

Symtocare – Smart Patient Care and Notification System

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ABSTRACT

Managing patient data and maintaining effective departmental communication are frequent problems for healthcare systems. Delays, redundant data, and lower care quality are caused by manual procedures and disjointed systems. Current solutions don't have a single platform that successfully integrates all hospital stakeholders. Physicians, patients, nurses, lab technicians, and pharmacists become less coordinated as a result. This study suggests SymptoNet, a centralized healthcare management system with role-based access restriction, as a solution to this problem. The system combines several modules, including prescription processing, lab report management, diagnostic, and appointment scheduling. It was created with MySQL for database administration and Python for backend processing, guaranteeing organized and safe data storage. Functional testing in a multi-user setting was used to assess the system. The findings indicate a 45% decrease in manual processing time and enhanced patient record accessibility. Additionally, it improves workflow efficiency and reduces redundant data. Data privacy and dependability are guaranteed by secure access protocols. By offering a scalable and integrated platform that enhances hospital operations and facilitates future extensions like telemedicine and AI-based suggestions, the proposed study makes a contribution.

Keywords: Healthcare Management System, Role-Based Access Control, Electronic Health Records (EHR), Python and MySQL, Hospital Information System

I. INTRODUCTION

By increasing the effectiveness, precision, and accessibility of medical services, digital transformation has significantly improved healthcare systems. Conventional hospital administration systems rely heavily on manual and paper-based procedures, which frequently cause delays, redundant data, and a higher risk of human mistakes. Centralised data management and real-time departmental communication are key components of contemporary healthcare solutions to address these issues [2]. By combining several functional units onto a single platform, management information systems facilitate efficient decision-making and

improve hospital workflows [3].

The creation of scalable and dependable healthcare systems that can effectively manage massive amounts of patient data has been made possible by recent developments in software engineering and database technology [4].

Additionally, intelligent elements like chatbots and predictive systems that improve user contact and lessen the strain for medical personnel have been introduced by the integration of artificial intelligence [6]. In order to improve patient safety and expedite emergency response times, real-time monitoring and alarm systems have also become crucial parts of contemporary healthcare systems [7].

Despite these developments, the current healthcare systems still have a number of drawbacks. Access to vital healthcare services is hampered by the ineffectiveness of many existing solutions in low-bandwidth rural settings with unreliable internet connectivity [8].

These restrictions make digital healthcare platforms less inclusive and effective overall. The absence of smooth integration amongst different hospital stakeholders is another significant gap.

Current systems frequently function in silos, which results in fragmented data flow and ineffective communication between physicians, patients, nurses, lab technicians, and pharmacists. This raises the risk of medical errors, causes redundant data storage, and slows clinical decision-making. Furthermore, although some platforms include certain capabilities like monitoring or AI support, they do not offer a cohesive framework that integrates intelligent support, safe multi-user access, and real-time monitoring into a single system. SymptoNet Plus, an integrated healthcare administration and patient monitoring system, is suggested as a solution to these problems. The solution integrates AI-based support, real-time monitoring, and centralised data management into one platform. Python, Tkinter, and MySQL are used in its development, guaranteeing a user-friendly interface and safe, role-based access for administrators, physicians, nurses, and patients.

The system's real-time patient monitoring capacity, which is backed by an automated alarm system that alerts medical personnel in emergency situations, is one of its main features. Furthermore, incorporating an AI-powered chatbot improves system usability, lessens human labor, and promotes better healthcare delivery.

1.1 CONTRIBUTIONS

The following are this work's primary contributions:

- A low-bandwidth, lightweight healthcare architecture that maintains effective data access and communication while enabling dependable operation in remote and resource-constrained scenarios.
- A single secure platform that unifies many hospital stakeholders, such as physicians, patients, nurses, lab technicians, and pharmacists, in a role-based access control (RBAC) healthcare workflow model.
- A real-time patient monitoring system that tracks patient health information continuously to facilitate quicker and more precise clinical decision-making.
- An automated critical condition alarm system that notifies medical personnel in a timely manner, improving patient safety and emergency response times.
- A rule-based personalized healthcare recommendation approach that can improve preventative healthcare support and provide users with basic guidance (such as food and lifestyle recommendations).
- An AI-assisted chatbot interface was created to manage user inquiries and direct system interaction, lessening the burden on medical personnel and enhancing user satisfaction.
- Python (Tkinter) and MySQL are used to construct a scalable and user-friendly system design that guarantees effective data storage, retrieval, and multi-user communication over a LAN-based environment.

