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Digital Signage Board

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Abstract— *This paper outlines the development of a GSM-based wireless noticeboard that incorporates Firebase as the cloud storage and retrieval system. A message can be changed in real-time using Short Message Service (SMS) and an Android app built in MIT App Inventor. The proposed system offers a much- improved method of a traditional noticeboard because it allows for remote access and timed notifications. The system uses an Arduino Uno, SIM800L GSM module, and an Amazon Fire Tablet as an interface. Complete and timely delivery of messages with real-time updates demonstrates the implementation and testing, making this a perfect solution for digital noticeboards. The notifications can be accessed by any device with the suggested android app. The results prove that the proposed system is a scalable and most cost-effective way for digital notice boards in educational institutions and public places. The future versions of the system can include support for multimedia (jpg, mp3, mp4, ppt etc.) and basic AI features.*

Keywords—Digital Signage Board, Cloud integrated Display, Transfer Learning, Wireless communication system, Firebase cloud integration, SMS Controlled Signage.

INTRODUCTION

In this era of fast-paced digitalization, efficient and dynamic communication channels are necessary in multiple domains including education institutions, office buildings, retail centers, train stations, and public spaces. Conventional notice boards require a person to write notices physically on the board, which is time-consuming and inefficient with regards to conveying time-sensitive information. Furthermore, along with the increasing push towards a smart and automated world, there is the requirement for cloud-based systems to permit wirelessly send updates and communication in real-time. This paper presents the design and implementation of a Digital Signage Board that utilizes GSM, Firebase cloud-based storage of data, and an Android mobile application to facilitate a solution for smart, remote controlled and dynamic information display. The change in approach frees the user from any physical requirement since they send messages by sending an SMS to the display board, or utilize the dedicated app, which in turn updates the digital sign. The display of the notice is implemented through an Amazon Fire Tablet using Firebase to retrieve and sync notices on a real-time basis. This initiative presents a resolution for SMS-driven digital signage using an Arduino Uno microcontroller combined with a GSM module. By utilizing a GSM network, the user can update the signage remotely using SMS text messages and GPRS service, with a web-based platform using as a display with which a user can access the information remotely. The system relies on a simple, low-cost microcontroller (Arduino Uno) along with a GSM module (for example, SIM800L) to send commands to Firebase, thus allowing 'live' updates to signage, during events, festival, or juggling multiple signs for public spaces.

I. RELATED WORK

Several studies have explored GSM-based digital signage systems for remote communication [1] using various technologies like GSM, IoT, WiFi and Bluetooth [7] based solutions. In this segment, we assess prior work regarding digital signage systems, GSM-based remote display boards, and cloud-connected notice boards including their advantages and shortcomings.

1. GSM-Based Notice Boards in [1], they described a GSM-based electronic notice board,

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consisting of an SMS-based system to allow users to update notices from a remote location. They have designed an Arduino-based case using a SIM900 GSM module to receive text messages and show them on an LCD screen. However, the system did not include cloud capabilities to allow for the storage and retrieval of previous notices. A different approach was taken in [2], where they developed an SMS-based LED display board for schools and offices. The board used a PIC microcontroller and a GSM module to receive messages to display on an LED matrix board. However, this method put limitations on capacity and scalability.

2. Some Notice Boards are integrated with IoT and Cloud Computing. The use of IoT and cloud computing has led to more advanced smart notice boards. In [3], the researchers created an IoT-based smart display system that used Wi-Fi and an ESP8266 microcontroller to obtain messages stored online. The smart display system allowed real-time updates but compromised reliability because it required a continuous internet connection which could be absent in areas with poor Wi-Fi access. A Firebase notice board was demonstrated in [4] where messages could be added by users through a web portal or mobile app, and retrieved by a Node MCU ESP8266 module. The study demonstrated the real-time synchronization features of Firebase, but did not include message updates through GSM, which would allow for function in more remote areas without internet access.

