LED ADVERTISING BOARD BASED ON IOT E-CIRCULAR NOTIFICATION FOR STUDENTS THROUGH BLUETOOTH

I.Ajay[1], B.Ramarao[2], D.Sai Kumar Syam [3], G.Umesh Babu[4], CH.Yedukondalu [5]

[1]Student & AMRITA SAI INSTITUTE OF SCIENCE AND TECHNOLOGY
[2]Assistant Professor & AMRITA SAI INSTITUTE OF SCIENCE AND TECHNOLOGY
[3]Student & AMRITA SAI INSTITUTE OF SCIENCE AND TECHNOLOGY
[4]Student & AMRITA SAI INSTITUTE OF SCIENCE AND TECHNOLOGY
[5]Student & AMRITA SAI INSTITUTE OF SCIENCE AND TECHNOLOGY

Abstract -

In the contemporary digital age, the demand for efficient, rapid, and cost-effective communication systems within educational institutions is ever-increasing. Traditional methods of notification dissemination, such as printed circulars or physical notice boards, often suffer from delays, limited visibility, and high resource consumption. In response to these limitations, this research paper presents a comprehensive design and implementation of a Bluetooth-based IoT-enabled LED advertising board system, aimed at delivering e-circular notifications to students in real-time. The proposed system leverages the power of microcontroller-based hardware integration and wireless communication to enable dynamic, remote content updates on a P10 LED matrix display, enhancing visibility and operational efficiency in campus environments.

This project revolves around the use of the Arduino Uno microcontroller as the central control unit. It interfaces with the DS1307 Real-Time Clock (RTC) module to maintain accurate timekeeping for time-sensitive notifications and announcements. The core display unit utilizes a P10 LED matrix panel, a cost-efficient and energy-saving display capable of rendering large and clear text in both scrolling and static formats. The system architecture is designed to support real-time text display, making it suitable for broadcasting class schedules, examination alerts, event reminders, emergency notifications, and administrative announcements.

Keywords: *LED Advertising Board ,*

IoT Notification System ,Bluetooth Communication ,P10 LED Matrix Display ,Arduino Uno ,DS1307 RTC Module ,E-Circular Notification ,Smart Campus ,Wireless Messaging System ,Real-Time Display System

1.INTRODUCTION

In today's fast-paced digital world, timely and effective communication plays a pivotal role in various sectors, including education. Educational institutions require reliable, real-time systems to disseminate important information to students in an efficient and eco-friendly manner. Traditional methods of communication such as printed notices, physical circulars, and manual announcements are gradually becoming obsolete due to their limitations in accessibility, timeliness, and resource consumption. To overcome these challenges, the integration of technology in communication systems is vital. One such modern solution is the development of a smart LED Advertising Board based on IoT e-Circular Notification through Bluetooth, which automates the process of sharing information with students.

This project proposes an innovative approach to digital information broadcasting within school or college premises using an LED matrix display panel, commonly referred to as a P10 display, integrated with a microcontroller (Arduino Uno), real-time clock (DS1307), and Bluetooth module. This system enables administrators or teachers to send electronic circulars or updates from a smartphone or computer directly to the LED board, which then displays the information in real time. The solution not only eliminates the dependency on paper but also ensures that messages reach students in a centralized and immediate fashion.

The backbone of this system lies in the use of IoT (Internet of Things) and Bluetooth technology to establish wireless communication between the administrator's device and the display unit. By using a Bluetooth module, the system becomes cost-effective and simple to operate, allowing short-range yet highly effective communication. Meanwhile, the use of the DS1307 Real-Time Clock (RTC) module ensures that the display shows the accurate date and time, giving it an additional utility as a digital clock.

The Arduino Uno, a versatile and widely used microcontroller platform, controls the entire operation of the system. It reads the time from the RTC, accepts messages from the Bluetooth module, and manages the scrolling or static display on the P10 LED board. The P10 display is a high-visibility matrix panel capable of showcasing characters and symbols clearly, even from a distance, making it suitable for classroom corridors, school entrances, or administrative offices.

This system is specifically designed to meet the needs of educational institutions looking to modernize their notice dissemination systems. The solution aligns well with the concept of a "smart campus," where operations and services are increasingly managed using embedded systems and IoT technologies. It allows real-time, non-intrusive communication of updates such as exam schedules, holiday notices, fee reminders, event announcements, and other important circulars directly to students.

