Smart Queue Management System

Under the guidance of
Prof. Shruthi M K
Assistant Professor
Aditya College of Engineering and Technology
Bangalore, India

Abhishree J S
Department of Electronics and Computer Engineering
Aditya College of Engineering and Technology
Bangalore, India
abhishreemurali878@gmail.com

Joshna K P
Department of Electronicsand Computer Engineering
Aditya College of Engineering and Technology
Bangalore, India
joshnakpreddy123@gmail.com

Monisha C
Department of Electronics and Computer Engineering
Aditya College of Engineering and Technology
Bangalore, India
monichac728@gmail.com

Abstract- Queue management is an essential part of public service environments such as hospitals, banks, restaurants and government offices. Conventional queue-handling practices often depend on manual token distribution and verbal announcements, which can create difficulties in organizing visitors and communicating service status.

This paper presents a Smart Queue Management System that integrates a web-based application with an Internet of Things (IoT) enabled token display unit.

The proposed application is developed using Python Flask, HTML, CSS, JavaScript and SQLite. It provides separate interfaces for visitors and authorized department staff.

Visitors can select a department, choose a service category, submit their details and obtain a unique token number. Staff members can access department-specific dashboards to call the next visitor, update token status, complete service operations and recall tokens.

For physical token notification, an ESP32 microcontroller is connected to four LCD displays. The web application transfers department-specific current and upcoming token details through an external REST API. The ESP32 obtains these details through Wi-Fi connectivity and displays the corresponding NOW and NEXT token numbers on the assigned LCD screens.

The proposed system brings together web application development, database management, API-based communication and embedded hardware to provide a centralized and organized queue management solution.

Keywords: Smart Queue Management, Internet of Things, ESP32, Flask, SQLite, REST API, Real-Time Token Display, LCD.

I. INTRODUCTION

In today's fast-growing world, managing people efficiently in public service areas has become an important challenge. Places such as hospitals, banks, educational institutions, railway stations, supermarkets, and government offices receive a large number of visitors every day. Providing services to all these people in an organized manner requires proper planning and effective queue management. However, traditional methods of handling queues often create difficulties such as overcrowding, long waiting periods, confusion, and inefficient use of time. These problems affect both customers and the staff responsible for providing services. To overcome these challenges, the Smart Queue Management System is proposed as a digital solution for improving the way queues are organized and controlled.

A queue management system is a method of arranging people in a specific order so that services can be provided systematically. In a conventional system, customers generally stand in physical lines and wait until their turn arrives. In some organizations, staff members distribute paper tokens manually to maintain the order of customers. Although these methods are simple to follow, they become difficult to manage when the number of visitors increases. Customers may have to remain near the service counter for extended periods, and staff members may experience additional pressure while handling multiple people. Sometimes, customers may also face uncertainty about their position in the queue and the time required before receiving the service.

The Smart Queue Management System aims to overcome these limitations by introducing a digital method of customer registration, token allocation, and queue monitoring. The main purpose of this project is to create an organized environment in which customers can obtain a token number and wait for their turn without continuously standing in a physical line. Each registered customer is assigned a unique token number, which helps maintain the correct order of service. The system stores the generated token details and manages the waiting list according to the sequence in which customers are registered.

The proposed system consists of different functional modules that work together to manage queue operations. The user registration module allows customers to enter the required information and select the service they need. After successful registration, the token generation module assigns a unique number to the customer. The generated token information is stored in a database so that it can be retrieved and processed whenever required. This digital approach helps reduce the effort involved in manual token distribution and makes customer information easier to manage.

Another important part of the system is the queue management module, which controls the sequence of customers waiting for service. Authorized staff members can access the administrative interface to view the registered tokens, identify the next customer, and call the appropriate token number. Once a customer receives the service, the token status can be updated to indicate that the process has been completed. This helps maintain an organized record of pending and completed services. It also allows staff members to manage the queue more systematically.

The system can also include a digital display module to show the currently serving token number. Customers waiting for their turn can observe the display and identify when their token is called. This reduces the need to repeatedly approach the counter to ask about their position. Depending on the implementation, the system can provide additional information such as waiting status, pending tokens, and service progress. These facilities make the queue management process more convenient and improve communication between customers and service providers.

The system also provides advantages to the employees responsible for handling customers. Instead of depending entirely on manual token distribution and physical queue arrangements, staff members can use a centralized platform to monitor the waiting list and control service operations. Maintaining token information digitally can improve the accuracy of queue handling and reduce confusion during busy working hours. The stored information may also help administrators understand the number of registered customers and review service activity.

