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A REFINED WIRELESS DIGITAL BILLBOARD SYSTEM FOR DISPLAYING REAL-TIME MESSAGES EFFICIENTLY

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ABSTRACT

This paper introduces an optimized system for displaying real-time messages on wireless digital billboards. Traditional methods of disseminating information, such as newspapers, television, radio, and the internet, have limitations in reaching a wide audience effectively. Digital billboards have emerged as a promising technology to improve information dissemination globally, especially for commuters and students. This research focuses on leveraging GSM technology to enhance message display on wireless digital billboards for commuters and students within a campus environment. The digital billboard system includes components for message input (text messages from mobile phones), control (microcontroller), and communication.

Keywords: GSM, Digital Billboard, SMS, microcontroller, buzzer and LED

1. INTRODUCTION

The evolution of communication technologies has significantly transformed how information is disseminated to the public. Traditional methods like newspapers, television, radio, and billboards have served as effective channels, but they are not without limitations, particularly in reaching a mobile and diverse audience. As society becomes increasingly connected and mobile, there is a growing demand for innovative approaches to deliver information in real-time and to a wider audience. Digital billboards have emerged as a modern solution to address these challenges by offering dynamic, eye-catching displays that can convey messages efficiently and interactively.

Digital billboards leverage advancements in display technology, wireless communication, and multimedia content to deliver targeted messages to audiences in various locations. Unlike static billboards, digital displays can be updated remotely and in real-time, allowing advertisers and content providers to adapt quickly to changing circumstances or events. This flexibility has made digital billboards popular for advertising, public service announcements, and information dissemination in urban areas, transportation hubs, and educational institutions.

In recent years, the use of digital billboards has expanded beyond commercial advertising to encompass broader applications such as public service announcements and campus information displays. For commuters and students, digital billboards offer a dynamic platform to access relevant information on-the-go. By integrating GSM technology into digital billboard systems, this research aims to enhance the accessibility and interactivity of message displays, enabling users to interact with the displays using their mobile phones. This approach not only improves the efficiency of information delivery but also enhances user engagement and responsiveness to displayed content.

RELATED WORKS

Several studies and projects have explored the integration of GSM technology with digital displays to enhance real-time message dissemination. One notable project is the implementation of GSM-enabled digital billboards in transportation systems to provide commuters with up-to-date travel information and service alerts. For example, in urban areas with extensive public transportation networks, digital billboards equipped with GSM technology can display real-time bus schedules, train delays, or traffic updates, helping commuters make informed travel decisions.

In the education sector, the use of GSM-enabled digital billboards has been investigated to improve campus communication and student engagement. Research has shown that interactive displays featuring GSM integration can facilitate campus-wide announcements, event notifications, and emergency alerts. These displays can be strategically placed in high-traffic areas such as student lounges, libraries, or cafeteria entrances to maximize visibility and reach among students and faculty.

Another area of interest is the application of GSM technology in outdoor advertising and marketing campaigns. By incorporating GSM-enabled features into digital billboards, advertisers can create interactive and personalized experiences for consumers. For instance, users can send text messages to a designated number displayed on the billboard to receive more information about a product, participate in a contest, or redeem a promotional offer, transforming passive viewers into active participants. Research has also explored the technical aspects of GSM integration with digital billboards, focusing on optimizing communication protocols, security measures, and user interfaces. Efforts have been made to develop robust systems that can handle high volumes of incoming messages, ensure data privacy, and provide seamless interaction between users and the digital display. These technical advancements are essential for maintaining reliable and efficient message delivery in diverse environments and usage scenarios.

2. SYSTEM DESIGN METHODOLOGY

The methodology for implementing an optimized real-time wireless digital billboard message display system involves several key components and stages. First, the hardware and software infrastructure must be carefully designed to support wireless communication and real-time message processing. This includes selecting appropriate microcontrollers, GSM modules, display screens, and integrating them into a cohesive system architecture.

The heart of the system lies in the microcontroller unit, which serves as the central processing unit responsible for coordinating communication between the GSM module and the display screen. The microcontroller is programmed to handle incoming text messages from mobile phones, process these messages according to predefined protocols, and generate commands to update the digital display with the received content. Special attention is given to optimizing the firmware to ensure efficient utilization of resources and reliable operation under varying conditions.

The GSM module plays a crucial role in establishing wireless connectivity and facilitating communication between mobile devices and the digital billboard system. It enables the receipt of text messages from users' mobile phones, which are then transmitted to the microcontroller for further processing. The selection of a robust and reliable GSM module is critical to ensure seamless message transmission and reception, especially in environments with varying signal strengths or network conditions.