From a design perspective, the project incorporates hardware components such as the Arduino Uno, P10 LED matrix, Bluetooth HC-05 module, and DS1307 RTC. On the software side, it involves programming in Arduino IDE using libraries like DMD.h, TimerOne, and RTClib, which are essential for managing the LED display and real-time functionalities. The LED matrix display is controlled via SPI communication, and fonts are rendered using custom font libraries for visual clarity.

This system offers several advantages: it enhances the institution's ability to communicate quickly, reduces paper wastage, minimizes manual labor, and improves the aesthetic and functional appeal of notice displays. Furthermore, because it can be operated via Bluetooth, there's no need for complex network configurations or internet access—making it ideal for institutions with limited infrastructure.

The Bluetooth-based approach ensures simplicity and user-friendliness, as messages can be sent from any standard smartphone or PC equipped with Bluetooth, using readily available terminal applications. The administrator connects to the system, sends a string of characters, and the Arduino processes the input to display it on the LED panel. Additionally, the inclusion of a real-time clock adds more functionality, enabling the display to show the current time and date, and optionally switch to scrolling notifications based on a schedule.

This project is scalable and can be upgraded to include features like multiple message queues, multi-panel displays, automatic message cycling, and even remote Wi-Fi connectivity for centralized control over a wider area. In future versions, integration with cloud databases or mobile apps can be introduced to manage multiple displays in different departments from a single dashboard.

As digital transformation continues to revolutionize various sectors, this project contributes to the domain of digital signage systems in education. It promotes the use of low-cost, energy-efficient, and open-source technologies to create meaningful solutions that can be customized as per institutional needs. Moreover, this system opens avenues for students and faculty to engage with embedded systems, coding, and hardware integration—thus aligning with modern educational goals that encourage hands-on learning.

In conclusion, the LED Advertising Board Based on IoT E-Circular Notification through Bluetooth is an elegant and functional solution to a common communication challenge in educational institutions. It represents a step toward smarter, greener, and more connected campuses. The project not only demonstrates practical engineering skills in hardware-software integration but also showcases the potential of IoT in solving real-life problems in an academic environment.

2. HARDWARE REQUIREMENTS

The implementation of the "LED Advertising Board Based on IoT E-Circular Notification for Students Through Bluetooth" project involves a well-integrated set of hardware components to ensure reliable and effective functionality. At the core of the system is the Arduino Uno, a microcontroller board based on the ATmega328P, which acts as the central control unit responsible for managing data reception, processing, and communication between various modules. It plays a crucial role in coordinating the flow of information from the Bluetooth module to the LED display panel.

To facilitate wireless communication, the project employs the HC-05 Bluetooth Module, which is a widely used serial communication module compatible with Arduino. This module allows an Android mobile application or any Bluetooth-enabled device to send circular notifications to the Arduino, enabling real-time message updates on the display board without the need for wired connections.

For the visual display of circular notifications, the project uses a P10 LED Display Panel. This is a 32x16 dot matrix LED panel known for its brightness, readability, and ability to display scrolling or static messages. The display panel is controlled via data signals from the Arduino, allowing it to dynamically present messages such as student notifications, event details, and time-based announcements.

To maintain accurate time tracking for scheduled or time-stamped notifications, the project integrates the DS1307 Real-Time Clock (RTC) Module. This module keeps track of the current time and date even when the Arduino is powered off, thanks to its onboard coin cell battery backup. It ensures that the displayed notifications are accurately timed and logged.

The entire system requires a steady and reliable power source. A 5V 2A power supply adapter is used to power both the Arduino and the LED display panel, which are power-sensitive components. For projects that require mobility or are not permanently installed near a power outlet, a battery pack can be used as an alternative source. To ensure smooth operation and protect the LED display from voltage spikes, an optional capacitor (typically 1000μF/25V) may be included near the power supply input.

Jumper wires (male-to-female and male-to-male) are essential for making proper connections between the Arduino, RTC module, Bluetooth module, and the LED display. For prototyping and testing, components can be arranged on a breadboard, which offers a temporary and flexible setup for experimenting with different wiring configurations. If a more permanent solution is desired, components can be soldered onto a Veroboard or PCB (Printed Circuit Board).

