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A SMART NOTIFICATION SYSTEM FOR TIMELY REMINDERS AND UPDATES

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ABSTRACT
The evolution of embedded systems and wireless communication technologies has paved the way for context-aware applications that enhance the efficiency of daily tasks. This paper presents a smart notification system engineered to provide timely alerts and essential updates across various domains such as religious centers, clinics, restaurants, and traffic junctions. The proposed model incorporates digital displays, embedded devices, LTE connectivity, cloud infrastructure, and a cross-platform mobile application. It ensures that relevant information is disseminated effectively to target users in real-time, thereby increasing user engagement, optimizing workflows, and enhancing decision-making.

Keywords:
Smart Notification, Embedded System, IoT, Cloud Integration, Context-Aware Alerts, Bluetooth, LTE, Public Displays

INTRODUCTION

The rapid advancement in communication technologies and embedded computing has allowed systems to become smarter and more user focused. Traditional alert systems often lack the ability to adapt based on contextual parameters such as user location, time of day, or urgency level. This has led to notification fatigue and reduced user responsiveness. To address these challenges, this project explores a smart notification infrastructure that integrates multiple hardware and software layers to ensure contextual, personalized, and real-time communication to its users.

This system is particularly applicable to environments where timing and accuracy of information dissemination are critical. For instance, religious centers benefit from automated prayer time alerts, clinics utilize it for appointment scheduling, restaurants use it for wait-time notifications, and traffic management units deploy it for real-time routing updates.

OBJECTIVES

- To design a smart notification mechanism capable of delivering location and time-sensitive information.
- To implement a modular system integrating cloud services, Bluetooth/Wi-Fi, LTE modules, and embedded platforms.
- To enhance user experience through intuitive mobile and web interfaces that ensure timely dissemination of critical data.
- To minimize redundant alerts and streamline communication using AI-driven notification prioritization.
- To enable multi-domain adaptability with a unified backend architecture.

PROBLEM STATEMENT

The majority of current notification systems are either static or non-context aware. This results in irrelevant or poorly timed notifications, contributing to user disengagement. There is a rising need for intelligent systems that not only manage the timing and relevance of alerts but also cater to diverse operational environments.

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MOTIVATION

- Information Overload: Users are inundated with notifications that lack contextual prioritization, resulting in stress and missed actions.
- Context Ignorance: Alerts often fail to consider the user's activity or environment.
- Multi-Device Dependency: With increasing reliance on multiple smart devices, there's a need for a synchronized notification system.
- Time Management: Efficient alerts contribute to improved scheduling and task execution in both personal and professional settings.

METHODOLOGY

The proposed smart notification system integrates both hardware and software components to deliver timely, context-aware alerts. At the heart of the system lies an embedded unit built around the Raspberry Pi 3B+, which functions as the central processor interfaced with peripheral components such as sensors, an LTE modem, and digital display units. The system architecture includes seamless cloud integration using Amazon Web Services (AWS), which acts as a central repository and synchronization hub for all incoming and outgoing data. This cloud platform allows remote access, data management, and coordination between different users and interfaces. Connectivity is achieved through multiple wireless protocols, including Wi-Fi, Bluetooth, GPS, and LTE, ensuring that communication between users and system modules remains robust and uninterrupted regardless of physical proximity. A mobile application serves as the primary user interface, enabling interaction for both admins (referred to as authors) and end-users (guests). Admins are authorized to update and manage system content, while guests receive notifications either locally through Bluetooth when in range of the device or remotely via GPS and mobile data. The functional flow begins with the admin transmitting updates through a LAN or WAN, which are then pushed to the cloud platform. Once synced, these updates are reflected across the smart display system and the mobile application interface used by guests.