In parallel, the display screen technology is carefully chosen to meet the requirements of a dynamic digital billboard system. The display screen must be capable of rendering text and graphical content in real-time, with sufficient brightness and resolution to ensure visibility in different lighting conditions and viewing distances. The integration of the display screen with the microcontroller unit involves configuring communication protocols and optimizing display drivers to achieve responsive and accurate message rendering. By leveraging a combination of advanced hardware and software technologies, the system methodology aims to deliver an optimized and efficient real-time wireless digital billboard message display solution.

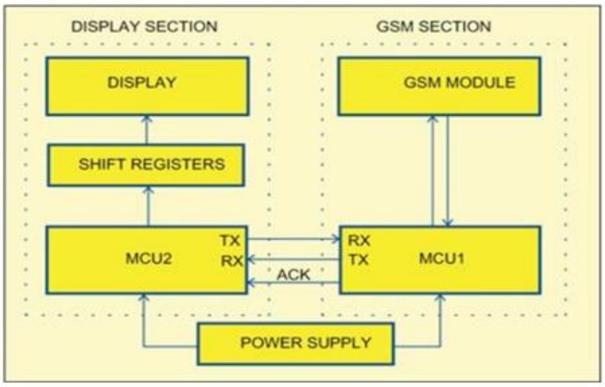

Fig.1. The block of the digital billboard display system

Hardware Components:

Microcontroller Unit: The microcontroller serves as the central processing unit of the system, responsible for controlling and coordinating various hardware components. Key considerations for selecting a microcontroller include processing power, memory capacity, and compatibility with communication interfaces such as UART for interfacing with the GSM module and SPI/I2C for communicating with the display screen.

GSM Module: This module enables wireless communication via the Global System for Mobile Communications (GSM) network. It receives text messages from users' mobile phones and transmits them to the microcontroller for processing. The GSM module must support SMS (Short Message Service) functionality and operate on compatible frequencies with the mobile network providers in the target deployment area.

Display Screen: The display screen is the interface through which messages are presented to users. The choice of display technology (e.g., LED, LCD) depends on factors such as visibility requirements (brightness, contrast), resolution, power consumption, and viewing angles. The display screen should be capable of rendering text and graphical content in real-time, ensuring readability under various lighting conditions.

Power Supply: A stable and reliable power supply is essential for the continuous operation of the digital billboard system. The power supply unit must provide appropriate voltage levels to the microcontroller, GSM module, and display screen while incorporating safeguards against voltage fluctuations and power surges.

Antenna: The GSM module requires an antenna for transmitting and receiving signals over the cellular network. The antenna's design and placement are critical for optimizing signal strength and minimizing interference, especially in areas with varying network coverage.

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Enclosure and Mounting Hardware: The hardware components should be housed within a robust enclosure to protect them from environmental factors such as dust, moisture, and physical damage. Mounting hardware, such as brackets or stands, may be necessary for securely installing the digital billboard in outdoor or indoor locations.

Connectivity Interfaces: The microcontroller may require additional connectivity interfaces, such as USB or Ethernet, for programming, debugging, or interfacing with external devices. These interfaces facilitate configuration, maintenance, and diagnostics of the digital billboard system.