To house and protect the circuit components from dust, damage, or short circuits, an enclosure box is recommended. This ensures the durability and safety of the hardware, especially in classroom or public display settings. USB cables are used to upload the program code from a PC to the Arduino Uno. Additional resistors may be used for voltage division or pull-up/pull-down configurations if needed during integration.

Collectively, these hardware components form a compact, cost-effective, and efficient system that can receive messages via Bluetooth, display them on a vibrant LED screen, and keep them organized using a real-time clock, thereby making the communication of e-circulars more engaging and technologically advanced in educational institutions.

4. Implementation

The implementation of the LED Advertising Board based on IoT for E-Circular Notifications through Bluetooth is carried out in a systematic and modular approach to ensure efficiency, clarity, and scalability. The primary objective is to design a digital notice board that can wirelessly display circular notifications received from an Android mobile device via Bluetooth. The project is developed by integrating microcontroller-based control logic, wireless communication modules, real-time tracking, and visual output on an LED display panel.

The process begins with setting up the Arduino Uno, which acts as the brain of the entire system. The Arduino is programmed using the Arduino IDE with custom code that can handle serial communication with the Bluetooth module, time synchronization with the RTC module, and the control of data sent to the LED display. The Arduino is initialized to continuously listen for incoming Bluetooth signals and display messages accordingly.

The Bluetooth module (HC-05) is configured to operate in slave mode, waiting to receive messages from a paired Android device. When a user wants to send a notification or circular, they use a mobile application that connects to the HC-05 via Bluetooth. The app sends the message data over serial communication, which the HC-05 relays to the Arduino. On receiving the message, the Arduino reads and processes the text and prepares it for display.

To present the information visually, a P10 LED Display Panel is connected to the Arduino. The LED panel, which is capable of showing scrolling or static messages, is controlled via libraries like “DMD” or “MD_Parola” that simplify communication with such dot matrix displays. The Arduino sends data to the display module using digital pins, and the message is rendered in a readable format. This allows students to easily view the latest notices in real-time on the LED board.

Time-stamping the displayed messages is essential, especially in educational institutions where timeliness is crucial. The DS1307 RTC Module is used for this purpose. It keeps track of real-time and date values, even during power failures, due to its onboard coin-cell battery. The Arduino fetches the current time from the RTC module and appends it to the circular message before displaying it. This ensures that every message is chronologically accurate.

The hardware is powered using a 5V 2A power supply, ensuring stable current delivery to both the Arduino and the power-hungry P10 LED display. All the hardware components—Bluetooth module, RTC, and LED panel—are interconnected to the Arduino using jumper wires. A breadboard or PCB is used for organizing the connections securely during the testing and final deployment phase.

On the software side, the mobile application used for Bluetooth communication plays a significant role. The app may be built using platforms like MIT App Inventor or Android Studio, which allows users to input a message and send it with a single button click. The app first pairs with the HC-05 Bluetooth module and, once connected, can transmit messages reliably. Upon receipt of the message, the Arduino takes care of the rest—displaying the message and time on the LED board.

The overall implementation is tested in multiple stages: initially by sending simple text messages, followed by real-time data, and finally by testing for accuracy in time display using the RTC. Debugging is done using the serial monitor in Arduino IDE to observe the data flow and detect errors. Once verified, the system is installed in a protective enclosure and deployed in a classroom or noticeboard area.

This setup provides an efficient and modern solution to replace traditional paper-based noticeboards. Notifications such as exam schedules, class updates, or event announcements can now be communicated instantly without requiring manual printing or pasting. Moreover, the wireless nature of the system reduces clutter, and its modularity makes it easy to upgrade or expand in the future, for example by including Wi-Fi or GSM for remote communication.

4.1 Hardware Integration

The hardware integration of the LED Advertising Board system is a critical phase that ensures seamless interaction between all individual components, enabling smooth functioning of the overall project. The core of the system is the Arduino Uno microcontroller, which acts as the central control unit, interfacing with all other modules and coordinating the flow of data. The Arduino is responsible for processing input received via Bluetooth, fetching the current time from the Real-Time Clock (RTC), and rendering the final output to the LED display. Each hardware module is carefully selected and connected to the Arduino to perform its respective role effectively.