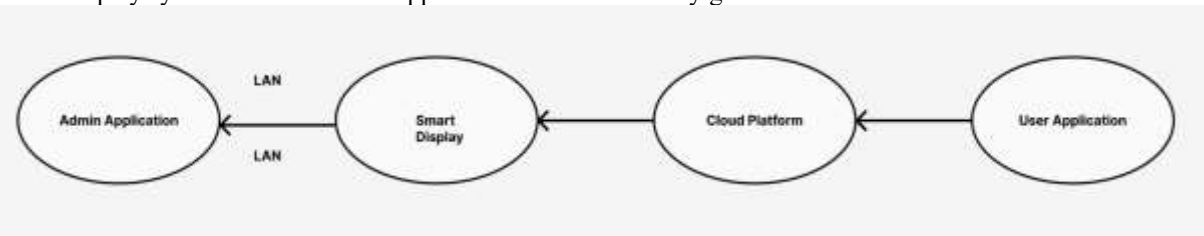

Fig 1: *Working flow*

ARCHITECTURE OVERVIEW

The system's architecture consists of several coordinated modules. Visual notifications are rendered using LED digital displays. Communication with the cloud is facilitated via the Simcom A7672S LTE modem, which also includes GPS and GSM functionalities for accurate positioning and real-time connectivity. Local data transmission is supported through Bluetooth 5.0 and Wi-Fi operating at 2.4GHz. The backend services are developed using Python Flask, offering lightweight server functionality hosted on the cloud. The entire embedded system operates on DietPi OS, a highly optimized operating system for single-board computers like Raspberry Pi, which ensures resource efficiency and stable performance.

Fig 2: Raspberry pi

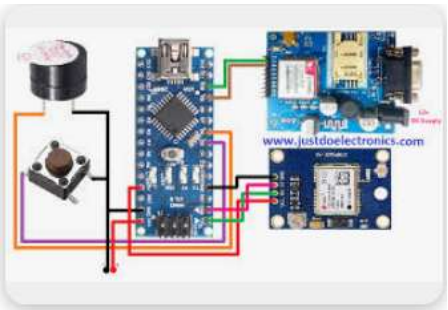

fig 3: Circuit connections

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HARDWARE USED

The hardware components utilized in this system are chosen for their efficiency, availability, and compatibility with IoT applications. The display unit is a 6×4 ft LED digital screen capable of rendering high-visibility content. Processing and control are managed by the Raspberry Pi 4 Model B, chosen for its computing capability and GPIO interfacing. A Simcom LTE modem equipped with GPS enables real-time data transmission and geolocation services. The system also includes embedded wireless modules to support various communication protocols, power supply units to ensure uninterrupted operation, and remote cloud-based servers hosted on AWS for data handling and application hosting.

DESIGN TOOLS AND TECHNOLOGIES

A range of modern tools and technologies were employed to design and implement the smart notification system. Figma was used extensively for UI/UX prototyping, enabling collaborative interface design and real-time feedback during the development process. The backend server is developed using Python Flask, offering a scalable and lightweight framework ideal for embedded applications. Amazon Web Services (AWS) provides the infrastructure for cloud hosting and data storage. Additionally, the system operates on DietPi, a lightweight Debian-based operating system optimized for embedded systems, which ensures minimal resource consumption and fast boot times.

IMPLEMENTATION DOMAINS

The smart notification system is designed to serve diverse environments with different informational needs. In religious institutions such as mosques, it can automatically broadcast Azan and Jamaat timings, ensuring timely participation in prayers. In clinics, it serves to alert patients about upcoming appointments or issue health-related reminders, improving operational efficiency. Restaurants benefit from the system by delivering updates on wait times, table availability, and promotional offers, thereby enhancing customer experience. At traffic junctions, the system can provide real-time updates regarding road conditions, closures, and alternate routes, helping commuters make informed decisions and avoid congestion.

