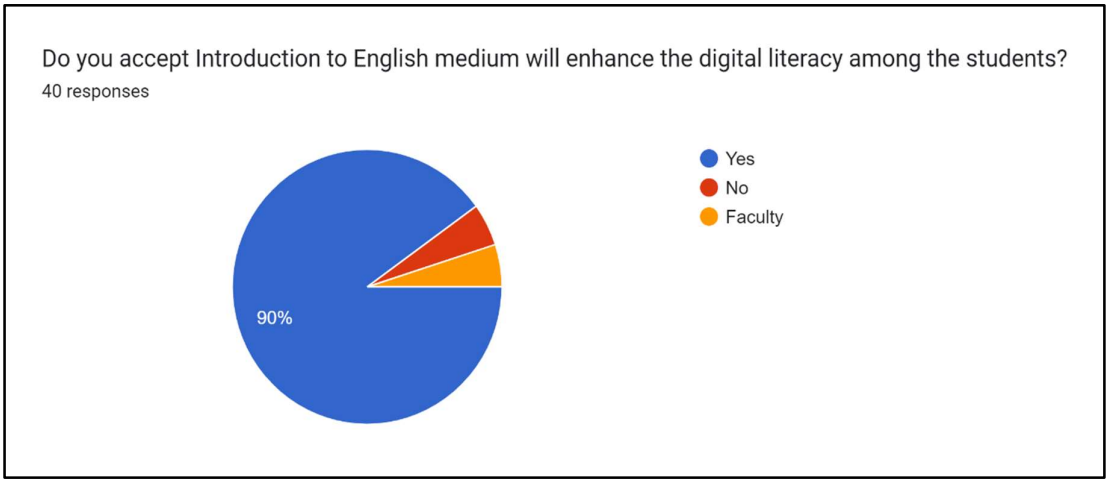
BOLETÍN DE LITERATURA ORAL, 10 (2023), PP. 471-476

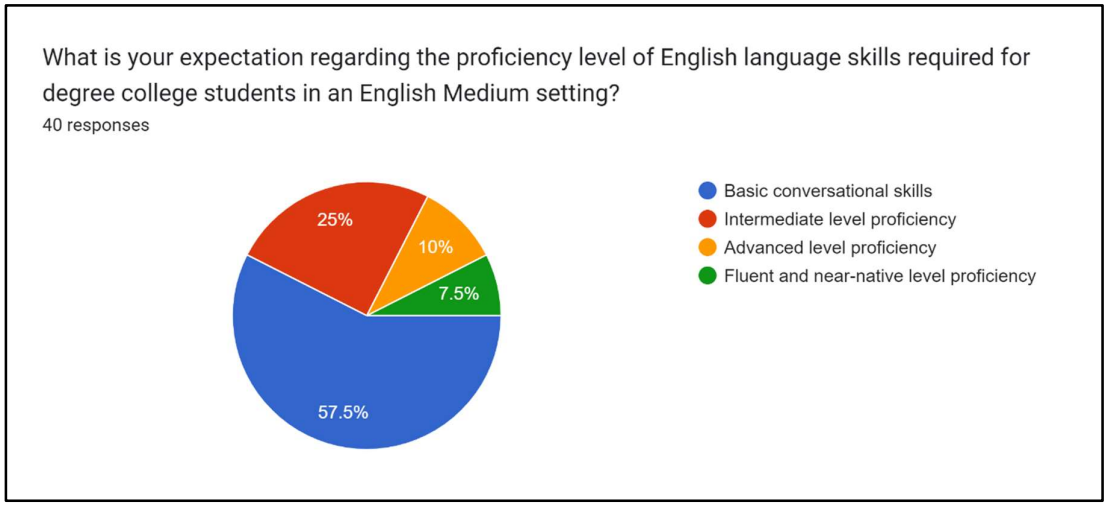
instruction, plays a crucial role in improving students' prospects in the job market. The high percentage of strong acceptance suggests a widespread belief in the positive impact of English Medium education on enhancing employability skills among degree college students.

**Q. No: 3**




The data reveals that 90% of the respondents accepted the statement that the introduction of English medium education will enhance digital literacy among students. This indicates a strong consensus among the participants regarding the potential positive impact of English medium instruction on students' digital literacy skills. Most respondents recognize that studying in English can facilitate access to digital resources and foster the development of language and technical competencies necessary for effective digital engagement. However, further examination of the viewpoints of the remaining 10% of respondents who did not accept the statement would provide valuable insights into their perspectives and contribute to a more comprehensive understanding of the relationship between English medium education and digital literacy enhancement.

**Q. No: 4.**




Based on the responses to the question, most respondents (57.5%) expressed the expectation that degree college students in an English Medium setting should possess basic communication skills in English. This suggests that they consider a foundational level of English proficiency as sufficient for students to navigate their academic requirements and effectively communicate in English. A significant portion

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of respondents (25%) expected students to have intermediate-level proficiency, indicating a desire for a higher level of English language skills among degree college students. This expectation likely reflects the belief that students should possess a more comprehensive grasp of the language to engage in more complex academic tasks and effectively participate in discussions and presentations. A smaller percentage of respondents (10%) anticipated that students should demonstrate advanced-level proficiency in English. This indicates a preference for a higher degree of language mastery, possibly driven by the perception that advanced language skills are crucial for academic excellence and future career prospects. A minority of respondents (7.5%) expected students to possess fluent and near-native level proficiency. This suggests an aspiration for a high standard of language fluency and competence, possibly emphasizing the importance of achieving native-like proficiency for academic success and international opportunities.

These responses highlight the diverse expectations regarding the required English language proficiency levels for degree college students in an English Medium setting. Understanding these expectations can inform curriculum development and language support initiatives to meet the varying needs and aspirations of students in their English language learning journey.

**5. Limitations**

While this research endeavour aimed to gather valuable insights from a group of 40 lecturers representing various disciplinary subjects, it is important to acknowledge certain limitations that may have influenced the study. The sample size of 40 lecturers may not fully represent the diverse perspectives and experiences of all lecturers in the field. Generalizing the findings to a larger population should be done with caution. The design of the questionnaire itself may have limitations in capturing the full complexity of the lecturers' opinions or gathering nuanced responses. Future studies could consider expanding the scope by including a more diverse range of participants from various educational institutions or regions to enhance the generalizability of the results.

**Conclusion**

In conclusion, the research study highlights the widespread support of multi-disciplinary teachers for the introduction of English medium education in degree colleges. While recognizing the advantages of English resources and global competitiveness, teachers acknowledge the challenges related to rural backgrounds and local accents. They emphasize the importance of training programs like TOTs, time for transition, and ongoing English proficiency initiatives. Collaborative efforts between teachers, institutions, and the education department are essential for successful implementation and the realization of the benefits of English medium education.

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# Exploring English Teacher Identity in Andhra Pradesh's Single Major Degree Honors Programs Insights from Online Forums

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## Abstract

This research delves into the potential repercussions of introducing single-major degree Honors programs in Degree Colleges of Andhra Pradesh on the identity of English teachers. With General English instruction limited to two semesters, there is a concern about possible identity erosion. Through in-depth observation of an exclusive online forum dedicated to English teachers in Andhra Pradesh, this qualitative study uncovers nuanced perspectives on the imminent changes. Thematic analysis highlights concern about professionalism and adaptability, while also shedding light on opportunities for innovation and interdisciplinary collaboration. This study contributes to the discourse on teacher identity amid evolving educational paradigms, offering valuable insights for policymakers and educational institutions. A thorough understanding of these dynamics is crucial for maintaining educational quality and ensuring the well-being of educators during curriculum transformations.

Keywords: Single-major degree Honors programs, General English instruction, Identity erosion, Online forum, Thematic analysis.

## 1. Introduction

Teacher Identity: Dynamic Influences:
Teacher identity is a complex and multifaceted construct, moulded by a myriad of factors such as pedagogical practices, curriculum design, and institutional contexts. Beijaard et al. (2004) assert through their research that teacher identity is a dynamic entity, prone to being shaped by external influences, with instructional time constraints being one such factor. Furthermore, Flores (2019) emphasizes that teachers' perceptions of their roles can undergo significant transformation in response to changes in the curriculum. This underscores the intricate interplay of various elements that contribute to the nuanced nature of teacher identity.

Educational Shift: English Perspectives:
Amidst the educational transformation unfolding in the 2023-24 academic year, this study delves into the perspectives of English teachers within the framework of Andhra Pradesh's Single Major Degree Honors programs. With a focus on understanding how these changes may influence teacher identity and instructional practices, the research aims to contribute valuable insights to the ongoing discourse on the evolving landscape of education.

The advent of Single Major Degree Honors programs aligned with the NEP 2020 signifies a progressive shift toward learner-centric education. Beyond introducing new academic frameworks, this transformative initiative demands a re-evaluation of pedagogical approaches and educational philosophies. Through a meticulous examination of these changes and their far-reaching implications, educators and institutions can adeptly navigate the shifting landscape, actively contributing to the holistic development of students.

This research seeks to unravel the intricacies of the evolving educational paradigm, shedding light on the nuanced impact of single-major degree Honors programs on English teachers. By doing so, it aims to provide a comprehensive understanding that can guide educators, policymakers, and institutions in effectively embracing and implementing these changes for the benefit of all stakeholders.

NEP 2020: Educational Evolution:
The educational landscape is undergoing a transformative shift propelled by the mandates outlined in the 2020 National Education Policy (NEP). This policy overhaul extends across various facets of higher education, notably introducing single-major degree Honors programs in degree colleges. Beyond reshaping academic structures, this paradigmatic change presents both unprecedented opportunities and challenges for educators, students, and institutions.

Central to the NEP 2020 is the pioneering introduction of single-major degree Honors programs. These programs stand out for their embrace of multiple exits and entries, empowering students to navigate their academic journey at their own pace. This progressive model is founded on the recognition of diverse learning pathways, acknowledging that one-size-fits-all approaches no longer cater to the multifaceted aspirations of learners.

A key aspect of the reimagined education landscape is the prioritization of skill development. These single-major degree programs are meticulously crafted to enhance students' skill sets, ensuring they emerge not only as subject-matter experts but also as well-rounded individuals ready for the dynamic global workforce. Furthermore, the inclusion of multidisciplinary subjects underscores the importance of fostering holistic and adaptable perspectives in students.

While the NEP's reforms instill optimism, they also present challenges. The comprehensive nature of these changes necessitates active engagement from educators, prompting adaptations in teaching methodologies and curriculum design. Simultaneously, these reforms open avenues for innovative pedagogies, interdisciplinary collaboration, and the cultivation of student agency, fostering an environment conducive to the evolving needs of education.

Pioneering Perspectives: Single Major Degree Honors in Andhra Pradesh:
Embarking on the eve of the anticipated implementation of Single Major Degree Honors programs, this research study stands as a groundbreaking endeavour, poised to pioneer exploration into uncharted territory. As the inaugural initiative in the specific context of Andhra Pradesh's new academic framework, the study holds the promise of offering valuable insights to educators and institutions, unravelling both challenges and opportunities on the horizon. Its findings are poised to guide educators in adapting to forthcoming changes while preserving the core of their professional identity. Furthermore, this research lays a robust foundation for future endeavors, contributing to a deeper understanding of teacher identity amid transformative educational paradigms.

## 2. Methodology

This qualitative research employs a focused observation methodology to glean insights from a specialized online forum dedicated to English educators involved in teaching General English at Degree colleges in Andhra Pradesh. The focused observation approach allows for a thorough exploration of participants' discussions, capturing their perspectives on the potential implications of Single Major Degree Honors programs on their professional identity. The primary data source consists of forum discussions encompassing threads related to the implementation of Single Major Degree Honors programs, General English instruction, and teacher identity. To ensure a comprehensive representation of viewpoints, relevant discussions, comments, and interactions are meticulously documented through screenshots.

The participants in the online forum are English teachers currently engaged in teaching General English at Degree colleges in Andhra Pradesh. The impetus for this study stems from a memorandum put forth by a coalition of language educators, prompted by the introduction of Single Major Degree Programs. This memorandum, disseminated through the English Teachers' Online Forum, catalyzes discussions on various facets of the proposed changes. The central issue revolves around a proposal to confine General English instruction to the initial two semesters of the degree program. The memorandum emphasizes that such a restriction poses a hindrance to students aspiring to pursue postgraduate studies in languages, thereby limiting their opportunities for language-focused research. This limitation is perceived as a potential threat to the core identity of language teachers. Consequently, the union of English educators is mobilizing to collectively advocate for the continuous integration of language studies throughout the entire four-year degree program.

A total of ten English teachers actively participated in the dialogue, contributing a rich tapestry of diverse viewpoints that echoed throughout the broader language forum. This discourse served as a revealing exploration into the intricate interplay among instructional decisions, language education, and the foundational elements of 'English Teacher Identity.' The conversation underscored the profound importance of collaborative endeavors in shaping the educational landscape, as elucidated in the table below.

## 3. Study

In a recent exchange on the English Forum, participants engaged in a meaningful discussion surrounding the status of English instruction in higher education. The following is a descriptive breakdown of the contributions made by each participant:

Participant 'A' expresses a serious concern, treating the issue with gravity. Participant 'B' highlights worries about the status of language in higher education. Participant 'C' reinforces and emphasizes the concerns expressed by Participant A. Participant 'D' advocates for collective action and aligns with the memorandum. Participant 'E' recalls UGC guidelines, questions the deviation of A.P Council for Higher Education, and emphasizes the risk of hindering essential written communication skills. Expresses concern about potential roles as service providers rather than creators of literature. Participant F reinforces the sentiments expressed by Participant E and underscores the importance of Communication Skills. Participant G proposes a meeting venue to discuss the issue, strongly recommending the continuation of English instruction in the additional two semesters. Participant H echoes and emphasizes the viewpoint of Participant G. Participant I recollects the historical evolution of English instruction, noting reductions from four to three semesters and now to two in Single Major Degree Honours programs. Participant J, from Acharya Nagarjuna University notes the presence of General English instruction until 2021 in affiliated colleges, supported by Participant K.

The participants collectively provide a diverse range of perspectives, contributing to a comprehensive discussion on the evolving landscape of English instruction in higher education. Their insights encompass concerns, historical context, and potential consequences of current policy changes, reflecting the depth and complexity of the topic at hand.

## 4. Findings and Discussion

This thematic analysis explores an online forum conversation centered around proposed modifications to English instruction within the Single Major Degree Honors Programs in Andhra Pradesh. The analysis is specifically dedicated to unraveling the potential implications of these alterations on the identity of English teachers, as articulated by participants in their discussions.

The genesis of this analysis lies in the perspectives of English teachers regarding the Educators' Union Memorandum on English Teacher Identity in the context of Andhra Pradesh's Single Major Degree Honors Programs. This examination delves into a memorandum put forth by a collective of language educators, delving into the nuanced theme of teacher identity against the backdrop of the implementation of Single Major Degree Programs in Andhra Pradesh.

The memorandum, serving as the focal point of discussion, was disseminated through the medium

of the English Teachers' Online Forum. This platform facilitated an expansive discourse among English educators, allowing for a comprehensive exploration of their viewpoints. At the core of the memorandum was a critical concern – the proposal to confine the instruction of General English exclusively to the initial two semesters. The union contended that such a restriction carried potential ramifications not only for language education but also for the overarching identity of language teachers.

Theme 1: Acknowledgment of Gravity and Significance

The theme centers around the acknowledgment of the gravity and significance of the matter at hand. Participant A's initial remark, coupled with subsequent affirmations from Participants B and C, underscores a collective recognition of the profound importance of the proposed changes in English instruction. This theme highlights a shared concern among participants, emphasizing that the suggested alterations carry weighty implications, prompting a united acknowledgment of the issue's seriousness.

Theme 2: Disruption of Established Norms and Disregard for UGC Guidelines

Participant E's detailed exposition brings to light the theme of challenging established norms and guidelines. The explicit reference to the UGC document, coupled with the inquiry into the A.P. Council's compliance, underscores a potential discord between official directives and the proposed modifications. This theme encapsulates participants' apprehensions regarding the potential disruption of the established educational framework and its potential repercussions on the identity of English teachers.