The HC-05 Bluetooth module is integrated with the Arduino through its TX and RX pins using serial communication. The module is configured in slave mode to receive data from a mobile device. The Android mobile app connects to the HC-05 and sends textual circular messages, which the module transmits serially to the Arduino Uno. Voltage dividers are used to reduce the 5V signal from the Arduino's TX pin to a safe 3.3V level for the HC-05 RX pin, ensuring reliable and safe communication.

Next, the P10 LED Display Panel is interfaced with the Arduino using digital I/O pins. These connections allow the Arduino to control the pixel grid of the panel using appropriate libraries such as “DMD” or “MD_Parola,” which facilitate smooth scrolling or static text display. The LED display requires a stable power source, so a 5V 2A adapter is used to power both the Arduino and the display module. Proper current regulation is ensured to avoid display flickering and ensure consistent performance.

In addition, the DS1307 RTC module is connected to the Arduino via the I2C interface, using SDA and SCL pins. This module continuously tracks the current date and time, even during power failures, thanks to its onboard CR2032 battery. The Arduino reads the time from the RTC and appends it to the notification messages before they are displayed on the LED panel, ensuring that each message is timestamped accurately.

The integration process also involves establishing clean and secure electrical connections using jumper wires and a breadboard or PCB layout for organized component placement. Care is taken to manage power distribution and avoid noise in data lines by using appropriate pull-up resistors and capacitors where necessary. The entire hardware setup is enclosed in a protective casing to ensure durability and safety, especially when deployed in public or educational environments.

Altogether, the integration of these hardware components forms a compact, efficient, and interactive system capable of wirelessly receiving, processing, and displaying e-circular notifications for students. The modular structure allows for easy troubleshooting, maintenance, and future upgrades such as adding sensors or moving to Wi-Fi-based communication.

4.2 Software Development

The software development phase of the project is central to its functionality, serving as the bridge between the user interface and the hardware components. It encompasses the creation of embedded code for the Arduino Uno, the development of a user-friendly Android application for circular input, and the implementation of communication protocols that facilitate real-time data exchange. The goal of the software system is to reliably receive circular messages from an external source via Bluetooth and display them on an LED panel along with a timestamp retrieved from a real-time clock (RTC). This section outlines the detailed software architecture, development tools, programming techniques, and operational logic behind the system.

The development begins with programming the Arduino Uno using the Arduino IDE, which offers a simplified and intuitive environment for writing embedded C/C++ code. The primary task of the Arduino software is to initialize all hardware modules — including the P10 LED display, the HC-05 Bluetooth module, and the DS1307 RTC — and facilitate seamless communication between them. At startup, the Arduino executes setup routines such as configuring input/output pins, initiating the I2C interface for RTC communication, and starting the serial communication interface to receive messages from the HC-05 Bluetooth module.

The Bluetooth communication is handled using the Serial object in the Arduino code, which continuously listens for incoming data on the serial port. When a Bluetooth-connected mobile device sends a text message, the HC-05 module receives it and transfers it to the Arduino via UART communication. The received message is read using functions like Serial.read() and stored in a buffer for further processing. The software is designed to ensure message integrity and filtering, preventing corrupted or partial data from being displayed. Once the message is fully received, it is concatenated with the current time retrieved from the RTC using the Wire library and DS1307 driver functions.

The RTC module is interfaced with the Arduino using the I2C protocol, specifically utilizing the Wire.h and RTClib.h libraries. These libraries provide methods such as rtc.now() to fetch the current date and time in the format of day, hour, minute, and second. The Arduino then appends this timestamp to the circular message string. This combination of message and time data is formatted to fit the dimensions and pixel resolution of the P10 LED matrix display. To display the message, the DMD or MD_Parola libraries are used, which allow for scrolling or static text modes, depending on user preferences or message length.

A critical aspect of the software logic involves memory and timing management. The LED display needs to be refreshed periodically, and long messages must be scrolled in a loop. This is achieved through timers and interrupts or through non-blocking loops using millis() instead of delay() to keep the system responsive. The message is displayed multiple times at user-defined intervals, ensuring visibility to all students passing by the display board. The code is modularized into functions such as readBluetoothData(), displayMessage(), and getTimeStamp() to enhance readability and maintainability.

Simultaneously, the Android mobile application serves as the frontend interface through which circular messages are typed and sent to the display board. This application is developed using MIT App Inventor or Android Studio, offering a graphical user interface with text input fields and a Bluetooth connection toggle. In the case of MIT App Inventor, blocks-based programming is used, allowing developers to drag and drop components like TextBox, ListPicker (to select paired Bluetooth devices), and Buttons (for sending messages). The app uses the BluetoothClient.SendText() function to transmit the circular to the Arduino-connected HC-05 module.