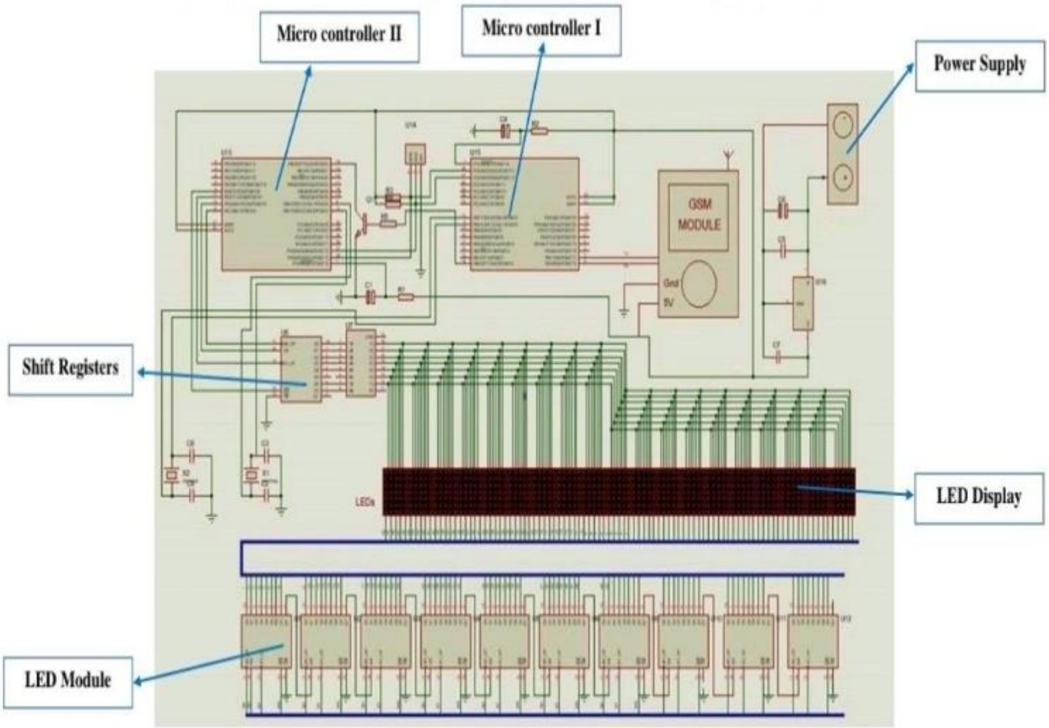

Fig.2: Circuit diagram of the Digital billboard message display

The system algorithm outlined above is designed to handle the reception and display of messages on the digital billboard. Here's a breakdown of the algorithm steps and their flowchart representation:

Initialization (Step 1): The system initializes and prepares for operation.

Sending Message (Step 2): The system is ready to receive a message sent from a mobile phone.

Receiving Message (Step 3): The system checks if any message has been received from the mobile phone.

Checking SMS Code (Step 4): If a message is received, the system checks if it contains a specific code denoting it as intended for the billboard.

Code Verification (Step 5): If the message contains the designated code, the system proceeds to verify the code.

Validating Code (Step 6): If the code matches, the system saves the message to non-volatile memory (EEPROM) for storage.

Message Retrieval (Step 8): The system fetches the stored message from EEPROM.

Validating Message (Step 9): The system checks if the retrieved message is valid and ready for display.

Message Content Verification (Step 10): If the message is valid, the system further checks if it conforms to specific formatting rules (starts with '*' and ends with '#').

Updating Message (Step 12): If the message meets the formatting criteria, it replaces the current message displayed on the billboard with the new message.

Displaying Old Message (Step 13): If the message does not meet the formatting criteria, the system continues to display the existing message.

Stopping (Step 14): The system stops once the message display process is completed.

The flowchart diagram (Figure 3) visually represents the sequence of operations described in the algorithm, illustrating the decision points, conditional branches, and iterative steps involved in processing messages and updating the display content on the digital billboard. This systematic approach ensures efficient handling of incoming messages and seamless presentation of information to users interacting with the digital display system.