Theme 3: Communication Proficiency and Professional Preparedness

Participant E's concerns regarding compromised written communication skills, especially in high-stakes exams like Group I and Civil Services, form the crux of this theme. The assertion that limited English instruction could impede students' readiness for success in professional assessments is intricately linked to the broader concept of teacher identity. This theme accentuates the interconnection between educational modifications and the pivotal role of teachers in equipping students for their future endeavours.

Theme 4: Societal Roles and Identity Formation

Participant E's apprehensions about the potential outcome of producing "waiters and servants" instead of authors and poets contribute to the theme of societal roles and identity. This theme emphasizes the overarching impact of educational changes on students' future trajectories, and, in turn, how English teachers perceive their pivotal role in shaping these societal roles and identities.

Theme 5: Focus on Communication Proficiency and Collaborative Advocacy

Participant F's resonance with Participant E's viewpoint further emphasizes the theme of communication skills, recognizing the critical role English teachers play in fostering effective

communication. Furthermore, Participant G's proposal for a collaborative meeting and advocacy underscores the theme of collective action as a means of preserving English teacher identity amidst the proposed changes. This theme highlights the importance of both communication skills and collaborative efforts in navigating the evolving landscape of English instruction.

Theme 6: Curriculum Evolution and Institutional Heritage

Participants I and J's recollections concerning the historical evolution of English instruction within the curriculum, particularly in specific institutions, underscore the theme of curriculum evolution and institutional heritage. This theme elucidates how shifts in instructional content over time can influence English teacher identity and the traditions associated with their pedagogical practices. It emphasizes the interconnectedness between changes in curriculum and the enduring legacy of institutions in shaping the identity of English teachers.

## 5. Conclusion

This thematic analysis underscores the multifaceted implications of the proposed alterations to English instruction within Andhra Pradesh's Single Major Degree Honors Programs, extending beyond the academic domain. The discourse reveals apprehensions regarding the potential erosion of English teacher identity, stemming from anticipated shifts in curriculum focus and societal roles. These identified themes collectively illuminate the intricate ways in which changes in educational paradigms can influence English teachers' perceptions of their roles, the skills they strive to impart, and their interconnectedness with broader educational frameworks.

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engineering proceedings

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*Proceeding Paper*

# Plant Disease Prognosis Using Spatial-Exploitation-Based Deep-Learning Models †

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**Abstract:** There have been several initiatives taken to guarantee higher yields and higher-quality crops as the agriculture sector grows. The agriculture industry is severely impacted by plant and agricultural illnesses and deficits. Several techniques and technologies have been developed to aid in the diagnosis, management, and eventual eradication of plant diseases. The efficient and accurate identification of plant diseases could be aided by the development of a quick and accurate model. The use of deep convolutional neural networks for image categorization has greatly improved accuracy. In this paper, we present a framework for automating disease detection by the use of a tailored DL architecture. Both the Plant Village dataset and the real-time field dataset are utilized in the testing process. Our model's results are compared to those of other spatial exploitation models. The results show that the proposed method is superior to the standard deep-learning classifier. This proves the network's potential for usage in real-time applications by extracting high-level features that boost the efficiency and accuracy while reducing the risk introduced by a manual procedure. In order to enable a prompt reaction, and perhaps a targeted pesticide application, the suggested method has the ability to provide the early diagnoses of plant vital health.

**Keywords:** artificial neural network; deep learning; disease identification; disease diagnosis; spatial exploitation; spatial models



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## 1. Introduction

Agriculture, a vital income source for many countries, relies on mechanized systems and techniques for efficient production and high standards [1]. Plant diseases and abnormalities can lead to substantial economic losses, often caused by insect infestation promoting pathogen spread [2]. Climate changes further complicate crop production, causing diseases and pests to escalate globally [3]. Traditional visual inspections by farmers lack accuracy, highlighting the need for advanced methods. Neural networks and spatial-exploitation-based CNN networks offer promising solutions for disease detection and early diagnosis. These models leverage spatial patterns in plant images, capturing intricate features and enhancing disease prognosis accuracy. Utilizing deep-learning techniques, like convolutional neural networks (CNNs), these models extract complex spatial features, enabling precise disease identification in crops. The focus is on harnessing plant image spatial characteristics to improve disease detection, bolstering agricultural practices, and reducing losses. The sections below detail our methodology, training procedures, measurements, disease diagnosis approach, and effectiveness assessment.

The remaining sections include: Section 2, where we cover our methodology, training procedure, and measurements. Section 3 covers our proposed method, our process for diagnosing disease, and our knowledge-based expert systems. Our study's effectiveness is assessed in Section 4, and the discussion is wrapped up in Section 5.

## 2. Literature Review

This review highlights recent research endeavors in the field of plant disease prognosis, showcasing various methodologies, findings, limitations, and advantages (Table 1).

**Table 1.** Plant disease prognosis studies.

| Reference | Methodology | Finding | Limitation | Advantage |
|---|---|---|---|---|
| [4] | Machine learning for disease detection | Enhanced accuracy in diagnosis | Dependent on data quality and quantity | Rapid, noninvasive diagnosis |
| [5] | Automated diagnosis challenges and opportunities | Integration of technology in agriculture | Limited access to advanced technology | Potential for early intervention |
| [6] | Convolutional neural networks | Improved early detection | Model complexity and training time | High accuracy and speed |
| [7] | Multi spectral image processing | Training and testing process | Model complexity | Proof of concept |
| [8] | Few shot learning approach | Fast processing | Complex model | Improved Speed |
| [9] | Regression technique | Hyperspectral images | Less accuracy | Improved speed |
| [10] | Deep learning for disease detection | Accurate multiclass classification | Requires large labeled datasets | Robust and scalable detection |
| [11] | Deep transfer learning | Enhanced network | Requires less data | Improved Accuracy |
| [12] | Hyperspectral images and machine learning | Enhanced spectral disease detection | Hardware and cost limitations | Improved spectral resolution |
| [13] | Deep-learning model for citrus diseases | High accuracy in citrus disease identification | Limited to specific diseases | Accurate and quick diagnosis |
| [14] | New image processing Techniques | Improved accuracy | Time delay in processing | Accuracy improved |
| [15] | Review of deep-learning techniques | Comprehensive overview of deep-learning applications | Lack of standardization | Wide applicability and effectiveness |
| [16] | AI and ML applications | Diverse AI and ML applications | Lack of interpretability | Broad coverage of AI techniques |
| [17] | Computer vision with ML algorithms | Integration of technique | Improved interpretability | Improved accuracy |
| [18] | Machine learning in smart agriculture | Integration of AI in agriculture | Infrastructure constraints | Enhanced efficiency and productivity |
| [19] | Deep learning for disease classification | High accuracy in classification | Data imbalance issues | Effective for large datasets |

## 3. Methodology

In this study, tomato plant images were collected from the "Plantvillage" dataset and a farm in Jalgaon, Maharashtra, India, to evaluate the proposed method's viability in real-world scenarios [5]. To enhance the dataset's quality and diversity, augmentation and annotations were applied to 67,437 images, ensuring variation in image characteristics. The images underwent preprocessing, including cleaning, scaling, and normalization, before being used for training [7].

Automatic plant identification is crucial due to factors such as climate change, habitat shifts, and species diversity [17]. This need is exacerbated by the practice of introducing genes from wild plant relatives into crops for improvement, necessitating the tracking of various plant taxonomies. The study emphasizes the importance of automated plant classification, especially in regions with unique species facing extinction. Understanding plant names aids conservation efforts and ecological system preservation [14].

To assess the model's robustness and prevent overfitting, various train–test–validation set splits were explored, ensuring the nonrepetition of images within the same category. Parameters were fine-tuned using the validation set, and the test set was utilized for the final model evaluation. Evaluation metrics, such as accuracy, precision, recall, F1-score, AUC-ROC, AUC-PR, the confusion matrix, the mean average precision (mAP), and visualizations, like the confusion matrix heatmap, the ROC curve, the precision–recall curve, feature maps, class activation mapping (CAM), Grad-CAM, and t-SNE visualization, were employed to assess the model performance comprehensively [3].

Transfer learning (TL) techniques, utilizing both new data and existing models, were employed in training the convolutional neural networks (CNNs). TL capitalizes on generic, low-level features learned by early CNN layers, enhancing the generalizability, especially when data is limited. Feature extraction and fine-tuning were utilized based on the dataset size and characteristics. The evaluation metrics and visualizations enabled the effective comparison of different spatial-exploitation-based deep-learning models for plant disease prognosis, offering valuable insights into their performance and areas for enhancement. The proposed model demonstrated real-time disease detection accuracy, identifying complex patterns in plant images and facilitating efficient disease management in agriculture [5].

## 4. Proposed Approach

### *4.1. Infrastructure and Tools*

To conduct our research, we utilized high-performance computing resources, specifically the Nvidia DGX100 server, renowned for its multimode GPU capability. The server configuration included 4 CPUs, 2 GPUs with 32 GB memory, and a system memory of 64 GB, equipped with 10,000 Cuda cores and 5000 tensor cores. Our research leveraged the Python programming language and prominent deep-learning frameworks, such as TensorFlow and Keras, for model implementation.

### *4.2. Predictive Analytics Process*

We employed a predictive analytics process [11] to forecast the outcomes of our model. This comprehensive approach involved utilizing historical data related to plant leaf disease detection, statistical modeling, data-mining techniques, and deep-learning algorithms. The predictive process encompassed several stages as depicted in Figure 1:

1. Defining a Project: Identification and definition of research objectives, scope, and datasets used for experimentation.
2. Data Gathering: Preparation and formulation of data through data-mining techniques from multiple sources.
3. Data Analysis: Preprocessing stages, such as resizing, normalizing, and modeling data, to extract usable information and draw conclusions.
4. Statistics: Validation of hypotheses and assumptions through statistical analysis using appropriate models.
5. Modelling: Creation of precise predictive models automatically, allowing for multiple evaluations to select the optimal solution.
6. Deployment: Automating decisions based on the models to integrate analytical results into routine decision-making processes, generating results, reports, and output.

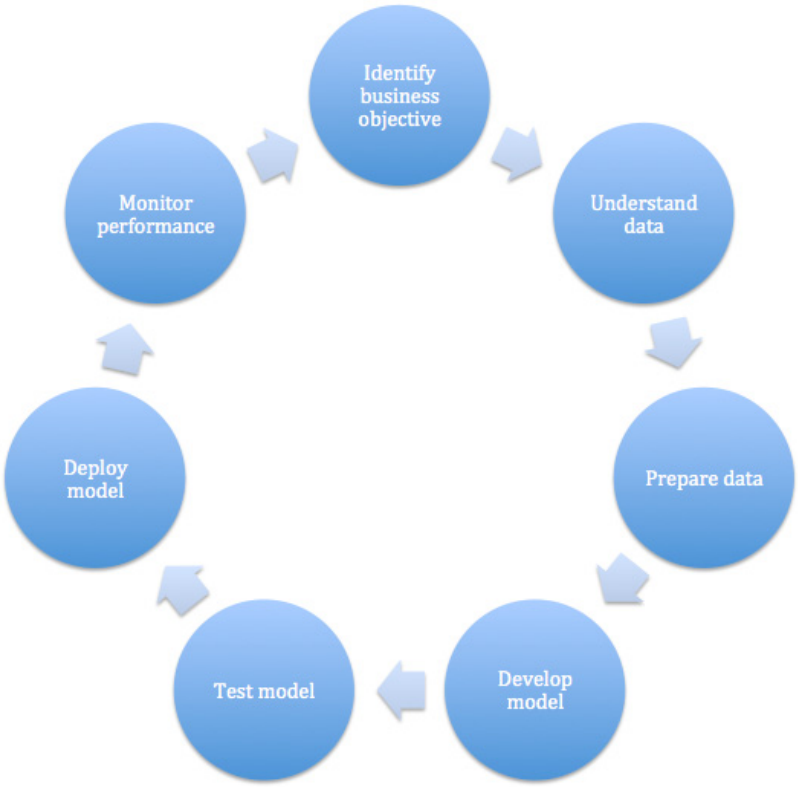


**Figure 1.** Predictive analytics process.

### *4.3. Knowledge-Based Expert Systems for Crop Disease Diagnosis*

Our research delved into knowledge-based expert systems designed to tackle complex tasks using deep knowledge foundations. These systems utilize artificial intelligence techniques to assist human decision-making processes, learning, and problem-solving within a specific domain. Unlike replicating the problem domain, these systems simulate human reasoning and employ heuristic or approximation methods to solve problems. In agriculture, knowledge-based expert systems find extensive applications, aiding tasks such as land management, water resource management, nutrient management, and crop disease detection and management.

### *4.4. Plant Disease Diagnosis*

The plant disease diagnosis process involves several precise steps, regardless of the disease type or circumstances. Each phase demands meticulous observations and inquiries:

1. Accurate Plant Identification: Identifying the infected plants, including scientific and generic names.
2. Distinguishing Characteristics: Recognizing the distinctive traits of healthy and diseased parts, accounting for variations in patterns, coloration, and growth rates.
3. Symptom and Sign Analysis: Identifying specific symptoms, such as stunted growth, tissue overgrowth, tissue death, and variations in appearance. Differentiating between symptoms and analyzing ecological causative agents.
4. Affected-Plant-Part Detection: Noting which plant parts are affected, such as roots, leaves, or stems.
5. Symptom Distribution: Observing the spread of affected plants in the area, noting patterns and distributions.
6. Host Specificity: Determining if the issue affects specific plant species or multiple species, aiding in understanding potential causes.

### *4.5. Plant Disease Management*

Plant disease management aims to mitigate the financial and aesthetic impact of diseases. Various principles guide disease management strategies, including:

- Exclusion: Preventing disease spread through geographical barriers and local prevention methods.
- Eradication: Eliminating the disease after introduction but before widespread dissemination.
- Protection: Implementing barriers, either mechanical, temporal, or economic, to prevent infection.
- Resistance: Using disease-resistant plants as a primary prevention method.
- Integrated Disease Management (IDM): Employing a combination of tactics, methods, disease diagnosis, and environmental monitoring to manage diseases effectively.

### *4.6. Methodology: Deep CNN and Otsu-Based Image Segmentation*

In our research, we opted for deep convolutional neural networks (CNNs) due to their effectiveness in replicating real-world data. We utilized the Keras machine-learning API and TensorFlow framework to develop our deep CNN model. The methodology included the following steps which are depicted in Figure 2:

- Data Acquisition: Utilizing real-time field images and the "PlantVillage" dataset, dividing the data into training, validation, and testing sets.
- Model Construction: Creating a multiclass multilayer CNN architecture suited for processing various images independent of size or orientation.
- Training and Validation: Scaling, normalizing, and training the model iteratively on the dataset to adapt to different images.
- Classification: Employing the trained deep CNN to categorize images into predefined classes, assessing its real-time performance on unseen images.

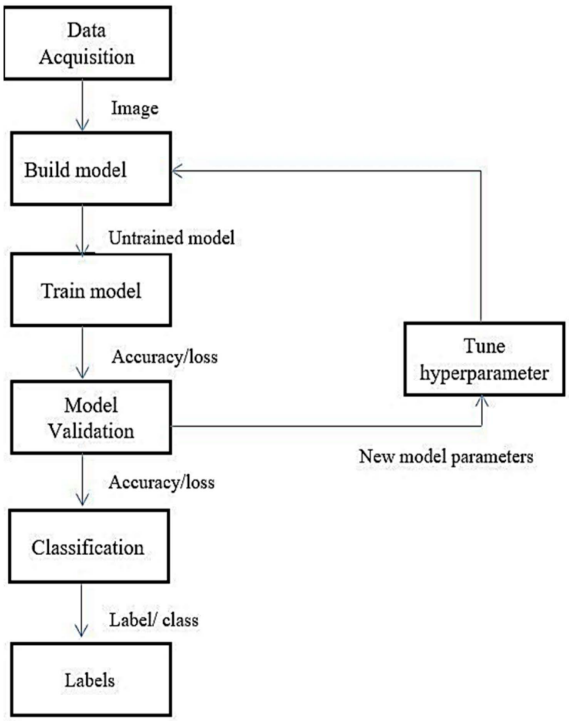


**Figure 2.** Framework used for training the model.

Additionally, we incorporated Otsu-based image segmentation, a variance-based method, to compute disease severity. This technique distinguished foreground pixels from background pixels by calculating the threshold value with the least variance between them, ensuring precise segmentation.