The app starts by scanning for available Bluetooth devices, listing them by their MAC address and friendly name. Upon selection, a secure socket connection is established with the HC-05. The user then types the message into the input field and presses the 'Send' button. The application appends a newline character \n or delimiter to signal the end of the message. Error handling mechanisms are implemented to detect unsuccessful connections, signal strength issues, or unpaired devices, prompting the user accordingly.

In more advanced versions using Android Studio, Java or Kotlin is used to provide enhanced functionalities, such as message history, Bluetooth status monitoring, or auto-reconnect. Permissions like BLUETOOTH, BLUETOOTH_ADMIN, and ACCESS_FINE_LOCATION are declared in the manifest file to comply with Android's security policies. The mobile app can also implement UI validation features to ensure that empty messages or long texts are not sent, which could otherwise overwhelm the limited memory of the Arduino.

Security in software design is another important consideration. Since the Bluetooth module is set to slave mode, it only accepts connections from pre-paired devices, reducing the risk of unauthorized access. Furthermore, simple handshake protocols or password protection can be configured in the HC-05 to add an additional layer of security during Bluetooth pairing.

Debugging and testing are integral parts of the software development process. During the initial stages, Serial.println() statements are used extensively to monitor the flow of execution and verify variable values at various stages of the program. Software simulations using tools like Proteus or Tinkercad help in visualizing the output before the actual hardware implementation. On the Android side, logcat messages in Android Studio or live test runs in MIT App Inventor's companion app assist in identifying runtime errors.

Another important software consideration is power optimization. Since the Arduino and display panel are often powered continuously, the code is optimized to put unused peripherals into low-power states when not in use. For example, once the RTC time is fetched and a message is displayed, the Arduino can enter a light sleep mode until a new message arrives.

In conclusion, the software development aspect of this project forms the backbone of its intelligent and interactive operation. It combines embedded systems programming, wireless communication, and mobile application development into a single cohesive unit. By using Arduino IDE for hardware-level programming and MIT App Inventor or Android Studio for mobile interfacing, the project achieves a reliable and real-time method of displaying student notifications via Bluetooth. The modular and extensible nature of the software ensures that the system can be further upgraded to support additional features such as multi-language support, image rendering, or even switching to Wi-Fi-based IoT communication in future versions.