3. There are also studies performed on smart notice boards having multimedia support like displaying presentations, images and videos. They have focused on the creation of multimedia-enabled digital signage systems. In [5], a digital signage board was created for Android devices that used Raspberry Pi and cloud storage technology that allowed users to display images, videos, and announcements remotely. Raspberry Pi, although implemented in the system, increased cost and complexity.In a different work [6], voice-based commands and text-to-speech (TTS) were intertwined into a digital notice board, increasing accessibility for visually impaired individuals, using Google's Speech API. Google’s Speech API can sometimes require an active internet connection, which may not always be convenient or available in all settings.

II. PROPOSED MODEL

In this work, we present a Digital Signage Board, which enables remote, real-time updates, supports GSM-based communication, utilizes Firebase cloud storage, and includes an Android Application. Our Digital Signage Board operates in online and offline modes, while existing smart boards depend solely on Internet access and traditional notice boards require manual updates. Our signage board gives real time updates directly from the cloud. Our model uses the GSM to receive the data and directly uploads it to cloud using the GPRS service of the same subscriber identification module services.

1. Framework of the System

The structure of the system includes three main components:

i. Hardware Module: Arduino Uno(figure 3), SIM800L GSM module(figure 1), power supply, and an Amazon Fire Tablet(figure 2) that represents the display unit.

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Figure 1. Sim800L module

ii. Cloud and database: It has Firebase Realtime Database where end-users can store messages and retrieve those messages later making it possible for scheduled messages. The cloud also creates a possibility for reminders and different messages that can be stored in it.

Figure 2. Display (Amazon fire tablet)

iii.Mobile Application: Built using MIT App Inventor, the mobile application allows end- users, among other things, to send messages, set reminders, and display multimedia content.

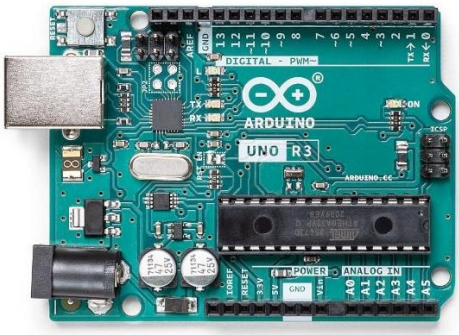

Figure 3. Arduino uno

2. Working Mechanism

i. Message Input & Transmission: Users are able to send SMS messages to the SIM800L GSM module. The module handles that message and uploads the data to the Firebase database. Users are also able to enter messages on the mobile app, which uploads the data to Firebase.

Figure 4. Firebase logo

ii. Data Processing & Storage: Messages are stored in Firebase with different tags for easy retrieval. The system encompasses the ability for scheduled messages and reminders, which the system will request from Firebase at the scheduled time.

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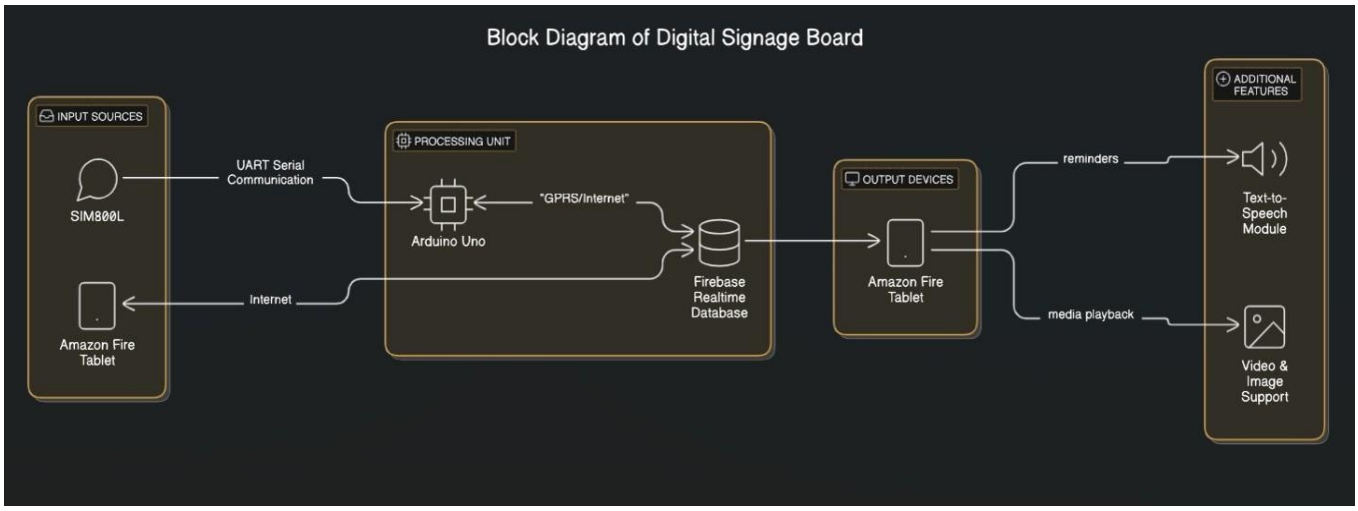