The main objective of this project is to design and develop a reliable, user-friendly, and efficient queue management solution that simplifies customer handling. It focuses on automatic token generation, proper queue sequencing, digital monitoring, and convenient administration. By combining these functions, the system aims to reduce unnecessary waiting, minimize overcrowding, improve the utilization of staff time, and provide a better experience for people visiting service centers.

Overall, the Smart Queue Management System offers a structured digital approach to handling customer queues. It replaces several manual activities with an organized token-based process and provides better control over customer registration and service allocation. The project aims to make queue management simpler, faster, and more convenient while supporting efficient service delivery in places where managing large numbers of visitors is necessary.

II. LITERATURE SURVEY

Queue management helps organizations serve people in an

orderly manner. Manual queue systems can cause delays, overcrowding, and confusion. Digital systems provide a simple way to generate tokens and manage waiting lines. They help improve service efficiency and reduce waiting time.

A. Traditional Queue Management Systems

Traditional queue management methods mainly depend on physical waiting lines and manual arrangements. Customers are expected to remain in a particular order until they receive the required service. This approach is easy to implement in small service environments, but it becomes difficult when the number of visitors increases. Maintaining the correct sequence, controlling crowd movement, and managing customer waiting periods can create additional work for employees. These limitations have encouraged the development of more organized digital queue solutions.

B. Token-Based Queue Management

Token-based queue management provides a systematic way of arranging customers according to their registration order. Each customer receives a separate identification number, which is used to determine when the service should be provided. This approach reduces confusion between customers and helps staff members maintain an organized service sequence. Digital token systems further improve this process by storing token information electronically and allowing the service order to be controlled through an application.

C. Digital Queue Display Systems

Digital display technology plays an important role in modern queue management. Electronic screens can present the token number currently being served and provide information about the next customer. This helps people waiting for service identify their turn without repeatedly approaching the counter. Digital displays also improve communication between service providers and customers. Their effectiveness depends on timely updates and proper synchronization with the queue management application.

D. Online Queue Registration and Virtual Tokens

Online queue registration allows customers to obtain tokens through a digital platform instead of collecting them physically at a service counter. This method can make the registration process more convenient and reduce unnecessary crowd formation. Research on mobile-supported hospital queue management has explored the use of mobile interfaces for token generation and management across different hospital service areas. Such approaches demonstrate how digital registration can support coordinated service operations.

E. Automated Queue Monitoring and Service Management

Automated queue monitoring helps employees manage customer flow by providing information about registered tokens, pending requests, and completed services. An administrative interface can be used to call the next token, update its status, and monitor ongoing operations. Digital queue management research also identifies the importance of providing clear queue information and supporting staff activities. These facilities can help improve coordination and make service operations more systematic.

F. Queue Management in Hospitals and Public Service Centers

Queue management is particularly important in hospitals and other public service organizations because visitors may need to access different departments or service counters. A hospital-based token booking system can help organize patient registration and service allocation. Research in this area explores digital token booking, appointment scheduling, and patient-flow management. Similar approaches can be adapted for banks, colleges, and government offices where customers need to access different services.

III. METHODOLOGY

The proposed Smart Queue Management System follows a systematic methodology to organize and manage customer queues efficiently. The development process includes requirement analysis, system design, token generation, queue management, display operations, system integration, testing, and evaluation. The main objective is to reduce waiting time, avoid overcrowding, minimize manual work, and improve customer convenience in hospitals, banks, colleges, and other public service centres.

A. Requirement Analysis

The initial stage involves identifying the problems associated with traditional queue management systems. The major requirements include automatic token generation, proper queue arrangement, customer identification, token management, and efficient service handling. These requirements help determine the necessary hardware components and software technologies.

B. System Architecture

The proposed system follows a modular architecture in which different components work together to manage customer queues. The main components include a token generation unit, processing unit, display unit, and operator control unit. Each component performs a specific function to maintain the proper sequence of customers and ensure smooth system operation.

C. Token Generation

The token generation module assigns a unique number to

generated through the token generation interface. The generated number helps identify each customer and maintains an organized order for providing services.

D. Queue Management

The queue management module maintains the sequence of generated tokens. It ensures that customers receive services according to their assigned token numbers. The operator can manage the queue and call the next customer after completing the current service.

E. Display Management

The display module provides information about the currently serving token number. Whenever the next customer is called, the displayed number is updated accordingly. This helps customers identify their turn and reduces confusion in the waiting area.

F. Hardware and Software Development

The hardware components are selected and connected according to the system requirements. The software program is developed to control token generation, maintain the queue sequence, and manage display operations. Proper coordination between hardware and software ensures the correct functioning of the system.

G. System Integration

In this stage, all individual components are combined into a complete system. The token generation unit, processing unit, display, and operator controls are connected and configured. The integrated system is checked to ensure that all components work together properly.