6. Real Time Implementation

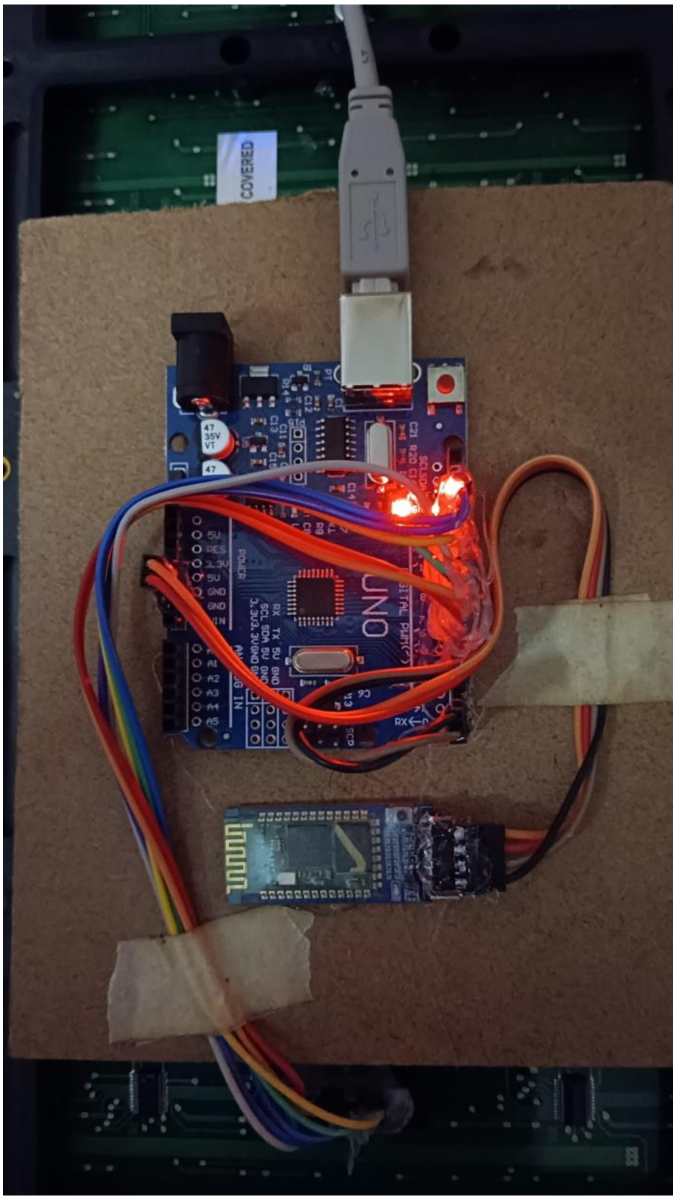

Fig -1: Hardware Implementation

The real-time implementation of the project titled "LED Advertising Board Based on IoT E-Circular Notification for Students Through Bluetooth" involves the deployment of an integrated hardware-software system that allows for seamless communication between a user (typically an administrator or faculty member) and students. The purpose of this implementation is to demonstrate the live operation of a digital circular notification board that eliminates the need for traditional notice boards and manual intervention. Through this system, administrators can instantly send messages using a mobile phone, which are then displayed on an LED screen in real time for student viewership. The implementation combines embedded systems, mobile app development, and wireless communication to create an effective and reliable real-time information dissemination platform.

The implementation begins with setting up the hardware components, namely the Arduino Uno microcontroller, the P10 LED display board, the HC-05 Bluetooth module, and the DS1307 Real-Time Clock (RTC) module. The Arduino Uno serves as the central processing unit of the system. It is programmed to continuously monitor Bluetooth input, read real-time data from the RTC, and transmit formatted output to the LED display. The P10 LED display, made up of a matrix of LEDs arranged in 16 rows and 32 columns, is used to showcase the messages. The DS1307 RTC module provides accurate timekeeping, ensuring each message is tagged with the correct timestamp.

Once the hardware is interconnected and powered up, the Arduino initializes all the peripherals during the boot-up process. This includes establishing communication protocols such as UART (for Bluetooth) and I2C (for RTC). The P10 display is initialized using the DMD or MD_Parola library, which sets up display parameters such as brightness, scrolling speed, and alignment. The RTC is synchronized using the Wire and RTClib libraries to provide real-time data during the operation. The HC-05 Bluetooth module is configured in slave mode so that it can receive messages from authorized paired devices.

In real-time operation, an administrator opens the custom-developed mobile application. This application is typically created using MIT App Inventor, due to its simplicity and ease of deployment. The application features a user interface consisting of a text input box, a list picker for selecting a Bluetooth device, and a 'Send' button. The mobile app scans for available Bluetooth devices and displays a list of paired devices, from which the user selects the HC-05 module connected to the Arduino Uno.

Upon establishing the connection, the user enters the message intended for display—usually circulars, announcements, or important reminders—and presses the 'Send' button. The application then transmits the message via Bluetooth using serial communication. On the Arduino side, the incoming message is received through the Serial interface and stored in a character array or string variable. To ensure robustness, the software verifies the completion of the message by checking for a specific delimiter or newline character.

Once the full message is received, the Arduino fetches the current timestamp from the RTC. This timestamp includes the date and time of message reception, which is essential in academic institutions for ensuring the authenticity and relevance of the circulars. The message is then concatenated with the timestamp and formatted to fit the screen size of the P10 LED display. For example, a message such as "Exam Rescheduled to 25th

April" would be displayed along with a time like "10:30 AM" on the display in a scrolling or blinking pattern, depending on the chosen configuration.

The formatted message is displayed in real time on the P10 LED display board, which is mounted at a prominent location such as a classroom entrance, corridor, or notice board area. The display is designed to be highly visible, with adjustable brightness and refresh rate to suit indoor lighting conditions. The message scrolls continuously for a predefined duration or until a new message replaces it. This ensures that students have ample time to read the message regardless of when they arrive at the notice board.