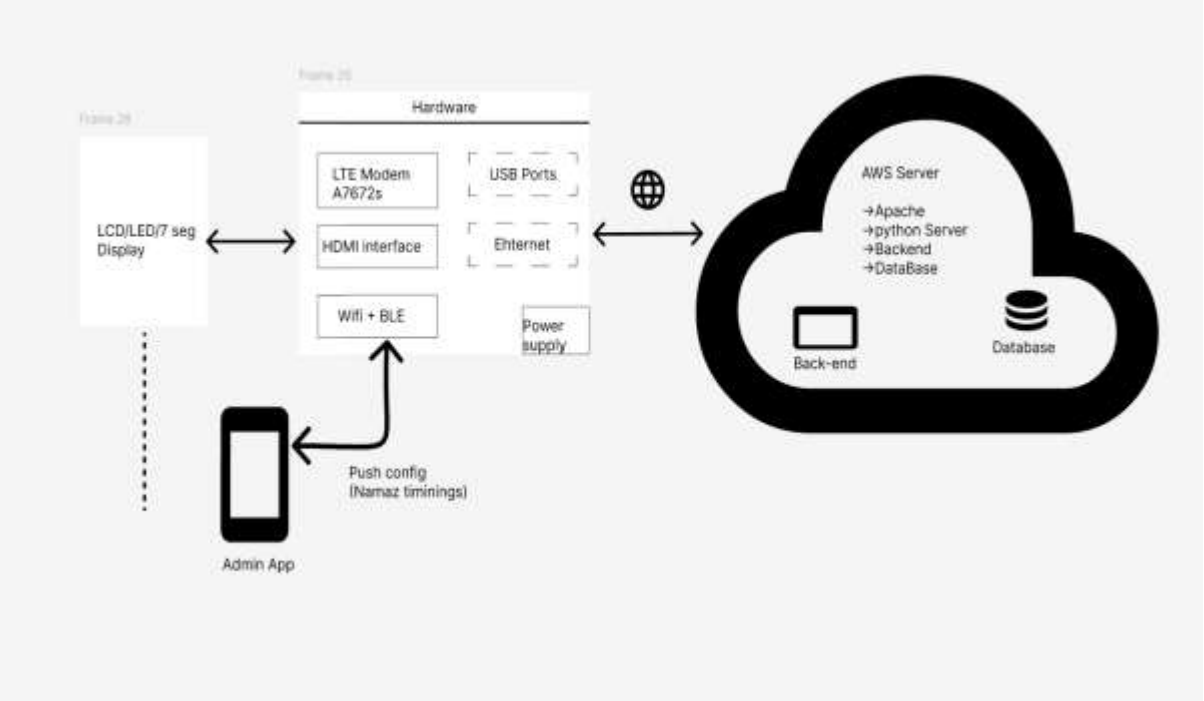

Fig 4: Working and Data Exchange from Server

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BENEFITS

The primary advantage of the proposed system is its ability to deliver efficient and relevant information to users based on their context and proximity. It enhances communication by ensuring that critical updates are neither missed nor delayed. The system promotes community engagement, especially in shared public spaces like mosques or clinics, by delivering announcements that are timely and easy to access. Improved time management is another key benefit, as users are kept informed about appointments, schedules, and events in a non-intrusive manner. The system's modularity ensures that it is both flexible and scalable, allowing for future integration into additional environments or applications.

PROJECT TIMELINE

Month	Activity
October	Project Title Finalization
November	Literature Survey and Tool Selection
December	UI/UX Design with Figma
January	Prototype Development and Testing
February	Conference/Journal Preparation

RESULTS AND DISCUSSION

This smart notification system embodies the convergence of embedded computing, wireless networking, and cloud platforms to deliver adaptive and efficient notifications. By catering to both specific and generalized settings, it reduces information overload and enhances productivity. The modularity of the system allows it to be extended to multiple domains without significant architectural overhaul.

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CONCLUSION

This smart notification system embodies the convergence of embedded computing, wireless networking, and cloud platforms to deliver adaptive and efficient notifications. By catering to both specific and generalized settings, it reduces information overload and enhances productivity. The modularity of the system allows it to be extended to multiple domains without significant architectural overhaul.

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