### *4.7. Algorithm*

The algorithm repeatedly finds the threshold that reduces the variance belonging to the same class determined by the weighted sum of the spread [13]. Grayscale typically has hues between 0 and 255 (0 and 1 in case of float).

The following equation is utilized to calculate the variance at threshold t:

$$\sigma^2(t) = \omega_{bg}(t)\sigma^2_{bg}(t) + \omega_{fg}(t)\sigma^2_{fg}(t) \quad (1)$$

where $\omega_{bg}(t)$ and $\omega_{fg}(t)$ represent the probability of pixels for a value of t, and $\sigma^2$ represents the deviation of color values.

Let $P_{all}$: total pixel count, and $P_{BG}$(t) and $P_{FG}$(t): background and foreground pixels, count at t. So, the updates are given by,

$$\omega_{bg}(t) = P_{bg}(t)/P_{all} \quad (2)$$

$$\omega_{fg}(t) = P_{fg}(t)/P_{all}$$

The variance is calculated using the formula below.

$$\sigma^2(t) = \frac{1}{N-1}\sum(x_i - \overline{x})^2 \quad (3)$$

where $x_i$ and x bar: the pixel value and its mean at i in the group ($b_g$ or $f_g$); N: the number of pixels. Figure 3 shows some of the instances from the Otsu-based segmentation process.

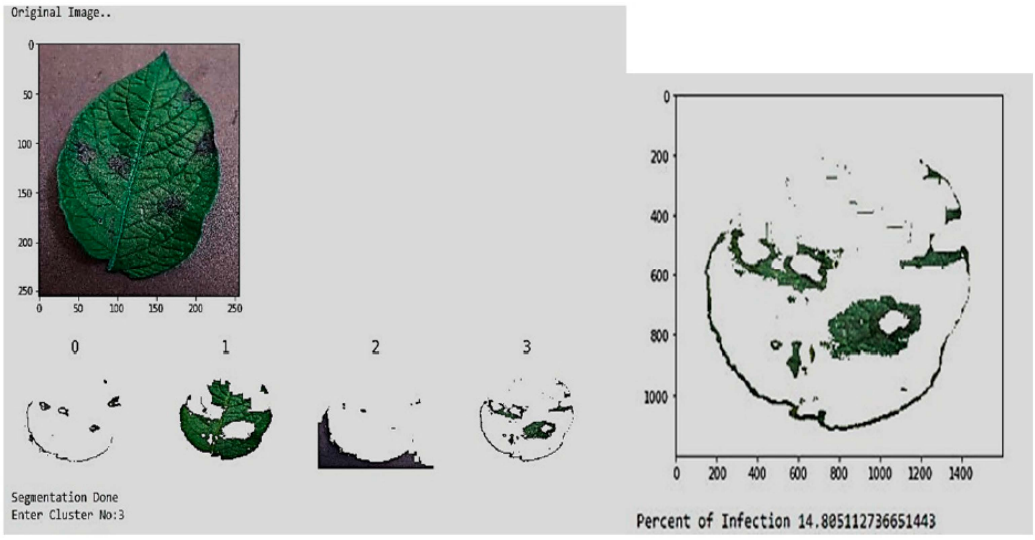


**Figure 3.** Otsu segmentation for disease severity grading.

## 5. Results and Discussion

Data splitting is a crucial component in artificial intelligence domain applications, especially when building models from data. This method ensures the development of data models and the processes that rely on data models. If the same dataset is used for the training and testing procedure, we could unknowingly encounter issues like overfitting. To overcome this issue, we have tested the performance of our implemented model on the varied dataset distribution ratio. From Figure 4, it is observed that the 70-10-20 train–test–valid split provides the maximum accuracy as compared to the other distributions. We therefore considered this distribution for further evaluating all the model's performance.

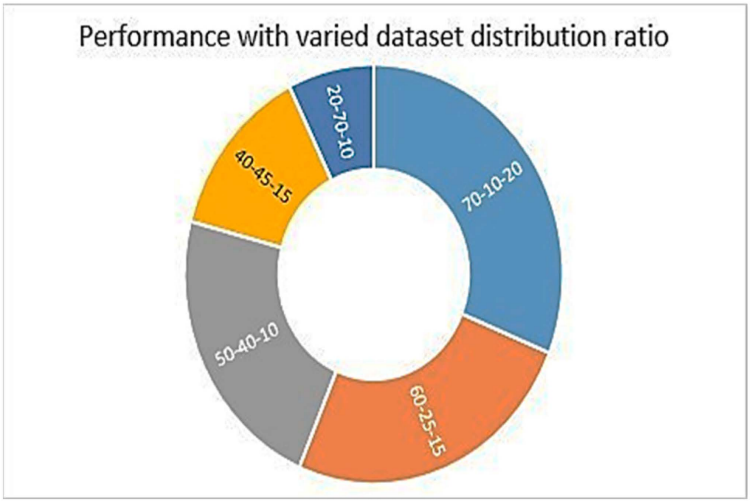


**Figure 4.** Performance of implemented model on varied dataset distribution ratio.

We implemented two choices of training mechanism strategies: implementation and training using the transfer learning method and training the model from scratch. From Table 2, it is observed that the performance indicators for the spatial-based models are higher for the models trained using TL. Also, the time required for training the model using TL is much less as compared to the model development from scratch. All the models are trained for 75 epochs, and then the accuracy starts converging after a decrease in the learning rate.

**Table 2.** Performance indicators for the spatial-exploitation-based models.

| **Models** | **Transfer Learning** | | | | **Training from Scratch** | | | |
|---|---|---|---|---|---|---|---|---|
| | A | P | R | F1 | A | P | R | F1 |
| LENET | 0.97 | 0.96 | 0.97 | 0.94 | 0.92 | 0.94 | 0.90 | 0.90 |
| ALEXNET | 0.98 | 0.97 | 0.98 | 0.96 | 0.94 | 0.92 | 0.92 | 0.90 |
| ZFNET | 0.97 | 0.99 | 0.99 | 0.98 | 0.94 | 0.91 | 0.91 | 0.91 |
| VGG-16 | 0.99 | 0.99 | 0.99 | 0.98 | 0.94 | 0.93 | 0.91 | 0.91 |
| VGG-19 | 0.99 | 0.99 | 0.99 | 0.99 | 0.95 | 0.95 | 0.93 | 0.94 |
| GOOGLENET | 0.99 | 0.99 | 0.99 | 0.99 | 0.97 | 0.96 | 0.94 | 0.95 |

Figure 5 depicts the accuracy of the existing spatial models and the implemented network evaluated on our dataset. It is observed that the existing models are finely tuned to improve the parameter indices. But, merely increasing the depth of the model does not necessarily improve the accuracy. Deeper models performed well in the case of a larger dataset. As compared to the existing model, the proposed model, through proper selection of hyperparameters, provided the maximum accuracy.

When we retain the remaining hyperparameter choices at a constant, the three variations in the dataset (color: Category 1, grayscale: Category 2, and segmented: Category 3), as shown in the Figure 6, exhibit a distinctive variance in performance across all experiments. When applied to Category 1, the models perform best. To evaluate the network flexibility in the lack of Category 1 information, and its capacity to acquire significant characteristics of specific diseases, we experimented with the grayscale version of the same dataset. Additionally, Category 3 of the entire dataset is developed to examine how the background affects the total results. As reflected from the diagram, the performance of Category 3 persistently outperforms that of Category 2, but only marginally less to that of Category 1.

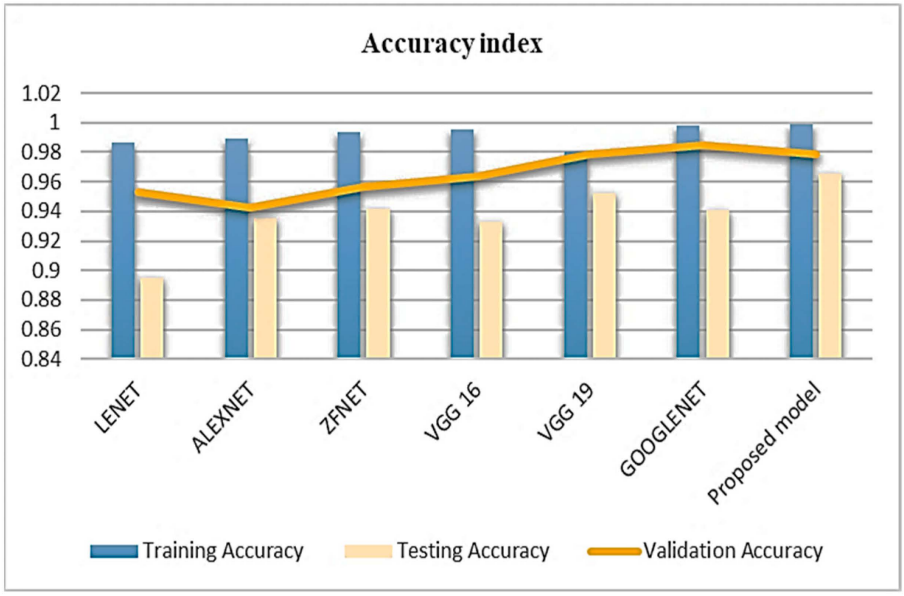


**Figure 5.** Comparison of existing and implemented model accuracy.

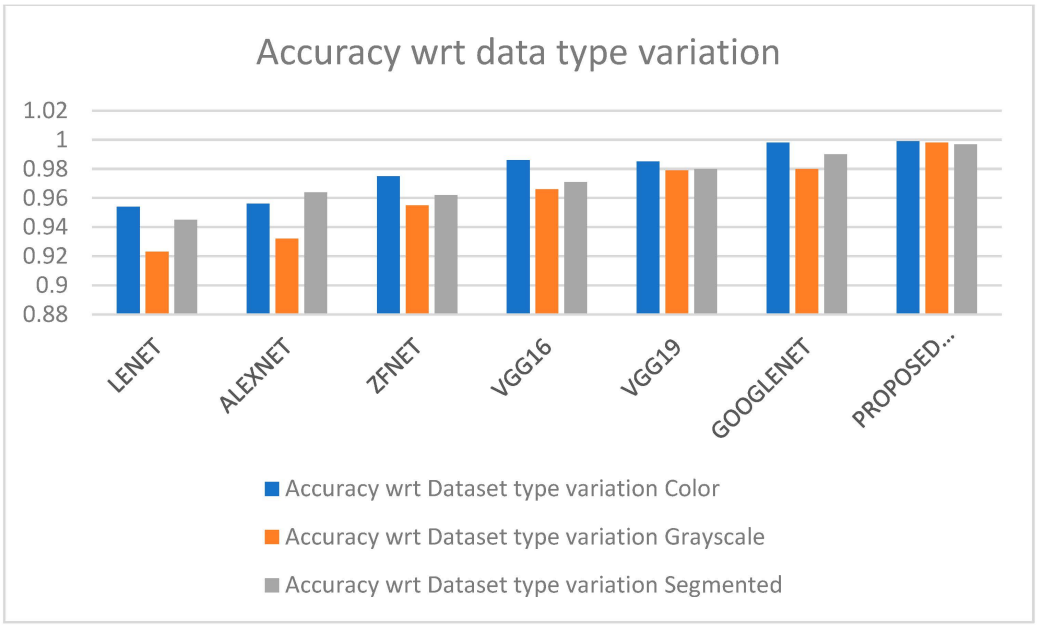


**Figure 6.** Performance analysis with three variations in the dataset.

Hyperparameters have a significant impact on the models' performance. Tables 3 and 4 depict the performance of our proposed model for the different values of the epochs, the learning rate, and the dropout rate. It is observed that, as we keep increasing the dropout rate, the model's convergence rate is slowed down, affecting the overall performance, whereas too low a value of the dropout rate does not show any improvement in the generalization capability and performance of the model. A higher dropout rate has higher variance, thus degrading the performance. The learning rate is another important parameter to improve the overall performance of the model. It determines the capability of the model to adapt to the problem. It is observed that the smaller the changes made to the weights with each update, the smaller the LR required for more epochs, whereas a higher LR provides fast adaptability and requires few epochs.

**Table 3.** Effect of the number of epochs on the accuracy.

| Number of Epochs | Training Accuracy | Training Loss | Validation Accuracy | Validation Loss |
|---|---|---|---|---|
| 25 | 0.8965 | 0.3865 | 0.9025 | 0.2145 |
| 40 | 0.9251 | 0.2456 | 0.9365 | 0.156 |
| 50 | 0.9564 | 0.0952 | 0.9657 | 0.123 |
| 75 | 0.9765 | 0.1365 | 0.9898 | 0.1021 |
| 100 | 0.8678 | 0.5862 | 0.8742 | 0.4658 |

**Table 4.** Experimental indices for different hyperparameter values.

| Number of Epochs | Learning Rate | Dropout Rate | Training Accuracy | Validation Accuracy | Training Loss | Validation Loss |
|---|---|---|---|---|---|---|
| 25 | 0.001 | 0.25 | 0.9354 | 0.8624 | 0.4362 | 0.4521 |
| 50 | 0.0001 | 0.25 | 0.9264 | 0.8951 | 0.3561 | 0.3125 |
| 75 | 0.1 | 0.15 | 0.9021 | 0.8999 | 0.2531 | 0.2001 |
| 75 | 0.001 | 0.25 | 0.9985 | 0.9854 | 0.1254 | 0.1564 |
| 75 | 0.0001 | 0.40 | 0.8694 | 0.832 | 0.3214 | 0.2154 |
| 75 | 0.00001 | 0.50 | 0.8216 | 0.8021 | 0.2145 | 0.5641 |

It is observed that, during the higher learning rate, we did not reach the optimal solution, whereas, when we tried for low values, we required too many iterations to reach the best value. Another important parameter is the number of epochs to be set for training the model. It helps to refine our network parameters. It is observed that setting a high value for epochs never increases the accuracy. It boosts the performance only up to certain limit, after which the accuracy again starts to degrade, resulting in model overfitting.

## 6. Conclusions

Identifying plant diseases is a challenging task that spans numerous academic disciplines. Growing businesses have the potential to save a significant amount of money by identifying diseases early in a crop field, but more importantly, they may be able to improve livelihoods. Deep-learning image classifiers can now be used in the early diagnosis of plant diseases because of advancements in computing power. There is a considerable amount of literature that has been published that claims very accurate levels of performance on newly developed image classifiers in the quest to enhance existing models for plant disease identification [20]. However, a significant proportion of this literature lacks a set of predefined methodologies, making comparisons between works challenging. In this paper, we outlined the performance of all spatial-exploitation-based CNN models, along with our developed model, on our generated dataset. We achieved higher and more resilient shared visual characteristics through our implemented architecture. The multidisease approaches for plant disease characterization have been demonstrated in this work. By stimulating the development of huge datasets and models that can easily make use of new crop-specific contextual information, few-shot, or incremental-learning techniques, new research directions are opened. To avoid water pollution and production losses, future research efforts should strive to incorporate a proper proportion of fungicides and pesticides depending on the disease severity.

**Author Contributions:** Conceptualization, J.V. and S.S.N.; methodology, N.S.C.K., M.K.M. and K.S.N.; validation, J.V. and S.S.N.; formal analysis, N.S.C.K., M.K.M. and K.S.N.; investigation, J.V. and S.S.N.; resources, N.S.C.K., M.K.M. and K.S.N.; data curation, J.V. and S.S.N.; writing—original draft preparation, J.V. and S.S.N.; validation, N.S.C.K., M.K.M. and K.S.N.; writing—review and editing, J.V. and S.S.N.; validation, N.S.C.K., M.K.M. and K.S.N.; visualization, J.V. and S.S.N.; supervision, N.S.C.K., M.K.M. and K.S.N. All authors have read and agreed to the published version of the manuscript.