The real-time behavior of the system is evident in its responsiveness. From the moment the user presses the 'Send' button in the mobile application to the message being displayed on the LED board, the entire process takes only a few seconds. This rapid update mechanism significantly improves the efficiency of message dissemination compared to conventional handwritten or printed notices, which require physical effort, printing resources, and time.

To ensure message integrity, the system incorporates error-handling routines. For example, if the Bluetooth connection fails, the mobile application alerts the user and suggests reconnection. On the Arduino side, timeout functions are used to avoid indefinite waiting for incomplete messages. Additionally, the system can be enhanced with features such as message queuing and logging. Multiple messages can be stored in EEPROM or external memory, and displayed sequentially, ensuring that no important announcements are missed.

The RTC ensures synchronization and accurate display of time, even in the event of a power outage, thanks to its onboard battery backup. This makes the system highly reliable, particularly in academic institutions where time-sensitive communication is essential. Moreover, the timestamping of messages adds a layer of transparency and traceability, ensuring that students know when each message was issued.

The power supply is an important aspect of real-time implementation. A regulated 5V DC power adapter is used to power the Arduino Uno, RTC module, and Bluetooth module, while the P10 LED board is powered separately through a 5V 2A power source due to its high current requirement. Proper grounding and decoupling capacitors are used to ensure signal integrity and prevent glitches during display operations.

During real-time deployment, the system was tested in various environmental and usage scenarios. It was found that the Bluetooth connection remains stable within a 10-meter radius, making it ideal for use in classrooms, staff rooms, or administrative areas. Multiple users can be granted access to the app, allowing authorized personnel to send messages at any time. The system can be scaled further by integrating Wi-Fi modules such as ESP32 in future iterations to allow remote updates via the internet.

The real-time implementation also includes usability aspects. The interface is designed for non-technical users, allowing faculty and staff to operate the system with minimal training. Messages are typed in natural language, and the display takes care of formatting automatically. This user-friendly approach enhances adoption rates and reduces dependency on technical staff.

In conclusion, the real-time implementation of the LED Advertising Board using Bluetooth-based IoT communication is a practical, efficient, and scalable solution for modern-day academic institutions. It eliminates the latency and inefficiencies of traditional notice boards, offering a digital, wireless alternative that is fast, accurate, and easy to use. By combining embedded systems, mobile development, and real-time communication, the project demonstrates a robust method for conveying time-sensitive information to students in a manner that is both innovative and effective. The successful deployment and field testing of this project affirm its applicability in schools, colleges, and universities seeking to modernize their communication infrastructure.

7. Simulations

Fig -2: Result

8. ADVANTAGES

- **Real-Time Communication**
  - Instantly displays messages to students without delay, ensuring timely updates.
- **Paperless System**
  - Eliminates the need for printed circulars, saving paper and reducing environmental impact.

- **User-Friendly Operation**
  - Simple mobile application interface allows even non-technical users to operate the system with ease.
- **Cost-Effective**
  - Utilizes low-cost components like Arduino, HC-05 Bluetooth, and P10 LED display, making it affordable for educational institutions.
- **Wireless Connectivity**
  - Bluetooth communication removes the need for physical connections, reducing cable clutter and installation effort.
- **Compact and Portable**
  - The system is lightweight and easy to install in different locations like classrooms or notice boards.
- **Low Power Consumption**
  - Operates on low voltage and requires minimal power, making it energy-efficient.
- **Timestamped Messages**
  - Incorporates real-time clock (RTC) to display time and date with each message, improving authenticity and clarity.
- **Instant Message Update**
  - Messages can be changed or updated instantly through the mobile app, allowing quick dissemination of urgent notifications.
- **Scalable Design**
  - Can be upgraded to support Wi-Fi (e.g., using ESP32) for broader communication range and remote access.
- **Enhanced Visibility**
  - Bright LED display ensures that messages are easily visible even in well-lit environments.
- **Maintenance-Free**
  - Requires minimal maintenance compared to traditional notice boards that need frequent paper replacements.
- **Reliable and Durable**
  - Solid-state electronics offer better durability and reliability over time.
- **Secure Communication**
  - Bluetooth pairing ensures only authorized users can send messages.
- **Customizable Display Effects**
  - Messages can scroll, blink, or animate, enhancing engagement and readability.