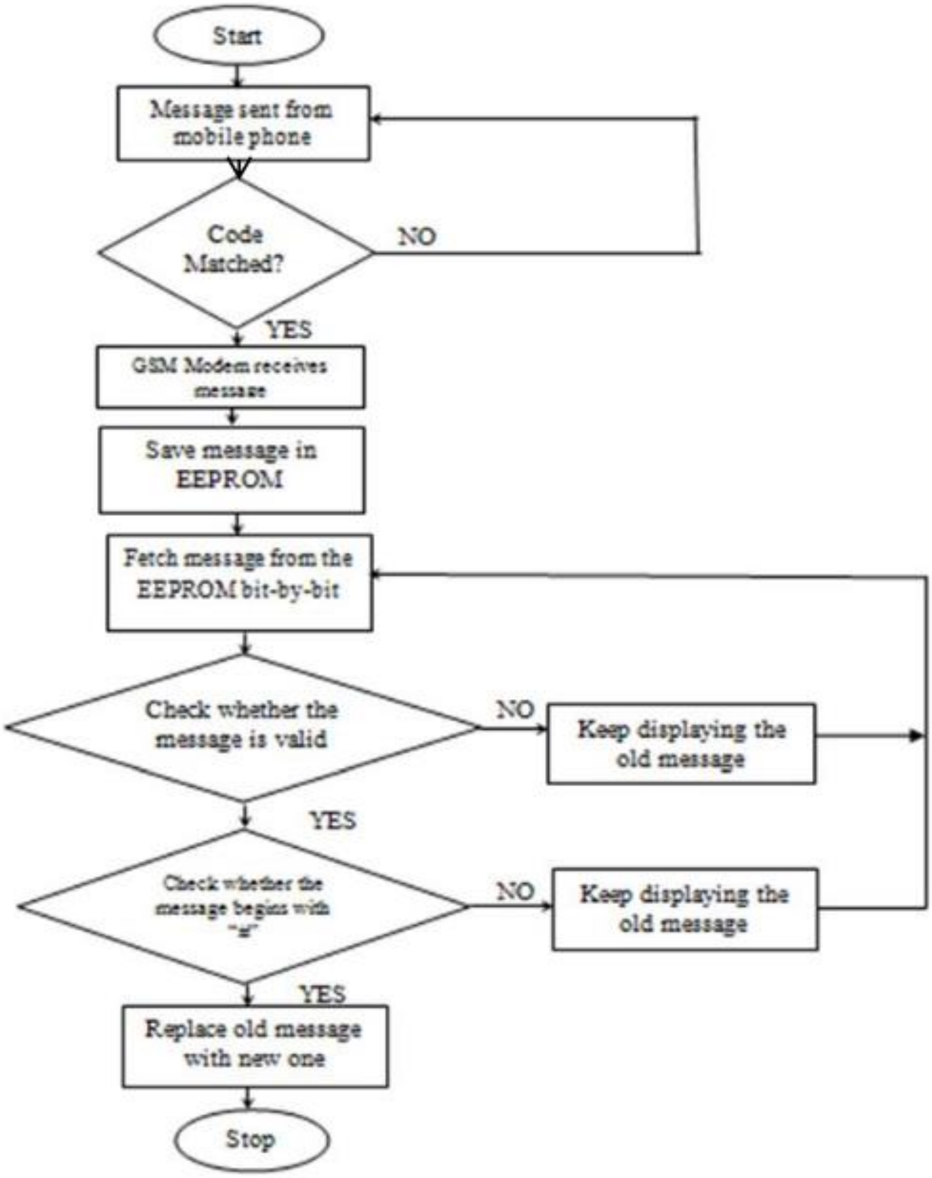

Fig.3. System flowchart for receiving and displaying message

The system software for this project was developed using the C programming language within the Arduino Integrated Development Environment (IDE). C was selected due to its simplicity and ease of coding, making it well-suited for embedded systems like microcontroller-based applications. The use of Arduino IDE provides a user-friendly platform for writing, compiling, and uploading code to the microcontroller, facilitating the development and testing of the system's functionality.

To ensure secure communication and message integrity, a symmetric encryption and decryption approach was implemented. This method allows the system to verify the authenticity of messages before displaying them on the digital billboard. By using encryption techniques, the system can validate incoming messages and prevent unauthorized or tampered data from being displayed to the public.

The prototype system (Figure 4) consists of both hardware and software components. The physical structure of the system is housed within an aluminum casing with specific dimensions (69.0cm x 18.0cm x 18.0cm), providing a robust and compact enclosure for the internal components. The digital billboard message display is constructed using various electronic components, including a microcontroller (such as an Arduino board), a GSM module for wireless communication, a shift register to control multiple LEDs, and a Max232 IC for serial communication interfacing.

The integration of hardware and software components enables the prototype system to receive messages wirelessly, process them securely using encryption techniques, and display the validated content on the LED matrix of the digital billboard. This combined approach leverages the capabilities of both hardware and software to achieve a functional and reliable real-time message display system, suitable for deployment in public spaces such as campuses or transportation hubs.

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Fig. 4: Constructed Digital Billboard Prototype

3. RESULTS

The SMS test for valid and invalid messages was conducted to assess the system's functionality in processing and displaying messages correctly. For valid messages containing both '*' and '#' symbols, such as "Hello, my people", the system successfully received, processed, and displayed the message on the digital billboard without any missing words or errors (see fig.5). This test confirmed the system's capability to handle and display valid SMS messages as intended.

In contrast, the system was also tested with an invalid message, which lacked the '#' symbol at the end. For example, sending the SMS message "*Heloooo" without including '#' resulted in the message not being displayed on the digital billboard. Instead, the billboard continued to display the previously sent message, demonstrating the system's ability to validate and reject invalid or incomplete SMS messages.