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RESEARCH

# Fabrication Model Design and Analysis of Flexible Polarization Surface Polariton Resonance with a Dual-Wing Antenna Structure Platform for Diverse Multiband Characteristics in the Measurement Environment

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**Abstract**
A new microstrip patch antenna design with a dual-wing construction is introduced to provide diverse multiband characteristics maintaining good antenna performance. The antenna exhibits resonances at multiple frequencies within the X-band due to the use of etched slots on the parasitic patch, considerably broadening its possible applications. This unique configuration is thoroughly investigated using numerical simulations as well as real testing. The proposed design showcases three distinct operational bands, operating at frequencies of 8.32 GHz, 10.33 GHz, and 11.69 GHz. These bands are supported by impedance bandwidths of 300 MHz (ranging from 8.21 to 8.51 GHz), 620 MHz (from 10.01 to 10.63 GHz), and 510 MHz (covering from 11.4 to 11.91 GHz). Furthermore, the antenna delivers favorable gains of 3.31 dB, 7.78 dB, and 7.48 dB at their respective frequencies. A commercially accessible electromagnetic simulation tool is used to simulate the antenna's design. This tool accurately predicts and analyses the performance of the antenna, validating simulated results with the experimental findings. The antenna has compact dimensions of $38 \times 38 \times 1.6$ mm$^3$ due to its unique design, which contributes to multiband capabilities and enhanced bandwidth. The antenna's wing form improves radiation patterns and surface current distribution. The directional flow of currents in distinct modes is recognizable at the three operational frequencies. This novel antenna design holds promise for applications demanding multiband capabilities and enhanced performance.

**Keywords** Wing-shaped design · Surface polariton resonance · Multiband characteristics

## Introduction

In this present era, there is a substantial increase in the demand for wireless communication applications. This surge is primarily driven by the fact that mobile devices are becoming more advanced in terms of features while also becoming smaller in size. As a result, the demand for antenna devices has grown significantly. This trend has led to an increased need for compact antennas that can handle multiple frequency bands to meet the goal of size reduction. These miniaturized antennas are often employed in small packaging systems and frequently used in a variety of resonant frequencies and impedance techniques. Researchers are actively working to produce such tiny antenna solutions because of their great demand in both practical and research contexts. Especially, the primary research focus in this area centers around developing methods for achieving resonance across multiple frequency bands [1–3]. Within modern communication systems, it is crucial to minimize the device size without compromising its radiation characteristics [4]. The microstrip patch antennas possess numerous advantageous qualities that render them a pivotal component in contemporary mobile communication systems. Additionally, these microstrip antennas find broad application in diverse fields such as satellite and cellular communications [5]. The interesting characteristics such as a compact form, compatibility with other circuit modules, minimal profile, and linearity simplify and enhance the reliability of antenna designs. While assessing antenna performance, bandwidth carries significant importance. Over recent years, the bandwidth of Multiple-Input Multiple-Output (MIMO) Antenna Systems (MSAs) has increased from a few percent to substantial percentages [6]. However, challenges such as limited bandwidth and gain continue to exist in antennas, prompting the investigation of different approaches to tackle these issues. In

Extended author information available on the last page of the article

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reference [7], a method that incorporates a folded T-shaped patch antenna associated with rectangular patches on both sides has showcased enhanced antenna characteristics. An alternative method involves a condensed design featuring a sickle-shaped patch reported in [8]. In various real-world scenarios, like in commercial applications, ensuring a larger data capacity and keeping the device size compact are essential factors to think about in the design of antennas [7, 9]. Elements such as dielectric material's permittivity, feeding techniques, patch design, and the arrangement of parasitic components significantly influence the bandwidth of patch antennas. Numerous strategies can be employed in wireless technologies to achieve wideband and multiband functionality. These devices include diverse feeding techniques, defective ground structures, fractal patterns, metamaterials, and planar antennas given in [10–12].

Moreover, it has been observed that by integrating slots in different shapes, the antenna can function effectively over a diverse range of resonant frequencies [13, 14]. Microstrip antennas are situated between two conducting layers, with the upper layer containing the patch and the lower layer accommodating the ground plane. Conventional methods used to induce antenna resonance comprise coaxial feeding and microfeeding [15]. Circular, rectangular, and ring structures are the prevalent shapes for patch antennas. In reference [16], an antenna integrated with metamaterials and incorporating split ring resonators demonstrates even frequency distribution and consistent radiation patterns. The effectiveness of the suggested designs in long-range scenarios was emphasized in citations [17, 18]. Furthermore, square and circular patch configurations integrating PIN diodes have been utilized to attain multiple frequency ranges and enhance gain. A simple microstrip design employing annular rings showcased the ability to operate in two distinct frequency bands. Performance parameters have been realized by employing liquid crystal metamaterial-loaded microstrip designs as compared to conventional models. In ref. [19], different frequency bands conforming to IEEE standards were introduced for the transmission of digital television signals through Ku-band satellites. The compact ultra-wideband planar antenna and asymmetric feed T-shaped patch antennas for WLAN, WiMAX, and Bluetooth applications are reported in [20–29].

This study presents a novel, compact, dual-wing structured multiband antenna design. The optimization process involves iterative steps and featuring X-band applications. The study introduces a microstrip antenna design with wing-shaped features and semi-circular slots on the patch, resulting in enhanced antenna gain. The conducting patch incorporates two wing structures achieved by etching circular patches, leading to improved return loss. The design process and analysis utilize a commercial software tool. The proposed antenna design is physically constructed, and the obtained results are compared with simulated data. The investigation includes an examination of co-polarization and cross-polarization characteristics, as well as a study of the current distribution for the suggested model.

## Antenna Design

Figure 1 illustrates the configuration of the wing-shaped monopole antenna with a multiband. Figure 2 shows the design is mounted on a cost-effective FR-4 substrate with a dielectric constant of 4.4 and geometry of $38 \times 38 \times 1.6\text{mm}^3$. Table 1 shows the parameters of the proposed antenna. The following Eqs. 1 and 2 are used to evaluate the antenna. The antenna is supplied with a signal through a 50-Ω microstrip line. The upper surface of the substrate accommodates the radiating element and feeding line, whereas the ground plane is located on the lower side. The radiating patch takes the form of a bat and is fine-tuned in dimensions using commercial software. A 50-Ω SMA connector is employed to connect with the microstrip feed line, facilitating signal transmission. Optimizing the size of wing-shaped antennas is a difficult and iterative process that requires a thorough understanding of electromagnetic theory, simulation tools, and engineering concepts. The proposed wing-shaped antenna is primarily focused on its edges instead of its center. Consequently, when the antenna's perimeter ($p$) is extended, the surface current follows a lengthier path. This extension effectively simulates a longer monopole length, leading to a reduction in the antenna's lowest resonance frequency ($f_L$).

$$f_L(GHz) = \frac{300}{p\sqrt{\varepsilon_{eff}}} \tag{1}$$

To reduce interferences caused by the system operating within the 8-12 GHz range, a circular-shaped C-shaped slot featuring a circular arc is introduced on the antenna patch. This slot is designed to create a band rejection effect. The overall length of the slot can be expressed by the following equation

$$f_{notch} = \frac{c}{2L\sqrt{\varepsilon_{eff}}} \tag{2}$$

Here, $c$ represents the speed of light in a vacuum, $L$ signifies the combined length of the C-shaped slot with a circular arc, and $\varepsilon_{eff}$ corresponds to the effective dielectric constant, calculated as

$$\varepsilon_{eff} = (1 + \varepsilon_r)/2 \tag{3}$$

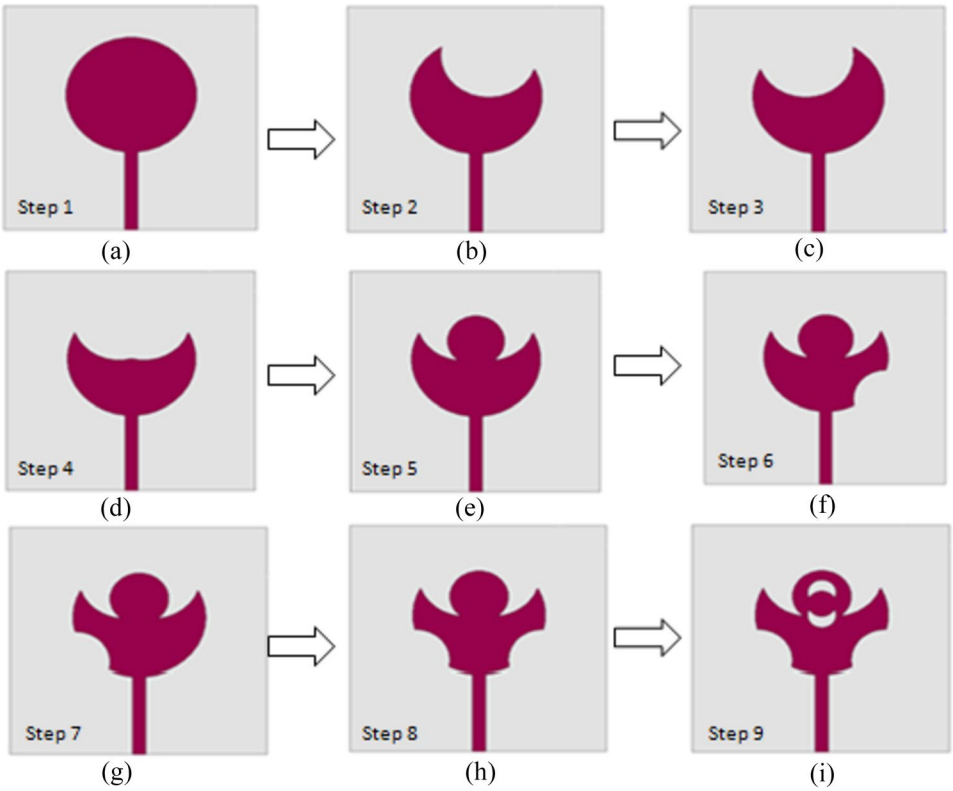



**Fig. 1** Step-wise study of the wing shapes design antenna

Figure 1 displays the evolution process of the antenna. The major component of the microstrip designs that affect the antenna characteristics is by changing the reflection analysis, bandwidth, radiation properties, and current flow study. In this work, the properties of the antenna are enhanced by considering a novel structure. The novelty of this work is accomplished by considering the modifications to the patch structure which improves the current distributions on the patch. To achieve the multiband operation, an iterative study has been conducted for the proposed design. Figure 1(a) displays the simple circular patch antenna design. Figure 1(b) and (c) show that the smaller and simpler circular patches were etched on either side of the design. Figure 1(d) by etching the patches on the two sides makes the antenna semi-circular in shape. In Fig. 1(e), a compact

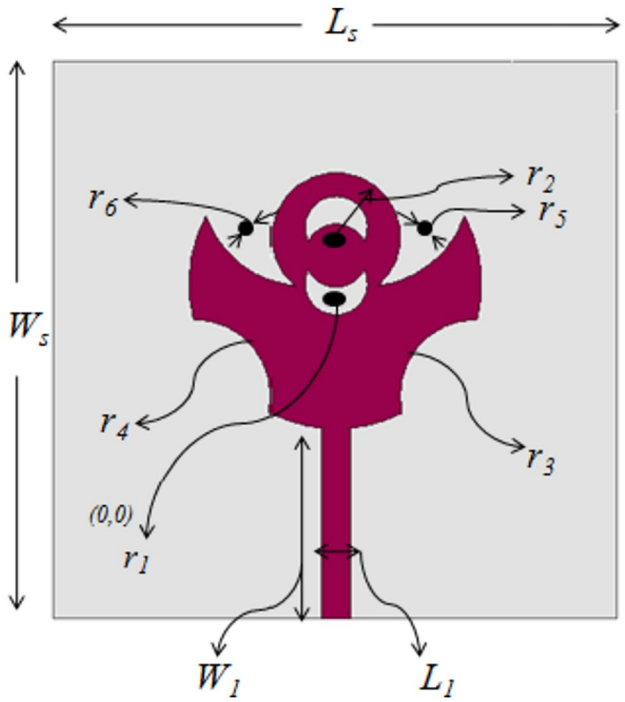



**Fig. 2** Final geometry of the designated antenna

**Table 1** The parameters of the proposed antenna in Fig. 2

| Parameter | Value (mm) |
|---|---|
| $L_s$ | 38 |
| $W_s$ | 38 |
| $L_1$ | 2 |
| $W_1$ | 18 |
| $r_1$ | 10.3 |
| $r_2$ | 2.3 |
| $r_3$ | 5.3 |
| $r_4$ | 5.3 |
| $r_5$ | 7.3 |
| $r_6$ | 7.3 |
| $r_6$ | 0.5 |

circular patch is integrated into the semi-circular patch design from the previous iteration. Figure 1(f) and (g) on the sides of the design miniaturized circular patches were etched at the bottom making the antenna resemble a wing structure. In Fig. 1(h), the wing-shaped microstrip design is shown. In Fig. 1(i), the final design of the proposed antenna with etched semi-circular slots is demonstrated.

## Results and Discussion

The suggested antenna's ideal arrangement consists of two semi-circular etched slots. The microstrip feed technique is considered for the designated antenna. The strip line is integrated with the parasitic patch and is observed in Fig. 2. The suggested model antenna realizes an impedance matching of 50 Ω. The return loss of the iterative study is observed in Fig. 3, and the characteristics of the nine case studies are executed in the evolution of the design. According to the first iterative study (Fig. 1(a)), the suggested model resonates at 7.57, 8.97, and 10.8 GHz, produced with a return loss of − 12.08, 11.56, and 12.4 dB. From the first iterative study, the impedance matching of ($S_{11} = -70$ dB) is obtained at the center frequency. In the second and third iteration study (Fig. 1(b) and (c)), it is observed that simpler patches were etched on the top end and the design operates at 7.72, 8.177, and 9.76 with $S_{11}$ of − 11.3, − 13.03, and − 14. 4 dB. Thus, in the preceding case study (Fig. 1(d)), it resembles a semi-circular structure and works at a frequency of 8.14 and 9.65 GHz with a return loss of − 15.01 and 18.3 dB. In the fifth step (Fig. 1(e)), a small circular patch is added at the center of the main patch. This advancement step makes the antenna operate at 9.76, 9.68, and 12.25 GHz with $S_{11}$ of − 10.63, − 11.9, and − 19.58 dB. Again in Fig. 1(f) and (g), sixth and seventh iteration steps, two minimal circular patches are etched

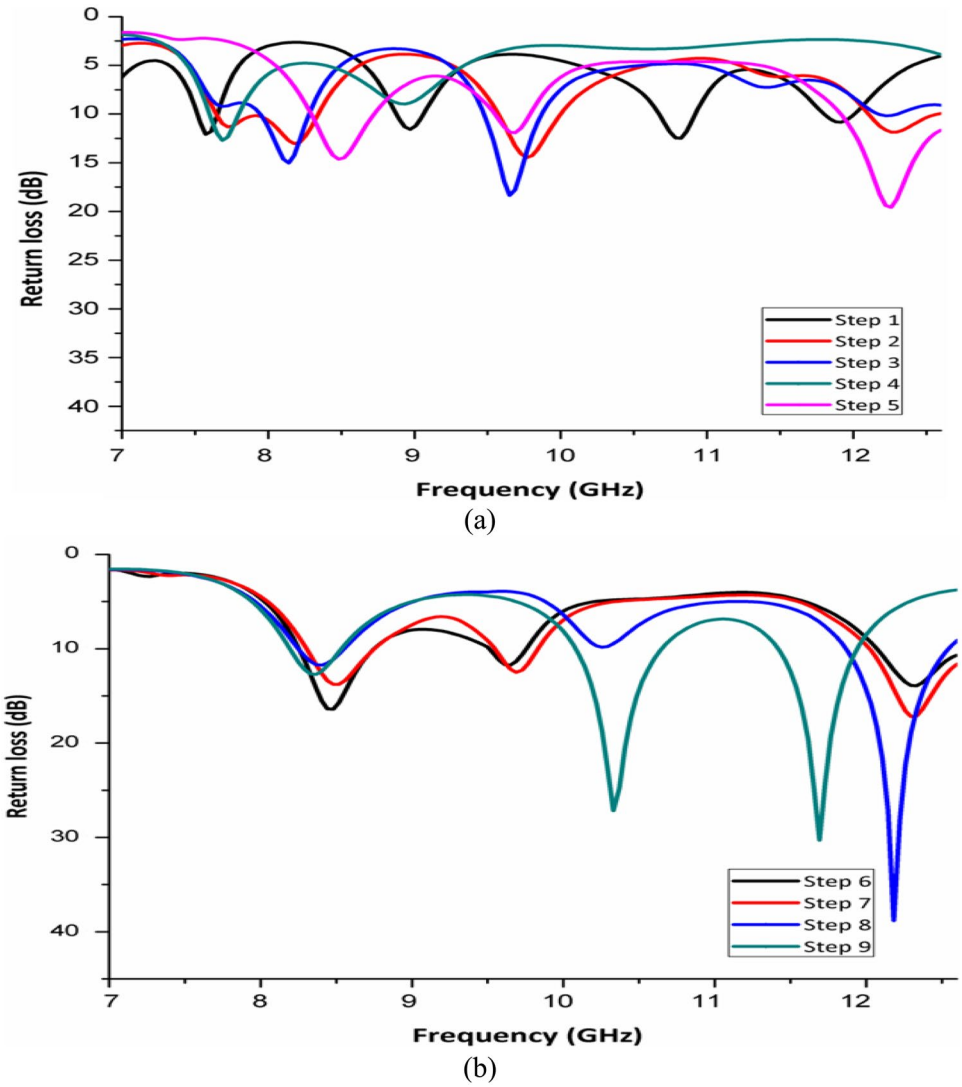



**Fig. 3** Nine suggested antennae return loss. **a** First five of the iteration study. **b** Last four of the iteration study

at the bottom of the main patch resulting in resonating at 8.48, 9.68, and 12.29 GHz with $S_{11}$ of − 13.7, − 12.48, and − 17.20 dB. Furthermore, in the eighth iteration step, a wing-structured antenna is developed by etching the circular portions and thus resulting in giving the antenna a novel design. This iteration operates at 10.25, 12.1, and 8.40 GHz with a return loss of − 11.74, − 9.84, and − 38.8 dB. Finally, in the last case study, two semi-circular shapes slots are etched at the top end thus resulting in acquiring the desired operating bands at 8.3, 10.3, and 11.6 GHz with good reflection loss of − 12.66, − 27.1, and 30.3 dB respectively. Here for a clear understanding of all the iterations, the first five case study results are shown in one figure, i.e., Fig. 3(a), and another set of iterations is shown in Fig. 3(b). The wing-shaped design antenna–specific type of MSA represents the shape of bird or airplane wings. The radiation properties depend upon various factors like shape, size, and feeding technique. However, the suggested antenna radiation patterns are shown in Fig. 5. The E-plane pattern is characterized equally in all the dimensions. It is achieved only when the suggested design is fed at the center of the countertenor. The H-plane pattern refers to the directional pattern concerned only in one direction.