iii. Message Display & Notifications: The Amazon Fire Tablet will continually request messages from Firebase and update the display in real time. If there is a scheduled reminder uploaded to Firebase, the tablet will send a text-to- speech notification. Users are able to navigate to media content (videos, images) and request to display them from the firebase cloud by google.

MIT APP INVENTOR

Figure 5. MIT App Creator

3. Features of Proposed System

i. GSM and Cloud Hybrid Communication – The system supports SMS updates for which we have used a gsm module and it also supports updates directly from firebase which makes it operational even with or without internet access.

ii. Remote Message Updates – Users can send messages or pass information from even hard to reach places even without the internet just the service from the service provider is enough.

iii. Real-Time Synchronization – The real- time database from firebase updates information almost immediately which makes sure our signage board is legit and immediate.

iv. Scheduling and Reminder System – Users can also schedule messages or announcements to be displayed at a certain time so that the important messages are shown when the time is right or to be needed.

v. Text-to-Speech Notification – Our system includes a text to speech(TTS) feature which reads the information or the announcements aloud for enhanced user experience.

vi. Multimedia Content Support – Along with text messages, our system also has support for other multimedia features like images, videos and presentations which are made possible by web based feature in the system.

vii. Cheap and Easy Solution – The project utilizes inexpensive components like the Arduino Uno, SIM800L, and Amazon Fire Tablet, that make it an easy-to-make educational solution for schools, offices, and public spaces.

viii. Easy-to-Use Mobile Application – The application was developed for the Android platform using MIT App Inventor, allowing users to send/receive messages, input calendar reminders.

ix. Dual Operational Mode – The system is able to operate in both online (Firebase) and offline

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(GSM SMS) modes guaranteeing sustained use even in areas with poor connectivity.

x. Secure and Reliable Communication – Messages sent via SMS and Firebase are stored securely and can be retrieved at any time while ensuring security of the notice board and uninterpreted access to notices.

Figure 6. Arduino Software

4. Advantages Over Existing System

5. The system has the following advantages over traditional GSM-based notice boards and IoT-based smart signage boards:

i. It has dual communication modes. It can work online using Firebase as well as offline using GSM.

ii. It will allow for advanced scheduling of messages rather than having to use simple SMS messaging formatted display for notifications

iii. It has advances in multimedia display capabilities.

iv. It has the ability to display graphics and videos which was not available in simplistically formatted notification displays.

v. The system has real-time updates over all devices via Firebase so that all devices update at the same time.

III. RESULTS AND DISCUSSION

The Digital Signage Board was successfully designed and developed with the use of an Arduino Uno, SIM800L GSM module, Firebase Realtime Database, and a mobile application utilizing an Amazon Fire Tablet and MIT App Inventor as a development platform. The evaluation criteria was based on message transmission and deliver time, real time and scheduled reminders updates, and ability to handle multimedia.

1. Message Transmission and Display

i. The system was tested on message delivery time using both SMS and the mobile app connected to Firebase.

ii. Messages delivered using SMS were received and displayed in less, or equal to, 5–10 seconds, depending on network connectivity.

iii. Messages transmitted using Firebase were updated and displayed in real time (<1 second delay) with cloud enabled synchronization.

iv. Scheduled reminders triggered at the scheduled time and functioned, using the announcing functionality, with the text-to-speech feature.