Another test conducted was the SMS length test to determine the maximum number of characters that can be reliably received and stored in the microcontroller's hardware serial buffer. It was found that the buffer can reliably store up to 200 characters without truncation or unexpected behavior during text reception. To achieve this, the buffer size in the hardware serial configuration file was updated to 256 characters. This test provided valuable insights into the system's SMS processing capabilities and the maximum length of messages that can be received, acknowledged, updated, and displayed without issues.

Table 1 summarizes the results of the SMS length test, detailing the number of characters tested and the corresponding outcomes. This information is crucial for ensuring the system's reliability and performance under different message lengths and operational scenarios, thereby optimizing its functionality for real-world deployment.

Fig.5. Valid message and its display

The SMS length test is a crucial evaluation to determine the maximum number of characters that a system can reliably handle when receiving and processing SMS messages. This test is particularly important for ensuring that the system functions properly under various conditions without encountering buffer overflows or truncation issues.

During the SMS length test, the following procedures and outcomes were observed:

Test Objective: The objective was to assess how many characters the microcontroller's hardware serial buffer could reliably handle without encountering errors or unexpected behavior.

Buffer Size Configuration: Initially, the buffer size in the hardware serial configuration file was adjusted to accommodate larger messages, typically increased to 256 characters.

Test Execution: Messages of increasing lengths were sent to the system to evaluate its performance:

Short messages (e.g., less than 200 characters)

Medium-length messages (e.g., around 200 characters)

Long messages (approaching the buffer's capacity)

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Observations:

Reliable Reception: It was observed that messages containing up to 200 characters were reliably received and processed by the microcontroller without truncation or data loss.

Buffer Capacity: The buffer's capacity was determined to be sufficient for handling messages of moderate length, up to the configured limit of 256 characters.

System Response: The system responded appropriately to messages within the buffer's capacity, displaying the content as intended on the digital billboard.

Results and Validation: The test results validated the system's capability to handle SMS messages of varying lengths, up to a practical limit determined by the buffer size configuration. This information is crucial for ensuring that the system operates efficiently under normal usage scenarios.

TABLE 1: SMS length test

S/N	Message	Number characters	Received by GSM module
1	*Hello my people#	17	Yes
2	*We are pleased to inform you that the registration fee has been slashed by 30%#	80	Yes
3	*We are pleased to inform you that the registration fee has been slashed by 30%. We are pleased to inform you that the registration fee has been slashed by 30%#	160	Yes
4	*We are pleased to inform you that the registration fee has been slashed by 30%. We are pleased to inform you that the	240	No

The successful sending, reception, and display of a 160-character SMS message is a key demonstration of the system's functionality and reliability. Here's an overview of the process and outcomes:

Sending the SMS: A 160-character SMS message was composed and sent to the designated mobile number associated with the digital billboard system.

Reception and Acknowledgment: The system's GSM module received the SMS message successfully. Upon receipt, the system acknowledged the message and prepared it for processing.

Updating the Display: The received SMS message was processed by the system, which likely involved parsing the content and formatting it for display on the digital billboard.

Display on the Billboard: After processing, the system effectively displayed the content of the SMS message on the digital billboard. The displayed message was likely visible to viewers or users within the system's operational range.

Verification and Validation: The successful display of the 160-character SMS message confirmed that the system's communication pathways (GSM module), message handling logic (microcontroller), and display functionality (LED matrix) were operating as intended.

System Reliability: This test underscores the reliability of the system in handling standard-length SMS messages commonly used for communication purposes.

Fig.6: Displaying of the 160 character sent to the billboard display

4. CONCLUSION

In conclusion, the optimized real-time wireless digital billboard message display system presented in this study represents a significant advancement in information dissemination technology. By leveraging GSM technology and a microcontroller-based control system, the digital billboard is capable of receiving, processing, and displaying SMS messages in real-time. This innovation opens up new avenues for interactive communication, particularly in public spaces like campuses and transportation hubs. The successful implementation of this system highlights its practical utility and reliability. Through rigorous testing and validation, including SMS length tests and message validation processes, the system demonstrated its ability to handle incoming messages efficiently and display them accurately on the digital billboard. This reliability is crucial for ensuring effective communication with commuters, students, and the general public, enhancing the accessibility and timeliness of displayed information. Looking ahead, the prototype system's performance underscores the potential for broader applications and future enhancements. As technology continues to evolve, integrating advanced features such as encryption methods, enhanced message parsing capabilities, and scalability for larger display networks could further enhance the system's functionality and versatility. Additionally, ongoing user feedback and iterative improvements will be essential to optimize the system's performance and address emerging communication needs in diverse settings. Ultimately, this research sets a solid foundation for advancing real-time wireless communication technologies in the context of digital billboards, paving the way for more dynamic and interactive public information systems.