By varying the patch dimensions through parametric analysis, an in-depth study of each parameter influences the design characteristics. This data can be used to accomplish the desired bandwidth and radiation pattern; a parametric study involves analyzing different characteristics of the patch and its performance. The patch dimension, substrate material, feed location, and varying parasitic elements. In Fig. 4(a–f), the parameters varying can be observed to validate the design. Table 2 tabulates the resonating behavior of the design.

Table 3 clarifies the findings from simulations of the resonating bands' gain, bandwidth, and return loss properties.

The radiation patterns in the far field of the wing-shaped antenna are calculated and subsequently confirmed through measurement at three specific frequencies: 8.32 GHz, 10.33 GHz, and 11.69 GHz (as illustrated in Fig. 5(a–c).

In the context of the (E-plane) and (H-plane) co-polarization patterns, the antenna showcases an omnidirectional form at 10.33 GHz, resembling a flower and dumbbell shape. However, as the frequency increases, especially beyond 10.33 GHz, the cross-polarization component also improves. This phenomenon can be attributed to the generation of additional modes at higher frequencies. As a result, the radiation patterns continue to meet satisfactory levels within the X-band frequency range, maintaining a favorable agreement with the observed results.

Cross-polarization patterns usually have weaker signals compared to co-polarization patterns because of reduced signals radiating in the sideways direction. This helps minimize unwanted radiation in different directions. The cross-polar patterns are higher than co-polar patterns; it could be due to the design of the antenna. To fix this unexpected difference, it is important to look closely at the design details and how the measurements were done. These types of unexpected strong signal changes might occur due to the geometrical design of the antenna.

## Fabricated Model

The fabricated model of the proposed device is observed in Fig. 6(a, b). The fabrication is carried out on the FR-4 substrate and tested in the measurement surroundings. Initially, the design is implemented in a software tool and takes into account the desired frequency, dimensions, substrate, material, substrate height, and permittivity. By cutting down the desired material and required size and ensuring the design is free from all contamination. Moreover, the copper layer served as a conducting layer. Performing the necessary steps, the fabrication of the model is achieved. The photography of the suggested design with scale is represented to assess the size of the antenna. It is also noted that after the completion of the fabrication of the desired model. The analysis of the simulated and experimental results is validated to evaluate the increased performance of the model.

Several variables might cause a mismatch between simulated and measured frequencies in antennas. Antenna simulations are based on mathematical models that make assumptions about the antenna's behavior and its operating environment. However, practically manufactured antennas can introduce complexity. Manufacturing tolerances, material qualities, ambient room conditions such as surrounding structures, electromagnetic interference, and measurement mistakes can all contribute to frequency discrepancies. Figure 7 clarifies the correlation of results between simulated and experimental study.

The gain of the suggested antenna refers to its capability to concentrate transmitted signals in a certain direction and received signals in another direction. The gain of the antenna is usually measured in dB. A high-gain antenna recommends improved signal strength in the desired path and also enhances the power of reception of the signal. Gain can also be determined by several parameters consisting of its design, size, shape, and operating bands. The parameters may vary according to the characteristics of the device. Table 4 clarifies the close observation of results in terms of simulated and measured values.

The field distributions provide information regarding the intensity of the field effects at a particular resonant frequency and provide information on the mode of propagation. As per your suggestion, a clear explanation of the surface current distribution of the proposed antenna is stated in the revised manuscript. Examining H-field current flow

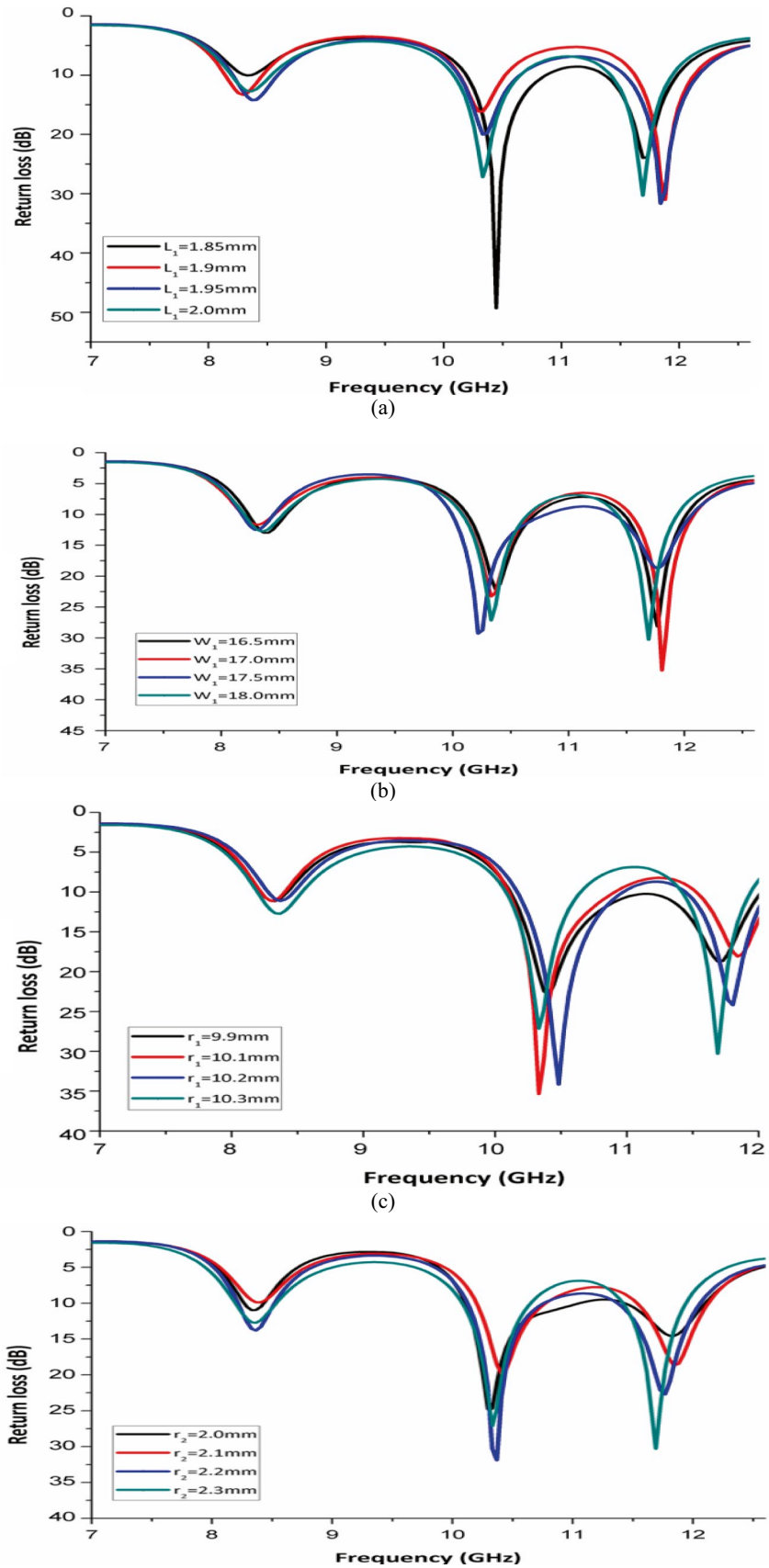



**Fig. 4** **a**–**f** Varying different case studies of parameters on the parasitic patch

**Fig. 4** (continued)

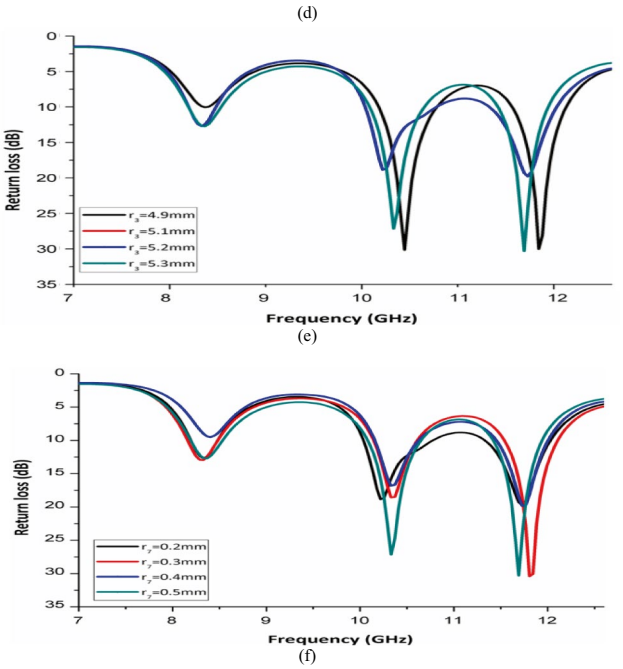



**Table 2** Return loss features of the suggested antennas in Fig. 1(a–i)

| Return loss (dB) | First band | | Second band | | Third band | |
|---|---|---|---|---|---|---|
| | $f_{11}$ (GHz) | $S_{11}$ (dB) | $f_{11}$ (GHz) | $S_{11}$ (dB) | $f_{11}$ (GHz) | $S_{11}$ (dB) |
| Figure 1(a) | 7.57 | − 12.08 | 8.97 | − 11.56 | 10.8 | − 12.4 |
| Figure 1(b) | 7.72 | − 11.3 | 8.177 | − 13.03 | 9.76 | − 14.4 |
| Figure 1(c) | 8.14 | − 15.01 | 9.65 | − 18.3 | | |
| Figure 1(d) | 7.68 | − 12.70 | 8.93 | − 8.95 | | |
| Figure 1(e) | 9.76 | − 10.63 | 9.68 | − 11.9 | 12.25 | − 19.58 |
| Figure 1(f) | 8.44 | − 16.3 | 9.65 | − 11.7 | 12.2 | − 13.89 |
| Figure 1(g) | 8.48 | − 13.7 | 9.68 | − 12.48 | 12.29 | − 17.20 |
| Figure 1(h) | 8.40 | − 11.74 | 10.25 | − 9.84 | 12.1 | − 38.8 |
| Figure 1(i) | 8.32 | − 12.66 | 10.33 | − 27.1 | 11.69 | − 30.3 |

is essential for fine-tuning electromagnetic compatibility in electronic systems, reducing interference, and improving antenna design. In areas such as wireless power transfer and medical imaging, H-field characteristics are vital for enhancing both efficiency and resolution. Moreover, a detailed study of H-field current flow is crucial for performance optimization. In summary, investigating the H-field contributes to the effective application of electromagnetic principles. The field distributions provide information regarding the intensity of the field effects at a particular resonant frequency and provide information on the mode of propagation.

Figure 8(a) and (c) clarify the surface current distribution of the proposed antenna at 8.3 GHz, 10.3 GHz, and 11.69 GHz respectively. To evaluate the total power of the antenna design, we have to assess the gain of transmitting and receiving antenna. Generally, the gain does not increase the power of the antenna, but the power of the signal redistributes the power in one direction. The current flow study is important and plays a major role in demonstrating the parameters of the design. The wing-shaped design introduces different variations on the

**Table 3** Findings from simulations of the resonating bands' gain, bandwidth, and return loss properties

| Bands | Operating frequency (GHz) | Return loss (dB) | Bandwidth (MHz) | Gain (dB) |
|---|---|---|---|---|
| 1st | 8.32 | − 12.66 | 300 | 3.31 |
| 2nd | 10.33 | − 27.1 | 620 | 7.78 |
| 3rd | 11.69 | − 30.3 | 510 | 7.48 |