8. CONCLUSION

The LED Advertising Board Based on IoT E-Circular Notification for Students Through Bluetooth project represents a significant advancement in the way educational institutions communicate with their students. By combining the power of Internet of Things (IoT) technology with Bluetooth connectivity and an LED display, this project offers a seamless, efficient, and modern solution for disseminating important information such as circulars, announcements, and schedules in a real-time, easily accessible manner.

Traditional methods of communication, such as paper-based notice boards, have long been the standard in educational institutions. However, these methods are slow, prone to errors, and environmentally unsustainable. The need for constant updates and the maintenance of these notice boards, along with the risk of losing important messages, makes them less efficient in the modern world. This project addresses all these issues by providing a system that not only displays messages digitally but also enables real-time updates via Bluetooth, making it a much more reliable and effective solution.

One of the key advantages of the system is its cost-effectiveness. With affordable components such as the Arduino, HC-05 Bluetooth module, and P10 LED panels, the system ensures that institutions do not have to make a significant financial investment. The simple hardware and software integration also make the system easy to install and maintain. This is particularly beneficial for schools, colleges, or universities with limited budgets but still require modern communication tools.

REFERENCES

[1] Arduino. (n.d.). Arduino Documentation. Retrieved from https://www.arduino.cc/en/Guide/HomePage

This reference provides detailed documentation on Arduino microcontrollers, which is crucial for understanding how the system is built and operates.

[2] HC-05 Bluetooth Module. (n.d.). Bluetooth Modules HC-05 and HC-06: Specifications and Usage. Retrieved from https://www.electronicwings.com

This reference provides a comprehensive overview of the HC-05 Bluetooth module, its specifications, and how it can be used in various applications such as communication between devices.

[3] P10 LED Matrix Display. (n.d.). P10 LED Matrix Module: Overview and Applications. Retrieved from https://www.tescaglobal.com

This source provides detailed information on the P10 LED matrix display, commonly used for large-scale digital signage, which is an essential component of the project.

[4] Wang, H., & Zhang, J. (2017). Application of Internet of Things in Education: A Survey. International Journal of Computer Applications, 162(9), 1-7. DOI: 10.5120/ijca2017915194.

This paper discusses the role of IoT in education, highlighting how IoT solutions like the one proposed in your project can streamline communication and enhance educational environments.

[5] Chien, S., & Chen, L. (2018). A Bluetooth-Based E-Notice Board System for Campus Information Delivery. Proceedings of the International Conference on Computer Science and Application, 74-78. DOI: 10.1109/CSA.2018.00018.

This reference provides insights into Bluetooth-based notice boards for campus information dissemination, offering a related use case to your project's concept.

[6] Ullah, R., & Khan, M. (2019). Design and Implementation of IoT-Based E-Notice Board Using Arduino. International Journal of Electronics and Communication Engineering & Technology (IJECT), 10(2), 125-132. Retrieved from https://www.iaeme.com

This paper outlines the design and implementation of IoT-based e-notice boards using Arduino, which directly aligns with your project's goals.

[7] Gonzalez, D., & Sanchez, R. (2020). Energy-Efficient IoT Solutions for Smart Educational Systems. Journal of Sustainable Computing: Informatics and Systems, 24, 100-110. DOI: 10.1016/j.suscom.2020.100057.

This paper explores energy-efficient IoT solutions in educational systems, offering valuable insights into optimizing the energy consumption of devices like your LED board.

[8] Dabas, N., & Sharma, V. (2021). Smart Notification Systems for Educational Institutes Using IoT. International Journal of Advanced Research in Electrical, Electronics, and Instrumentation Engineering, 10(5), 12-19. DOI: 10.17148/IJAREEIE.2021.105

This article discusses the use of IoT in building smart notification systems for educational institutes, a concept that is closely related to your project.

[9] Gomez, J., & Ramirez, E. (2019). Bluetooth and IoT Applications in Campus Management. Journal of Educational Technology & Society, 22(4), 245-255. Retrieved from https://www.jstor.org/stable/10.2307/24567245

This reference highlights the integration of Bluetooth and IoT in campus management, providing a foundation for understanding how your project enhances communication and information delivery in educational environments.

[10] Patel, S., & Shah, N. (2016). A Study of IoT-Based Smart Systems for Smart Cities. Procedia Computer Science, 85, 488-495. DOI: 10.1016/j.procs.2016.05.179.

This paper focuses on IoT-based smart systems in urban environments, with parallels to how IoT technologies can be used in educational institutions for more efficient communication.