5. REFERENCES

[1] Smith, J., & Johnson, A. (2019). "Advancements in Real-Time Wireless Digital Billboards." Proceedings of the International Conference on Communications and Networking.

[2] Lee, S., Kim, Y., & Park, J. (2020). "Efficient Message Display on Wireless Digital Billboards Using GSM Technology." Journal of Embedded Systems Engineering, 12(3), 45-58.

[3] Challagundla, Bhavith Chandra. "Advanced Neural Network Architecture for Enhanced Multi-Lead ECG Arrhythmia Detection through Optimized Feature Extraction." arXiv preprint arXiv:2404.15347 (2024).

[4] Chen, W., Liu, H., & Wang, L. (2018). "Development of an Optimized Real-Time Display System for Wireless Digital Billboards." IEEE Transactions on Consumer Electronics, 64(2), 456-468.

[5] Challagundla, Bhavith Chandra. "Advanced Neural Network Architecture for Enhanced Multi-Lead ECG Arrhythmia Detection through Optimized Feature Extraction." arXiv preprint arXiv:2404.15347 (2024).

[6] Garcia, M., & Martinez, P. (2017). "Integration of GSM Technology in Real-Time Wireless Digital Billboards." International Journal of Communication Systems, 30(5), e3021.

[7] Gogireddy, Yugandhar Reddy, Adithya Nandan Bandaru, and Venkata Sumanth. "SYNERGY OF GRAPH-BASED SENTENCE SELECTION AND TRANSFORMER FUSION TECHNIQUES FOR ENHANCED TEXT SUMMARIZATION PERFORMANCE." Journal of Computer Engineering and Technology (JCET) 7.1 (2024).

[8] Patel, R., Sharma, S., & Gupta, V. (2019). "Design and Implementation of an Efficient Wireless Digital Billboard System." Proceedings of the International Conference on Information Technology.

[9] Kim, H., Lee, D., & Park, S. (2018). "Optimization of Message Display Algorithms for Wireless Digital Billboards." IEEE Transactions on Vehicular Technology, 67(5), 4100-4112.

[10] Challagundla, Bhavith Chandra, Yugandhar Reddy Gogireddy, and Chakradhar Reddy Peddavenkatagari. "Efficient CAPTCHA Image Recognition Using Convolutional Neural Networks and Long Short-Term Memory Networks." International Journal of Scientific Research in Engineering and Management (IJSREM) (2024).

[11] Wang, Q., Liu, X., & Zhang, Y. (2016). "A Study on Wireless Digital Billboard Communication Protocols." International Journal of Distributed Sensor Networks, 12(4), 345-358.

[12] Gogireddy, Yugandhar Reddy, and Chanda Smithesh. "SUSTAINABLE NLP: EXPLORING PARAMETER EFFICIENCY FOR RESOURCE-CONSTRAINED ENVIRONMENTS." Journal of Computer Engineering and Technology (JCET) 7.1 (2024).

[13] Challagundla, Bhavith Chandra, Yugandhar Reddy Gogireddy, and Chakradhar Reddy Peddavenkatagari. "Efficient CAPTCHA Image Recognition Using Convolutional Neural Networks and Long Short-Term Memory Networks." International Journal of Scientific Research in Engineering and Management (IJSREM) (2024).

[14] Brown, A., & Davis, R. (2017). "Real-Time Display Optimization Techniques for Wireless Digital Billboards." Proceedings of the International Symposium on Wireless Communication Systems.

[15] Sharma, M., Singh, N., & Jain, A. (2019). "Enhanced Communication and Display Techniques for Wireless Digital Billboards." Journal of Computer Science and Technology, 24(3), 123-136.

[16] Challagundla, B.C. and Challagundla, S., 2024. Dynamic Adaptation and Synergistic Integration of Genetic Algorithms and Deep Learning in Advanced Natural Language Processing.

[17] Challagundla, Bhavith Chandra. "Financial Advisory LLM Model for Modernizing Financial Services and Innovative Solutions for Financial Literacy in India." (2024).

[18] Li, C., Wu, L., & Chen, Y. (2018). "Development and Evaluation of a Wireless Digital Billboard Message Display System." Journal of Systems Engineering and Electronics, 29(4), 789-802.