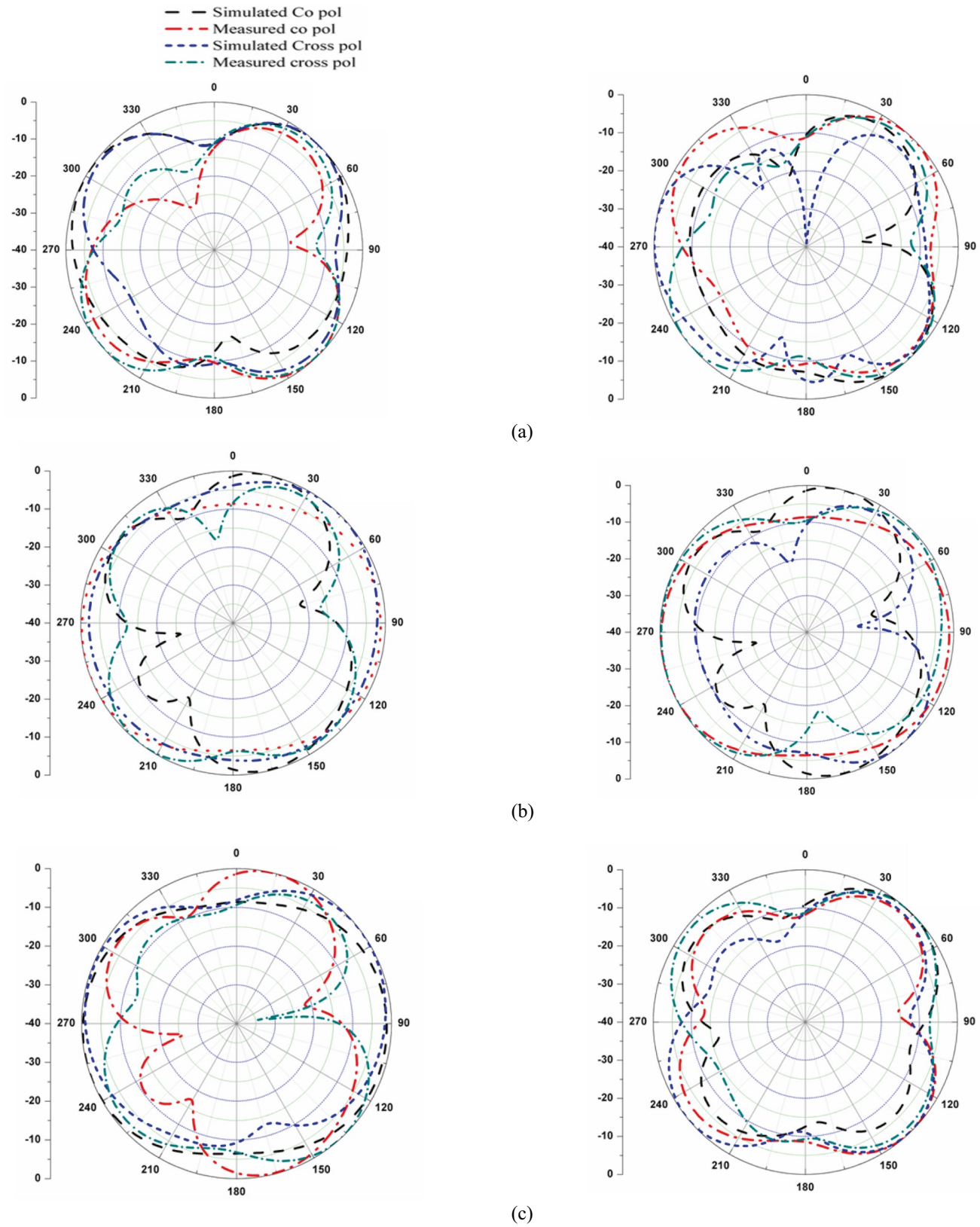



**Fig. 5** Radiation parameters at three center frequencies. **a** 8.3 GHz, **b** 10.33 GHz, **c** 11.69 GHz

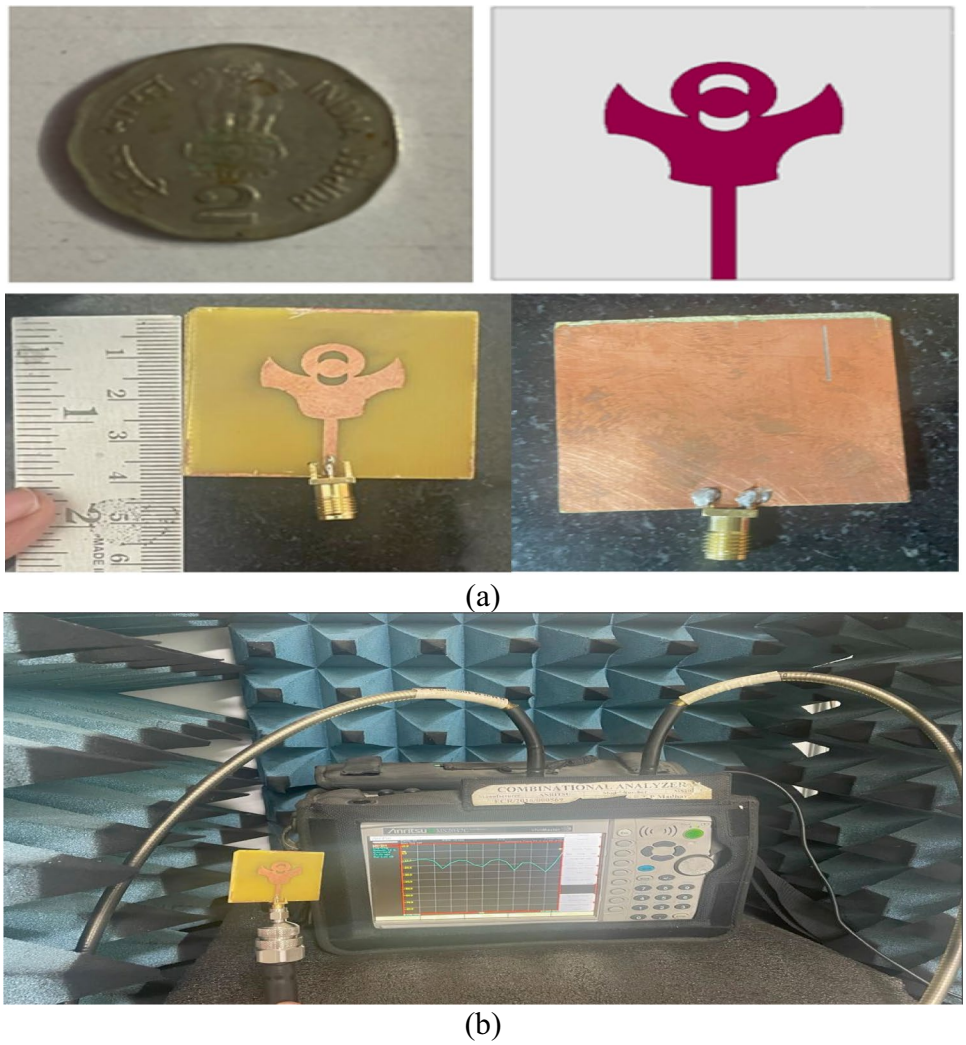



**Fig. 6** The layout of the designated antenna. **a** Fabricated model, **b** close view of the measurement environment

patch. The variations influence the radiation properties of the antenna. The patch itself acts as a resonating element and carries the distribution of currents. The direction may vary across the resonating element for the spatial distribution. The simulation current flow of the proposed design is observed in Fig. 9(a–c).

Figures 10 and 11 illustrate the radiation efficiency and gain characteristics of the antenna. The graph demonstrates that the computed radiation efficiency consistently exceeds 80.0% across the operational frequency range. The actual antenna gains exhibit good consistency, ranging from 3.3 to

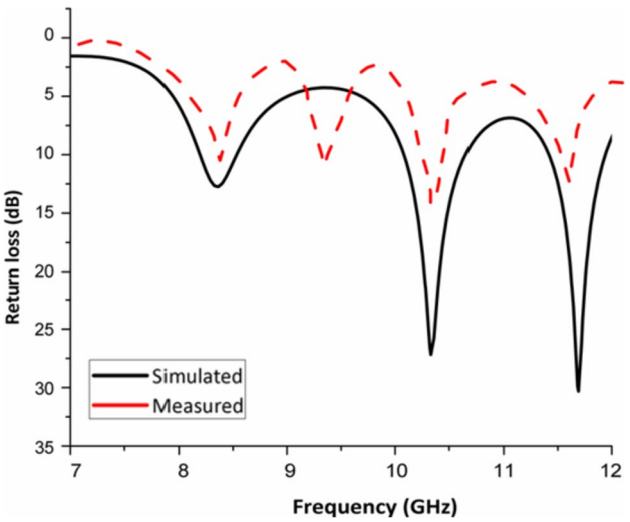
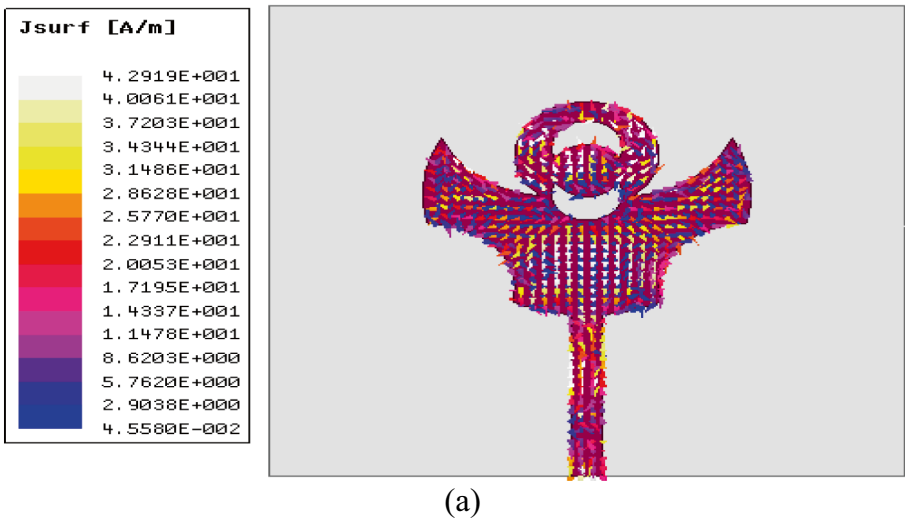


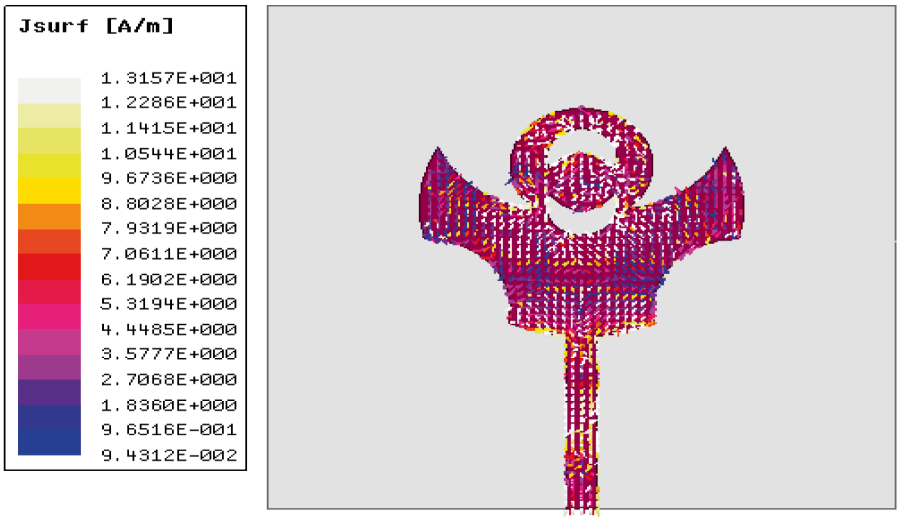

**Fig. 7** The correlation of results between simulated and experimental study

**Table 4** Close observation of results in terms of simulated and measured values

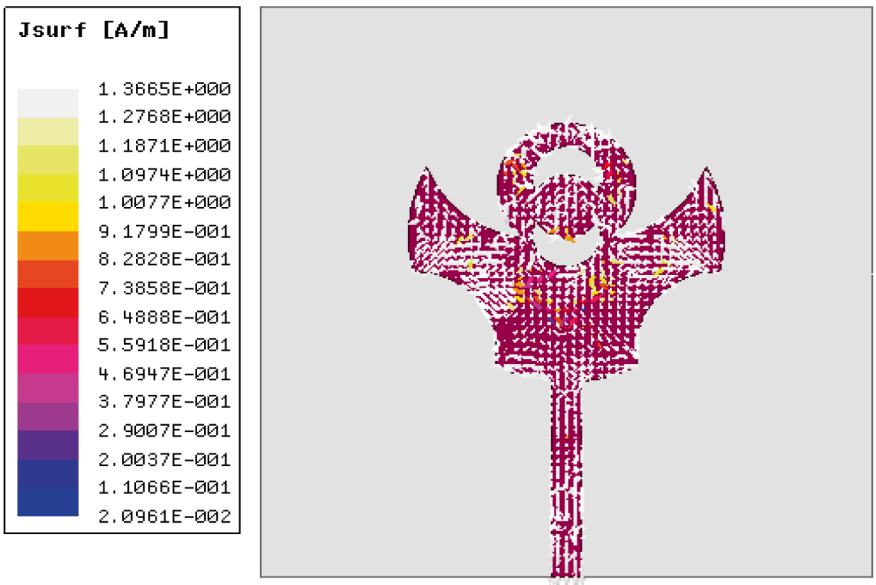
| | Operating frequency (GHz) | Return loss (dB) | Bandwidth (MHz) | Proposed antenna Gain (dB) |
|---|---|---|---|---|
| | 8.32 | − 12.66 | 300 | 3.31 |
| Simulation | 10.33 | − 27.1 | 620 | 7.78 |
| | 11.69 | − 30.3 | 510 | 7.48 |
| | 8.31 | − 12.5 | 310 | 3.2 |
| Measured | 10.35 | − 21.4 | 630 | 7.5 |
| | 11.72 | − 27.3 | 490 | 7.1 |




(a)




(b)




(c)

**Fig. 8** The surface current distribution of the proposed antenna is **a** 8.3 GHz, **b** 10.3 GHz, **c** 11.69 GHz

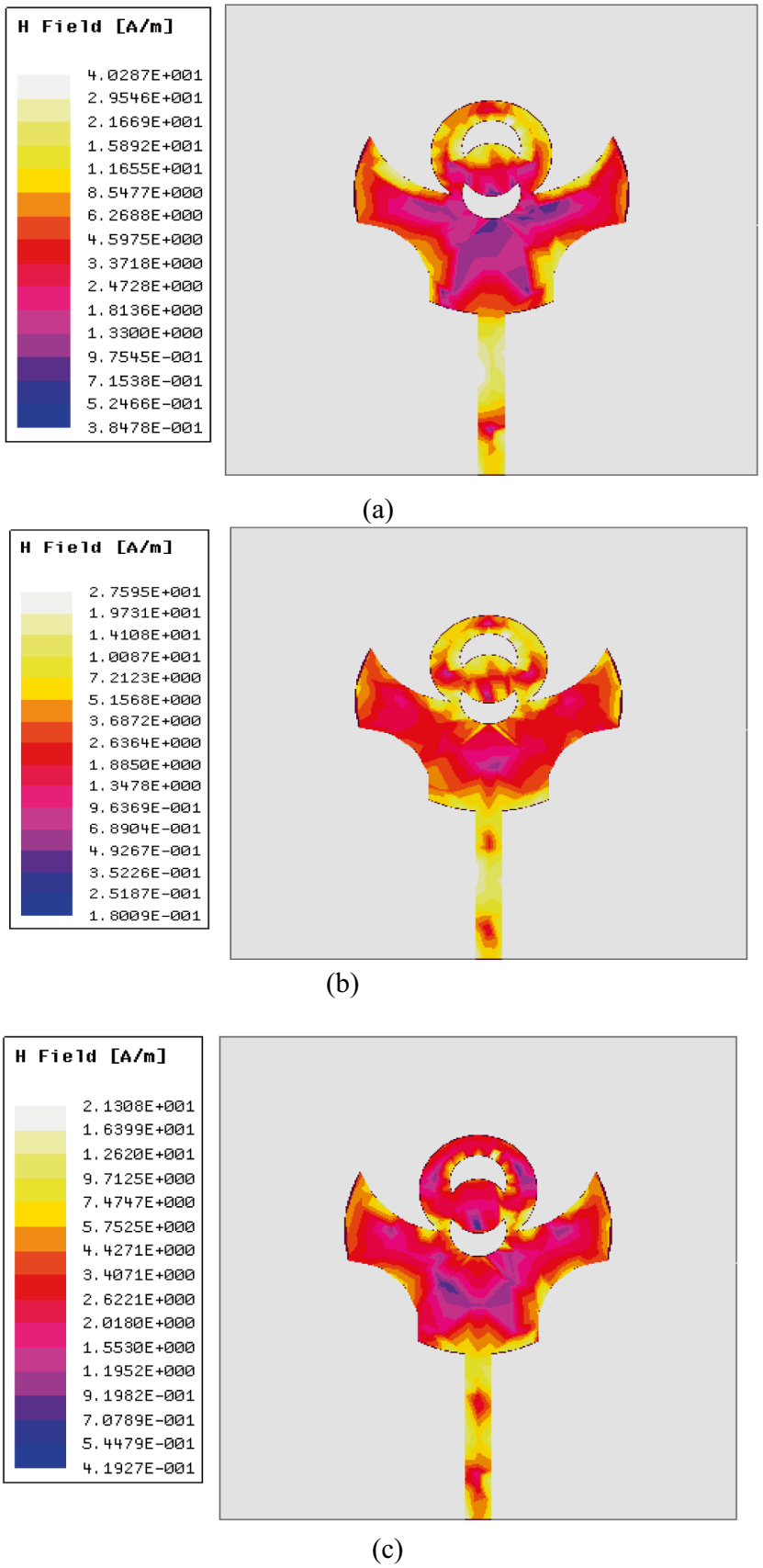



**Fig. 9** Simulation of the H-field current flow study on the patch at **a** 8.3 GHz, **b** 10.3 GHz, **c** 11.69 GHz

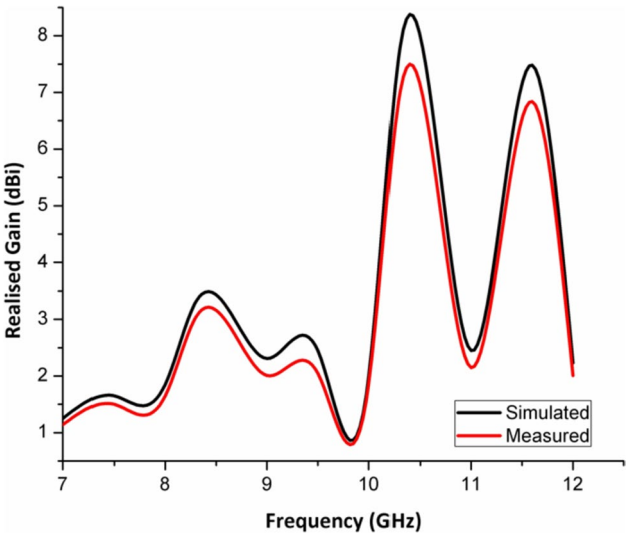



**Fig. 10** Realized gain at three operating frequencies

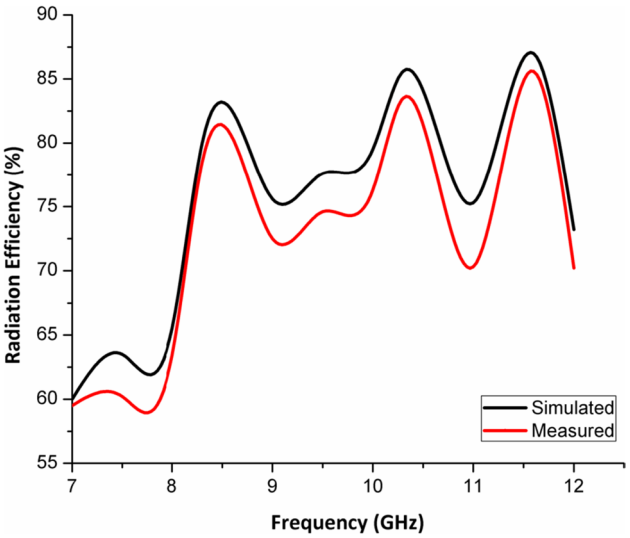



**Fig. 11** Radiation efficiency at resonant bands

7.48 dB, showing a close alignment between simulated and measured values.