H. System Testing

The developed system is tested to verify the accuracy of token generation, proper queue arrangement, and correct display updates. Different test cases are performed to identify errors and improve the reliability and efficiency of the system.

I. System Implementation

After successful testing, the system can be implemented in hospitals, banks, educational institutions, government offices, and other public service centres. Customers receive tokens and wait for their assigned numbers, while service operators control the queue systematically.

J. Performance Evaluation

The final stage evaluates the system based on token generation accuracy, queue handling efficiency, display performance, reliability, and ease of use. The evaluation helps determine how effectively the system reduces manual effort, avoids confusion, and improves the customer waiting experience.

IV. EXISTING SYSTEM

The existing queue management process in hospitals, banks, restaurants, and government offices commonly relies on manual token distribution and traditional waiting-line arrangements. Visitors are required to collect tokens physically and wait until their numbers are announced by the service staff. This approach often creates overcrowding, delays, and difficulties in maintaining an organized queue.

In some service environments, basic digital token systems are used to manage visitor registration and queue sequences. However, these systems may not provide centralized management or real-time information about the current and upcoming tokens. Visitors may need to depend on staff announcements or repeatedly check with service counters to know their turn.

Traditional queue management methods also involve manual record maintenance, which can increase the possibility of errors and make it difficult to track visitor information. Managing multiple departments independently may further complicate queue monitoring and coordination.

A. Manual Token Distribution

Visitors need to collect physical tokens from service counters. This process requires staff involvement and may lead to delays during busy hours.

B. Lack of Real-Time Updates

Traditional systems may not provide automatic updates about the currently serving and upcoming token numbers, making it difficult for visitors to know their queue status.

C. Limited Department Management

Managing queues separately across hospitals, banks, restaurants, and government offices can make monitoring and coordination difficult.

D. Manual Record Maintenance

Visitor details and token information may be maintained using registers or separate records, increasing paperwork and the possibility of human errors.

E. Lack of Display Integration

Some existing applications do not include connected hardware displays to show the latest token information directly to visitors.

F. Limitations of the Existing System

The major limitations include:

- Dependence on manual token distribution and announcements.
- Delays in updating queue information.
- Difficulty in monitoring multiple service departments.
- Increased paperwork and manual record maintenance.
- Limited accessibility to current and upcoming token details.
- Lack of integration between web applications and physical display devices.

G. Summary

The existing queue management methods provide basic facilities for organizing visitors but may not offer centralized control, automatic token updates, and real-time

display facilities. These limitations create a need for an improved solution that combines web-based queue management with IoT technology to provide better coordination, faster information updates, and an organized visitor experience.

V. PROPOSED SYSTEM

The proposed Smart Queue Management System with IoT-Based Real-Time Token Display is designed to overcome the limitations of traditional queue management methods by providing a centralized and automated platform. The system is developed to manage visitor queues in four different service departments: Hospitals, Banks, Restaurants, and Government Offices.

A. Visitor Registration and Token Generation

Visitors can access the web application, select their preferred department, choose a service category, and enter the required details. After registration, the system automatically generates a unique token number.

B. Department-Wise Staff Management

Separate login facilities are provided for each department. Authorized staff members can access their dashboards and manage visitor queues, registrations, and service activities.

C. Automated Queue Processing

The system provides options to call the next token, mark a token as serving, complete the service, and recall previously called tokens. Queue information is updated whenever an operation is performed.

D. Database Management

SQLite is used to maintain visitor details, department information, staff accounts, token records, and queue history. It helps store and retrieve information systematically.

E. Real-Time Token Updates

The application calculates the currently serving token (NOW) and the next waiting token (NEXT) for each department. Updated information is transmitted to an external REST API using HTTP requests.

F. IoT-Based Display System

An ESP32 microcontroller retrieves the latest token information through Wi-Fi. It processes the received data and updates the corresponding LCD display assigned to each department.

G. Four Department Display Integration

Four LCD displays are connected to the ESP32 microcontroller. Each display represents one service department:

- LCD 1 – Hospital
- LCD 2 – Bank
- LCD 3 – Restaurant
- LCD 4 – Government Office

Each LCD displays the department name, current token number, and upcoming token number to help visitors identify their turn.

H. Visitor Tracking and Reports

Visitors can monitor their token status and queue position through the web application. The system also provides reports and analytical information about registrations, completed services, and queue activities.

I. Advantages of the Proposed System

The major advantages include:

- Reduces manual token distribution and announcements.
- Provides automatic token generation.
- Supports centralized management of four departments.
- Displays current and upcoming tokens through LCD screens.
- Improves communication between visitors and service staff.
- Maintains visitor and queue records in a database.
- Provides convenient token tracking and reporting facilities.
- Reduces confusion and improves queue organization.
-

J. Summary

The proposed Smart Queue Management System provides an integrated approach to handling visitor queues using web technologies and IoT-based hardware. By combining online registration, automatic token generation, department-wise queue management, and real-time LCD displays, the system aims to improve service coordination, minimize manual intervention, and provide a more convenient experience for visitors and staff.