2. Multimedia Content Support

i. The application successfully retrieved and represented URL links to video and images as stored in GDrive.

ii. There were no buffering issues with videos, assuming internet access was stable.

iii. The system functioned well to change between text-based onwards and multimedia content, making it a flexible digital signage system.

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3. System Performance and Reliability

i. The dual communication mode (GSM Firebase) guaranteed that messages were delivered anytime, even when one network mode wasn't functioning.

ii. Our power consumption tests confirmed that the system could run using a 12V adapter, and that

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battery-based operation a 5V power bank and be engaged and be successful while the operation was relatively short-term.

iii. The Amazon Fire Tablet always remained responsive to update messages from Firebase, thus confirming the system had a stable user experience when used.

4. Limitations and Challenges

i. GSM-based SMS delivery had timing issues related to network strength, resulting in delays when sending and receiving SMS messaging unfortunately only for the rural area.

ii. Multimedia messaging required an internet connection, limiting the app's flexibility when it was offline.

iii. SIM800L module requires a strong power supply (5V, 2A), if not consistent because lower power reliably caused unstable operations.

iv. The multimedia function is not the best since we are using a web based page for the content.

5. User feedback

i. Testing of the system has been done by the users in a college environment which resulted in a positive feedback for ease of use and real time updates.

ii. Suggestions were also considered like adding voice commands which will be added in future versions and support for multiple notice boards in different locations which is considered.

6. Comparitive analysis with traditional notice board

Feature	**Traditional**	**Digital Signage**
Update method	Manual	Remote(SMS or App)
Realtime updates	No	Yes
Multimedia support	No	Yes
Schedules messages	No	Yes
Cost efficiency	High(printing costs)	Low

Table 1. Comparision between traditional and digital notice boards

IV. CONCLUSION AND FUTURE WORKS

The Digital Signage Board effectively combines GSM communication, cloud data storage (Firebase), and an interactive Android application to create an effective, and remote-access alternative to traditional notice boards. The system allows for the updating of messages in real-time, displaying multimedia content, scheduling reminders, and sending text-to-speech notifications, thus offering an easy to use solution for instituions, offices and public places. In comparison to traditional notice boards, the system eliminates manual updates, lowers operational costs, and increases accessibility through SMS or mobile app updates. Utilizing Firebase supports rapid propagation of data, allowing the information to be retrievable on multiple connected devices instantly. The project has demonstrated a high reliability factor and user accessibility; its dual communication modes (GSM & Firebase) also allow for message redundancy. The deployment of the system has successfully proven feasibility and scalability for real world utility. There are limitations however; SMS based messages can be dependent on mobile network coverage, and multimedia content can depend on internet connectivity. Even with these weaknesses, the system forms a strong base for the future of digital signage technologies.

There are many improvements that can be made to enhance system functionality, efficiency, and user experience.

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i. Voice-Controlled Notice Updates - The users can be able to update the notice through their voice.
ii. Offline Mode for Multimedia - Adding local storage capability to the Amazon Fire Tablet to stream and view previously received images and videos while offline. Unlike the current version using web interface.
iii. Integration with IoT Devices - Integrating the signage board with IoT devices. For example, motion sensors that would only display the board when a user is present.
iv. QR Code-Based Interaction - Allowing users to simply scan the QR code located on the board to update their mobile device with the notice information.
v. Custom Access Levels per User - Creating role based access control (RBAC) so different user roles like "admin", "student", "employee" could post or limit notice view to specific notice types such as topping numerous notices on a board, and/or allowing a student to post to only an event bulletin board.
vi. Security Features - Adding an authentication mechanism that can enable only authorized users to update, and/or edit notice content. Rich experiences like these will generate more interaction, intelligence, and scalability to the Digital Signage Board by providing customizable solutions for designers and/or users to build upon emergence in smart communications and automations.

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