The suggested antenna gain at corresponding frequencies is given in Fig. 11. The observation of simulated and experimental case studies is closely seen in Table 4. The suggested antenna design is also compared with other models in Table 5. When compared with the results and dimensions of the suggested model with other works, the proposed model outperforms.

## Conclusion

In this study, a novel dual-wing structured monopole antenna with multiband features is proposed. The multiband operating frequencies are achieved by etching circular curved slots on the radiating patch. The proposed model is designed for X-band applications at 8.3 GHz, 10.3 GHz, and 11.6 GHz operating frequencies featuring satellite, and space applications. The impact of varying slot width and length on both the center frequency and bandwidth of the notched bands is systematically examined through parameter analysis. Finally, the suggested antenna offers the capability to operate across multiple frequency bands within the X-band range. To achieve the wing-shaped configuration, the parasitic patch is etched symmetrically with smaller semi-circular patches. To enhance accuracy, the performance assessment of the proposed antenna employs surface current methods.

**Author Contribution** Conceptualization: R. Thandaiah Prabu, M. Benisha, P. Kalpana Devi, R. Harikrishnan. Data curation, formal analysis, investigation: T. Gomathi, Kandrapu Rajesh Kumar, T. D. Subha, Shaik Hasane Ahammad, M. Suman, Md. Amzad Hossain, Ahmed Nabih Zaki Rashed. Methodology: Shaik Hasane Ahammad, M. Suman. Resources, software: R. Thandaiah Prabu, M. Benisha, Shaik Hasane Ahammad, M. Suman. Supervision, validation: Shaik Hasane Ahammad, Ahmed Nabih Zaki Rashed, Md. Amzad Hossain. Visualization; writing—original draft: T. Gomathi, Kandrapu Rajesh Kumar, T. D. Subha, Ahmed Nabih Zaki Rashed, Shaik Hasane Ahammad. Writing—review editing: R. Thandaiah Prabu, Md. Amzad Hossain, Shaik Hasane Ahammad, Ahmed Nabih Zaki Rashed.

**Table 5** Comparison of this study with published works

| Ref. no. | Size (mm) | Freq (GHz) | $S_{11}$ (dB) | Bandwidth (MHz) | Gain (dB) |
|---|---|---|---|---|---|
| [20] | 48×35×0.8 | 1.6–3 | −15 | 1400 | 6.8 |
| [24] | 50×30×1.6 | 1.81, 3.7, 5.9, 8.94, 12.7 | | 660, 640, 2300, 1870 | 6.5 dBi |
| [25] | 45×50×1.6 | 3.32–3.65, 4.67–5.15 | −15, −20 | 300, 480 | 5.12, 5.02 |
| [26] | 70×70×0.8 | 1.66–2.71 | −15 | 1000 | 9.5 |
| This work | 38×38×1.6 | 8.32, 10.33, 11.69 | −12.66, −27.1, −30.3 | 300, 620, 510 | 3.33, 7.78, 7.48 |

**Data Availability** Not Applicable.

## Declarations

**Ethics Approval** Not applicable.

**Consent to Participate** Not applicable.

**Consent for Publication** Not applicable.

**Competing Interests** The authors declare no competing interests.

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# DESIGN OF A NOVEL PI FUNCTIONAL OBSERVER BASED LOAD FREQUENCY CONTROLLER FOR INTERCONNECTED POWER SYSTEM

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**ABSTRACT**

The increase in population has led to the increase in the demand of the power in terms the size and. To meet this demand a decentralized power structure has emerged. The main advantage of decentralized power system is to overcome the delay in decision making unlike the centralized power system. In the present paper, load frequency control (LFC) in the decentralized scenario is analyzed using state space. The stability of the power system can be observed through a state-feedback controller rather than being directly monitored by the system Instead of guessing the system states, a Functional Observer (FO) is made to evaluate the control input. The stability can also be guaranteed by using the suggested controller, as the observer gains can be calculated theoretically. An industry-standard IEEE test system is used to evaluate the effectiveness of the suggested methods. It has been found that functional observers perform more effectively than both functional and traditional state observers.

**Keywords:** *Inter Connected Power System, Load Frequency Control (LFC), PI Functional Observer, Leunberger Observer*

## 1. INTRODUCTION

In Science and Engineering estimation of the system's state and its analysis is a crucial aspect. Measuring the input and output values are a straightforward way to learn about the internal state of any given system. Dynamic state estimation (DSE) is the name given to the investigation of internal elements that lead to changes in the provided system in this method. [10] The majority of engineering areas (via. Electrical, Electronics, Civil, Mechanical, Aerospace, Chemical, etc. [18]) areas can use this DSE)

On the other hand, a sub system called observer Even though it is a component of another system, an observer only uses the system's input and output to estimate the internal states or circumstances of that system. This nomenclature is proposed by D.Luenberger initially in 1966[37]. State Observers, Functional Observers and Bounding Observers are often used [5]. Observer and state observer are the terms used in industrial applications, are interchangeable. Instead, Functional Observer employs probabilistic and statistical method in their work. These are typically offered in scaled down versions and are created for Linear Time Invariant (LTI) systems [3].

This Paper primarily discusses the use of above mentioned observers where Transmission line failures, generator failures, changes in demand (power), changes in system configuration, and other disturbances commonly occur in the power system. In order to bring the system to the equilibrium state i.e., to the stable state in a rapid way the proposed system is used. The absence of the feedback observers in the earlier methods is a big disadvantage. This lacks the continuous monitoring of the system. With the state feedback observers the continuous monitoring is easy. Therefore the Proposed method is more advantageous than the earlier methods.

The power transported can be calculated using State Observers. The term "tie-lines" is frequently used to describe the transmission lines in use [7]. The same supply frequency must be used by all the units in any area of the Tie-Line.

All the areas and equipment operating in steady state are shielded from frequency changes and tie line changing by the Load Frequency Control (LFC) method [31]. This article major goal is to provide thorough examination of linear and Non-linear DSE method for LFC and detection of fault using phasor measurement units (PMU's) [35].These days the Power system is integrated with different types of generators , transmission network and measuring devices[11] which share the properties similar to that of conventional power system.

## 2. MULTI-AREA POWER SYSTEM MODEL

In this study, a linearized version of the model employed in [24] is considered. The $i^{th}$ region of the N-area power system is depicted in Fig 1 and its state-space model is represented by

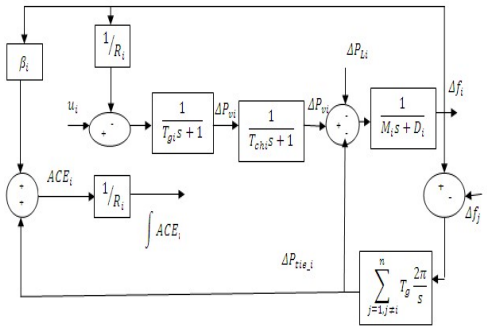


*Figure 1: Dynamic model of the $i_{th}$ area in a N-area LFC scheme*

$$\dot{x}_i = A_i x_i + \sum_{j=1,j\neq i}^{N} \Delta A_{ij} x_j + B_i u_i + F_i d_i$$

$$y_i = C_i x_i \qquad (1)$$

$x_i$ is the state vector; $u_i$ is the control input; $d_i$ is the vector of load disturbance; $y_i$ is the output vector; $\Delta f_i, \Delta P_{mi}$, $\Delta P_{vi}$ and $\Delta P_{Li}$ are the mechanical output of the generator, the load, the valve position, and the frequency deviations, accordingly. $M_i$, $D_i$, $T_{gi}$, $T_{chi}$, and $R_i$ signify the governor's time constant, the turbine's time constant, the speed drop, the generator's moment of inertia, and the generator's damping coefficient.; $\beta_1$ is frequency bias factor; $T_{ij}$ is the tie-line synchronizing coefficient between the $i^{th}$ and $j^{th}$ control area; $\sum_{j=1,j\neq i}^{N} \Delta a_{ij} x_j$ are the area-interactions $a_i \in R^{n_i \times n_i}$., $a_{ij} \in R^{n_i \times n_j}$, $B_i \in R^{n_i \times m_i}$, $F_i \in R^{n_i \times q_i}$, and $C_i \in R^{p_i \times n_i}$ are known constant matrices. According to (1), The N-area power system's state-space model can be modelled as

$$\dot{x} = ax + \Delta ax + Bu + Fd$$

$$y = cx \qquad (2)$$

$$\Delta a = [0\ \Delta a_{12} \cdots \Delta a_{1N}\ \Delta a_{21} \vdots\ 0 \vdots \cdots \ddots\ \Delta a_{2N} \vdots\ \Delta a_{N1}\ \Delta a_{N2}\ 0\ ]$$

$a \in R^{n\times n}$, $\Delta a \in R^{n\times n}$, $B \in R^{n\times m}$, $F \in R^{n\times q}$, and $C \in R^{p\times n}$, are known constant matrices, where $n = \sum_{i=1}^{N} n_i$, $m = \sum_{i=1}^{N} m_i$, $q = \sum_{i=1}^{N} q_i$ , and $p = \sum_{i=1}^{N} p_i$

## 3. EMPLOYING FUNCTIONAL OBSERVERS FOR DSE AND LFC IN THE POWER SYSTEM

A functional observer (FO) model is implemented in a power system with two interconnected areas, connected by a single tie-line. This quasi-decentralized FO model is considered the most suitable for this network configuration [14]. The FO serves as the basis for creating a model that can observe the system's behaviour and dynamics. In this setup, the load frequency control (LFC) signal is generated using a control signal. Instead of constructing the control signal by combining individual state signals, the required signal is directly obtained from the functional observer (FO).

To monitor the power consumed, voltage magnitudes, phase angles, and current magnitude of the tie-line, Phasor Measurement Units (PMUs) are utilized. These devices provide accurate measurements and enable real-time monitoring of the system's electrical quantities.. Before actually designing the Novel Functional Observer (FO) the state estimation and different parameters like Peak overshoot, settling time etc., of different Observers are measured.

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### 3.1 State Observer/Estimator

Because of data acquisition issues and cost limitations, it might not be possible to monitor every state variable under actual circumstances. In order to obtain state feedback [35] a state estimate method is needed for each state of the state vector.

Let x^(t)=estimate of the state vector x(t)

State Observer/Estimator

$\dot{x}=\alpha x+Bu$ (3)

$y=cx$ (4)

The state vector in this case is x, and the output is y. (It also contains a state vector x estimate). u is a representation of the control signal.

Open-loop Observer (L= [0], α obs= α)

$\hat{x}(t)=\alpha x^{\wedge}(t)+Bu$ (5)

The observer fails due to disturbances in the system and modelling mistake of system.

Open-Loop Estimation Error,

Estimation Error:

$\tilde{x}(t)=x(t)-x^{\wedge}(t)$ (6)

$\tilde{x}(t)=x^{\cdot}(t)+(x^{\wedge}(t))=A\alpha(t)$ (7)

Hence

$\tilde{x}(t)=e^{\wedge}At\ \tilde{x}(0)$ (8)

Error Dynamics:

Errors in the modelling process cannot be corrected. State matrix A, which is not stable and with an unbounded error.

$\tilde{x}=\alpha x^{\wedge}+Bu+L(y-Cx^{\wedge})$

$\tilde{x}=\alpha_{obs}\ x^{\wedge}+Bu+Ly$ (9)

where, $\alpha_{obs}=\alpha-LC$ (10)

The matrix L is given Eigen values. To obtain the accurate estimation, it is necessary to simplify the equation with respect to an open-loop observer.

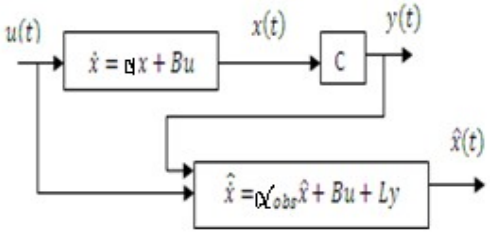


*Figure 2: Block diagram of observer*

Theorem1:

Unless the dual system ($\alpha^T$, $C^T$) is subjected to control, the system (C,$\alpha$) is observable [35]. As long as ($\alpha^T$, $C^T$) is in control, Eigen values can be (stable) allocated randomly with the use of the state's feedback.

$\dot{x}=\alpha^T x+C^T u$ (11)

$u=-L^T x$ (12)

$\dot{x}=(\alpha^T-C^T L^T)x$ (13)

$(\alpha^T-C^T L^T)^T=\alpha-LC$ (14)

Similar Eigen values are obtained.

### 3.2 Functional Observer

Functional Observer performs better than State Observer when applied to load frequency control (LFC) [36].

Functional observer

$\dot{x}=\alpha x+Bu$ (15)

$y=Cx$ (16)

$z=Lx$ (17)

Where x,y, z ,w and u are functions of time 't'.

Here, $x\in R^n, u\in R^m$ are the vectors of the state considered, $y\in R^p$is the obtained vector of the state and $z(t)\in R^r$ is the vector that is to be estimated. α $\in R^{nxn}$, B $\in R^{nxm}$, C $\in R^{pxn}$ and L $\in R^{rxn}$ are the matrices of the constants that are known. The proposed structure for a Functional Observer is a system that is dynamic and capable of asymptotically tracking the variable z(t):

$\dot{w}=Nw+Jy+Hu$ (18)

$\hat{z}=Gw+Ey$ (19)

The following are the definitions of $\alpha$, B and C, the system matrices and N, J, H, D and E, the observer matrices

$\alpha\in R^{nxn}$ N$\in R^{qxq}$ B $\in R^{nxm}$

J$\in R^{qxp}$ C $\in R^{pxn}$ H $\in R^{qxm}$

L $\in R^{rxn}$ D $\in R^{rxp}$ E $\in R^{rxp}$

Theorem 2*:*

By using the q[th] order Functional Observer of (18) and (19), Lx (t) is estimated,

Provided the following conditions are met:

N is a stability matrix

JC = P $\alpha$ -NP (20)

H = PB (21)

L = DP + EC (22)

In state estimation, the observer error is expressed as

e(t) ≜w- Px (23)

Where, w and x are functions of time't'.