VI. ADVANTAGES

The Smart Queue Management System provides several advantages by integrating web application technology, database management, and IoT-based hardware. It helps improve the overall queue handling process in hospitals, banks, restaurants, and government offices.

1. **Time Saving:** Reduces the time spent on manual token distribution and queue management.
2. **Easy Registration:** Allows visitors to register through an online platform without depending entirely on physical counters.
3. **Automatic Token Generation:** Generates unique token numbers for visitors and maintains an organized service sequence.
4. **Reduced Overcrowding:** Helps manage visitor flow and reduces unnecessary gathering near service counters.
5. **Real-Time Information:** Displays current and upcoming token numbers through LCD screens, helping visitors identify their service turn.
6. **Multi-Department Support:** Supports queue management for four different service departments through a centralized application.

7. **Efficient Staff Management:** Provides separate dashboards for authorized staff to handle registrations and queue activities.
8. **Reliable Data Storage:** Maintains visitor details, token records, department information, and service history using an SQLite database.
9. **IoT Integration:** Uses an ESP32 microcontroller and Wi-Fi connectivity to transfer updated token information to the LCD displays.
10. **Improved Communication:** Keeps visitors informed about queue progress through the web application and physical display units.

VII. CONCLUSION

The Smart Queue Management System with IoT-Based Real-Time Token Display provides an effective solution for managing visitor queues in hospitals, banks, restaurants, and government offices. The system combines a web-based application, Python Flask, SQLite database, and department-wise staff dashboards to simplify visitor registration, automatic token generation, and queue processing. It reduces the difficulties associated with traditional queue handling by minimizing manual work, maintaining digital records, and providing an organized method of managing visitors. The integration of the ESP32 microcontroller with four LCD displays further improves the functionality of the system by presenting the current (NOW) and upcoming (NEXT) token numbers for each department. Through Wi-Fi connectivity and REST API communication, updated token information can be transferred from the web application to the hardware displays. Overall, the project aims to improve service coordination, reduce visitor confusion, maintain accurate records, and provide a convenient queue management experience. The system can also be enhanced in the future by introducing mobile notifications, estimated waiting-time calculations, and additional department support.

VIII. REFERENCES

1. A. A. Sandy, Septriandi, Z. Saputra, and Y. D. Santi, "Healthcare Queue Management: IoT-Based Automated Patient Calling System for Primary Care Facilities," *ELECTRON Jurnal Ilmiah Teknik Elektro*, vol. 6, no. 2, 2025. Available Online. jurnalelectron.org
2. P. S. Basgaran and N. Ibrahim, "Design and Development of Lasto Virtual Queue Management System," *Applied Information Technology and Computer Science*, vol. 4, no. 1, pp. 916–934, 2023. Available Online. IJCRT

3. "CRPF-QC: An Efficient CSI Recurrence Plot-Based Framework for Queue Counting," *IEEE Internet of Things Journal*, vol. 11, no. 19, pp. 31699–31714, 2024. DOI: 10.1109/JIOT.2024.3419181. IJCRT

4. R. Gouiaa, M. A. Akhloufi, and M. Shahbazi, "Advances in Convolutional Neural Networks Based Crowd Counting and Density Estimation," *Big Data and Cognitive Computing*, vol. 5, no. 4, Article 50, 2021. Available Online. IJCRT
5. "Monitoring Large Crowds With WiFi: A Privacy-Preserving Approach," *IEEE Systems Journal*, vol. 16, no. 2, pp. 2148–2159, 2022. Available Online. IJCRT

6. Y. Yigit et al., "Autonomous Queue Management System in Software-Defined Routers for Sensor Networks," *2024 IEEE 10th World Forum on Internet of Things*, pp. 719–724, 2024. Available Online. napier-repository.worktribe.com

Technical Documentation
7. Python Software Foundation, "Python Documentation." Available: https://docs.python.org/3/

8. Pallets Projects, "Flask Web Development Framework Documentation"Available:https://flask.palletsprojects.com/
9. SQLite Consortium, "SQLite Documentation." Available: https://www.sqlite.org/docs.html

10. Espressif Systems, "ESP32 Technical Reference and Documentation." Available: https://docs.espressif.com/

11. Arduino, "Arduino Documentation." Available: https://docs.arduino.cc/
12. Mozilla Developer Network, "HTML, CSS and JavaScriptDocumentation."Available:https://developer.mozilla.org/