By derivation, we get

$\dot{e}(t)=\dot{w}(t)+\dot{P}\dot{x}(t)$ (24)

$\dot{e}(t)=Nw(t)+JC\dot{x}(t)+Hu(t)-PAx(t)-PBu(t)$ (24)

Applying conditions (15) and (16) yields

$\dot{e}(t)$ =N e(t) (25)

The above solution is in the manner of an exponential function

$e(t)=e^{Nt}$ (26)

in which dynamics of the observer are organised by the variable named N in (26).

On the application of the conditions,

$$e(t) = w - Px \quad (27)$$

By simplifying,

$$e(t) = \hat{z} - Lx = D(w-Px) \quad (28)$$

The above equation should asymptotically approach zero. Note that α and N has no common Eigen values, but P has a single solution. And, X and e can be derived easily from the above conditions.

$$\dot{x}(t) = \alpha x(t) + Bu(t) = \alpha x(t) - B(Dw(t) + Ey(t))$$

$$\dot{x}(t) = (\alpha + BL)x(t) + (BD)e(t) \quad (29)$$

$$\dot{e}(t) = Ne(t) \quad (30)$$

This results in a composite system similar to the full-state observer as

$$[\dot{x}(t) : \dot{e}(t)] = [K_1 : K_2 \; : K_3 \; K_4][x(t) : e(t)] \quad (31)$$

Where, $K_1 = \alpha + BL \quad K_2 = BD$

$K_3 = 0 \quad K_4 = N$

Apart from the fact that instead of -Kx(t) the control law is assigned with Lx(t) and the difference in representation, they are identical to each other. Considering the given constraints, achieving a functional state of the system requires an $r^{th}$ order observer, where the order r should be minimized. The observer matrices must be designed to facilitate ease of assigning Eigen value and easiness of the control algorithm, enabling easy application. In order to estimate the order, the ranks of the matrix are considered into account.

$$rank[L\alpha \; C\alpha \;\; C \; L] = rank[C\alpha \; C \; L] \quad (32)$$

$$rank[sL - L \; C \; L] = rank[C\alpha \; C \; L] \;\; s \in C, R(s) \geq 0 \quad (33)$$

When the ranks on both the left-hand side (LHS) and the right-hand side (RHS) are equal, the condition is considered satisfied. According to the findings of the author in reference [21], this condition is equivalent to the detectability of the pair (F, G)

Where

$$F = L\alpha L^{+} - L\alpha(I - L^{+}L)[C\alpha(I - L^{+}L) \; C(I - L^{+}L)]^{+}[CA\alpha \; CL^{+}] \quad (34)$$

$$G = (I - [C\alpha(I - L^{+}L) \; C(I - L^{+}L)][C\alpha(I - L^{+}L) \; C(I - L^{+}L)]^{+})[C\alpha L^{+} \; CL^{+}] \quad (35)$$

Where, L+ denotes the Moore-Penrose generalized inverse of matrix L. Furthermore, if matrices J, H, and E satisfy Theorem 1, a Hurwitz matrix N can be expressed as follows.

$$N = F - ZG \quad (36)$$

Where, the matrix Z is obtained through a pole placement method to ensure stability of the system, specifically F - ZG. E and K matrices are derived based on the given equation.

$$[E : K] = L\bar{\alpha}\Sigma^{+} + Z(I - \Sigma\Sigma^{+}) \quad (37)$$

Where,

$$\bar{\alpha} = \alpha(I - L^{+}L), \quad \bar{C} = C(I - L^{+}L)$$

and $\Sigma = \bar{C}\,\bar{\alpha}\,\bar{C}$

Matrix J, H are obtained according to

$$J = K + NE \quad (38)$$

$$H = (L - EC)B \quad (39)$$

By employing this algorithm, it becomes straightforward to compute all the necessary observer parameters, ultimately leading to the construction of a functional observer in the specified form.

$$\dot{w}(t) = Nw + Jy + Hu \quad (40)$$

$$\hat{z}(t) = w + Ey \quad (41)$$

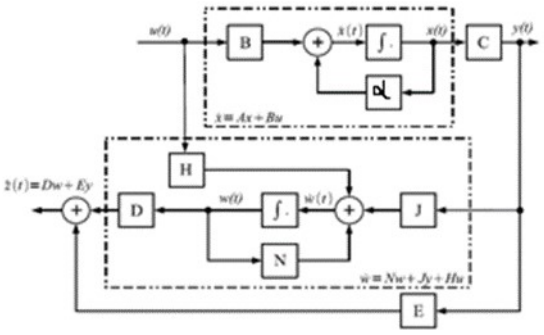


*Figure 3: Schematic of a Functional Observer*

### 3.3 Functional observer with a Conventional Controller

Simple presumptions (One approach is to integrate transmission lines and multiple bus bars into a single unified unit, approximating all generators in a particular region into one producing unit, etc.) may not be adequate for such a complicated power system to function when the distribution network becomes more complex. Without making these assumptions, we analyze a semi-distributed functional observer method in this research for cross-line power and frequency management in multi-area interconnection power networks [13]. The creation of control signals and the use of the semi-distributed functional observer were also taken into consideration using a two-domain linear system coupled to a single connection line model. The F0 [3] technique to LFC in highly linked power grids is further

developed as a result. Estimating the control signal is required during the LFC signal generation procedure. Using a functional observer to directly estimate the desired signal is more sensible than estimating each individual state and then combining these estimates linearly to generate the control signal [5]. Here, a semi-dispersive functional observer for producing control signals is taken into consideration. A functional observer (FO) estimation technique utilizes PMU measurements of voltage, current, phase angle, and tie-line power measurements [2]. The proposed FO-based controller is characterized by its straightforward design and performance that is comparable to full-order observers. Additionally, functional observability standards are fewer strict than governmental standards, because analysis and design take the complete network topology into account [l 2].

## 4. DESIGN OF FO BASED CONTROLLER

Let the estimate of e be ê.

$$\dot{\hat{\tilde{e}}} = \alpha\hat{\tilde{e}} - B\Gamma_c^T\hat{\tilde{e}} + \Gamma_o(e_1 - \hat{e}_1) \quad (42)$$

Where, $\Gamma_0 \equiv [\gamma_1^o, \gamma_2^o, \dots, \gamma_n^o]^T \epsilon R^m$ is the gain vector of the observer.

Observer error,

$$\dot{\tilde{e}} = \alpha_o\tilde{e} + B(g(x)(u^* - u_{PID} - u_d - u_s) - d) \quad (43)$$

Assuming the observability of (C, α), the gain vector of the observer Γo could be rigorously selected to be Hurwitz, accompanied by a symmetric positive definite matrix P and a positive definite matrix Qo. If we consider the Laplace transform L(.) of $\tilde{e}_1$, the resulting transform function may be expressed as L($\tilde{e}_1$) by choosing $M(s)$ such that $M(s) = s^m + b_1 s^{m-1} + \cdots + b_m,\ m < n$ and $M^{-1}(s)$ is a proper stable transfer function and $N(s)M(s)$ is a proper SPR transfer function. Hence $L(\tilde{e}_1)$ can be written as:

$$L(\tilde{e}_1) = N(s)M(s)M^{-1}(s)L(g(x)(u^* - u_{PID}) - d) - N(s)M(s)M^{-1}(s)L(g(x)u_d) - N(s)M(s)M^{-1}(s)L(g(x)u_s) + N(s)M(s)L(u^* - u_{PID}) - d) - L(u^* - u_{PID})) \quad (44)$$

Represent the function φ such that

$$L(\varphi) = M(s)^{-1}L(g(x)(u^* - u_{PID}) - d) - L(u^* - u_{PID}).$$

Hence, the dynamic equation can be written as

$$\dot{\tilde{e}}_1 = C_m^T\tilde{e} \quad (45)$$

Where, $B_m = [0,0,\dots,0,0,\dots,b_1,b_2,\dots b_m]^T \epsilon R^n$, $C_m = [1,0,\dots 0]^T \epsilon R^n$

For further analysis, there is necessity of 2 assumptions mentioned below:

Assumption 1: The uncertain non-linear function $f(x)$ for the states is bounded by a upper bound function $f^u(x)$, i.e., $f(x) \le f^u(x)$. The uncertain non-linear function $g(x)$ related with the input is bounded by $g_l \le \| g(x) \| \le g^u$ where both upper and lower boundaries $g^u$ and $g_l$ are positive constants.

Assumption 2: The function $\varphi$ is bounded by $\| \varphi \| \le \varepsilon$ where $\varepsilon$ is a positive constant.

On differentiation of V w.r.t to t, we get

$$\dot{V} = \frac{1}{2}\left((\tilde{e}^T\alpha_0^T P\tilde{e} + \tilde{e}^T P\alpha_0\tilde{e}) + (u^* - u_{PID} + \varphi - \tilde{u}_d - \tilde{u}_s)^T B_m^T P\tilde{e} + \tilde{e}^T PB_m(u^* - u_{PID} + \varphi - \tilde{u}_d - \tilde{u}_s)\right) \quad (46)$$

But it is given that,

$$\alpha_0^T P + P\alpha_0 = -Q \quad (47)$$

And $$PB_m = C_m \quad (48)$$

Where, $Q = Q^T > 0$. Substituting (47), (48) and (45) in (46) we get,

$$\dot{V} \le -\frac{1}{2}|\tilde{e}^T Q\tilde{e}| + |e_1||u^* - u_{PID}| + \tilde{e}_1(\varphi - \underline{u}_d) - \tilde{e}_1\underline{u}_s \quad (49)$$

From the above assumptions, $u_d$ can be designed such that $\tilde{e}_1(\varphi - \underline{u}_d) \le 0$.

$$u_d = \varepsilon + k, \quad (50)$$

$$if\ \tilde{e}_1 \ge 0\ and\ \varphi > 0\ 0$$
$$if\ \tilde{e}_1 \ge 0\ and\ \varphi < 0\ 0$$
$$if\ \tilde{e}_1 \ge 0\ and\ \varphi > 0 - (\varepsilon + k),$$
$$if\ \tilde{e}_1 \ge 0\ and\ \varphi < 0$$

Where, k is a positive constant. Substituting $u_d$ in (49),

$$\dot{V} \le -\frac{1}{2}|\tilde{e}^T Q\tilde{e}| + |\tilde{e}_1||u^* - u_{PID}| - \tilde{e}_1\tilde{u}_s$$

$$\dot{V} \le -\frac{1}{2}\lambda_{min}(Q)|\tilde{e}_1|^2 + |\tilde{e}_1||u^* - u_{PID}| - \tilde{e}_1\tilde{u}_s \quad (51)$$

$$\dot{V} \le \ -1/2\,\lambda\_min\,(Q)\,|e\hat{}\_1\,|\hat{}2 + |e\hat{}\_1\,|(1/|g\_1\,|\,(|f\hat{}u\,(x\hat{})| + |y\_m\hat{}((n))\,| + |\Gamma\_e\hat{}T e\hat{}\,|\,) + |u\_PID\,|\,) - e\hat{}\_1\,u\_s\,) \quad (52)$$

$$V_d(K_{PID}) \le -\frac{1}{2}\lambda_{min}(Q)|\tilde{e}_1|^2 + |\tilde{e}_1|\left(\frac{1}{|g_1|}\left(|f^u(\hat{x})| + |y_m^{(n)}| + |\Gamma_e^T\hat{e}|\right) + |u_{PID}|\right) \quad (53)$$

If $K_{PID}$ estimated by MGA results in $\dot{V}_d(K_{PID}) < 0$, $\dot{V} < 0$ is satisfied: given that $u_s$ is not applied to the input in (12). On the other hand, if $\dot{V}_d(K_{PID}) > 0$, $u_s$ should be applied leading to the

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condition $\dot{V} < 0$.

To mitigate the destabilizing effect caused by the inclusion or exclusion of $u_s$ in the PID controller, a gate function can be introduced.

## 5. RESULTS AND DISCUSSIONS

The method employed has been simulated using Simulink (Matlab) and the demand increase for the first area is $\Delta P_{D1}$ and second area is $\Delta P_{D2}$. Both the first area's demand ($\Delta P_{D1}$) and the second area's demand ($\Delta P_{D2}$) have been evaluated against input perturbations. Figures 4 to 6 demonstrate how the system reacts more rapidly in terms of control, which also eliminates frequency variations. Therefore, in terms of control and frequency damping, under all operational conditions, the theoretical model outperforms the FOWO and Full order Luenberger Observer (FOLO). Table 1 presents a quantitative analysis of the performance resilience under different operating conditions. It includes the settling time, undershoot, and overshoot values determined for various operational points. The numerical results are displayed for the operating point with a 10% band of step load change. The recommended PI Functional Observer (PIFO) outperforms both the FOWO and LO, as shown in Table 1.

From the Table 1 it can be observed that the PI Functional Observer has less settling time than the other observers. From the results obtained it is PIFO settles 27% faster than FOLO and settles 48% faster than FOWO. Also the Overshoot and Undershoot values at different operating points have been improved in PIFO than FOLO and FOWO.

*Table 1: $f_1(t)$ Response in Various Strategies of Performance*

| Operating point | Controller | Over shoot (P.U) | Under shoot ( P.U) | Setting time (sec) |
|---|---|---|---|---|
| 1 | PI Functional Observer | 0.09419 | -0.0990 | 4.758 |
| | Full order Luenberger Observer | 0.1220 | -0.0990 | 6.505 |
| | Functional Observer without controller | 0.1073 | -0.0990 | 9.187 |
| 2 | PI Functional Observer | 0.1039 | -0.1147 | 4.616 |
| | Full order Luenberger Observer | 0.1163 | -0.1147 | 6.125 |
| | Functional Observer without controller | 0.1214 | -0.1147 | 6.967 |
| 3 | PI controller based Functional Observer | 0.1025 | -0.1108 | 4.804 |
| | Full order Luenberger Observer | 0.1143 | -0.1108 | 6.326 |
| | Functional Observer without controller | 0.1188 | -0.1108 | 7.241 |

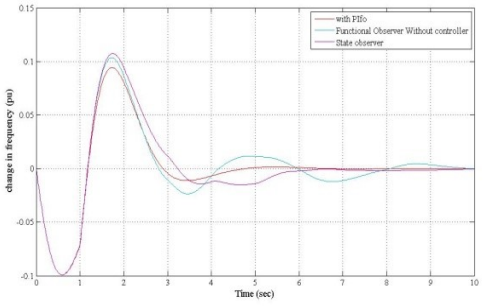


*Figure 4: Frequency variation resulting from a step rise in demand at OP 1 (OP refers to operating point)*

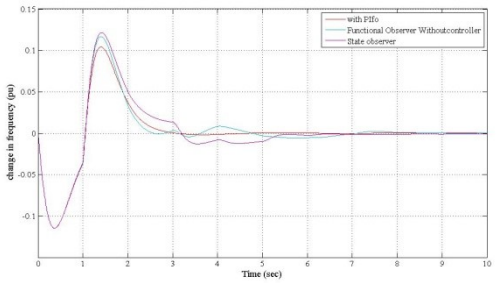


*Figure 5: Frequency variation resulting from a step rise in demand at OP 2*

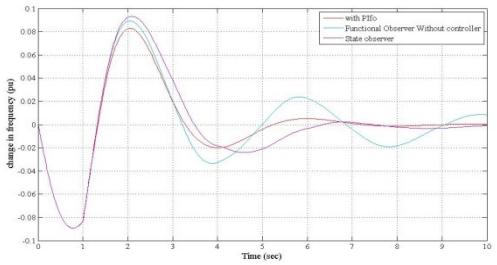


*Figure 6 : Frequency variation resulting from a step rise in demand at OP 3*

## 6. CONCLUSIONS

The load frequency control has been addressed in this paper employing the utilization of a PI Functional Observer (PIFO) as a viable approach for addressing the multi-area power system. A comparative performance evaluation was conducted on a usual two-area thermal power system with reheat capability. The objective was to assess its ability to attenuate disturbances and accurately track reference frequencies under various load conditions. During the evaluation, the suggested Observer model's performance was compared to that of a Functional Observer, which operates without a conventional controller, and a Luenberger Observer. Various operating conditions were considered, and the evaluation was based on criteria such as settling time and maximum overshoots/undershoots. The proposed Observer here shows the robustness in terms of stability and consistency in performance.

Though the required parameters achieved are better than the other observers but the complexity of the system will be more as the system size increases. This is not considered in this paper.

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