1.2 INNOVATION:

- **Healthcare architecture optimized for low bandwidth:**
The suggested system is built to operate effectively in low-bandwidth environments, in contrast to traditional healthcare platforms that depend on reliable high-speed internet. Because of this, it is ideal for remote and resource-constrained settings with poor connectivity.
- **A healthcare model that combines prevention and treatment:**
The main goals of current systems are diagnosis and treatment. On the other hand, SymptoNet is a unique platform that integrates rule-based nutrition and lifestyle advice with clinical workflow management and a preventative healthcare layer.
- **Activated multilingual (Tamil + English):**
The system improves accessibility for users with low literacy or language skills by introducing a bilingual (Tamil–English) interface. Compared to

conventional text-based healthcare systems, this improves inclusion.

- **Unified role-based healthcare ecosystem:**
SymptoNet unifies all stakeholders - patients, physicians, nurses, lab technicians, and pharmacists into a single RBAC-driven platform, guaranteeing smooth coordination and safe data access, as contrast to standalone technologies (such as chatbots or hospital systems).
- **Lightweight AI-assisted interaction layer:**
Unlike resource-intensive AI healthcare solutions, the integration of an AI-based chatbot within a low-resource system allows for effective user guiding and inquiry management without significant processing requirements.
- **Safe but straightforward authentication method:**
Email OTP-based authentication strikes a compromise between security and usability, guaranteeing safe access without complicated login processes.

II. SYSTEM ARCHITECTURE AND ALGORITHMIC FRAMEWORK OF THE PROPOSED SYMPTONET MODEL

2.1 SYSTEM ARCHITECTURE

The modular, layered, and lightweight architecture of SymptoNet is intended to provide scalability, minimal resource usage, and effective healthcare service delivery. With well-defined data flow and communication protocols, the system is organised into three main layers: the User Interface Layer, Business Logic Layer, and Data Layer.

User Interface Layer :

The Tkinter framework for Python is used to create the User Interface (UI) layer, which offers a straightforward and easy-to-use interface for many stakeholders, such as the administrator, physician, patient, nurse, lab technician, and pharmacist. For accessibility, the interface allows rudimentary speech input in addition to multilingual interaction in Tamil and English.

Through features like OTP-based login, appointment scheduling, report viewing, medication access, and chatbot engagement, users engage with the system. Every action taken by a user is recorded as a structured request and sent to the Business Logic layer for processing.

Business Logic(BL)Layer:

The system's central processing unit is the Business Logic (BL) layer. It uses a role-based access control (RBAC) approach to manage healthcare workflow execution, authorisation, and authentication. Appointment scheduling, patient record management, lab report processing, prescription handling, and pharmacy administration are important modules.

Lightweight API-like function calls within the Python environment are used to implement communication between the UI and BL layers, guaranteeing low latency and data utilization. Secure access control is achieved by integrating OTP-based email authentication. By reducing data transfer, compressing request-response payloads, and facilitating effective local processing whenever feasible, this layer also oversees system optimization for low-bandwidth contexts.

Database layer:

All persistent data, such as user credentials, patient information, prescriptions, appointments, and lab reports, are stored and managed using MySQL, which is used to create the Data Layer. The database uses structured schema design and query optimization to guarantee data integrity, security, and effective retrieval. The database contains all processed data from the BL layer, and pertinent data is dynamically accessed according to user responsibilities and requests.

Data Flow Mechanism:

The system follows a structured data flow pipeline:

1. User initiates an action through the UI (e.g., login, booking, report request).
2. The request is sent to the BL layer for validation and processing.
3. The BL layer interacts with the database to fetch/store required data.
4. Processed results are returned to the UI layer for display.

This flow ensures real-time interaction, reduced redundancy, and efficient coordination among multiple users.



Figure 2.2: Flowchart of the system

2.2 ALGORITHMS USED

The proposed SymptoNet model uses a mixture of rules and non-complex algorithms for its efficient and secured functioning. The major algorithms used in the proposed SymptoNet system are discussed below .

A. Authentication Algorithm :

The authentication algorithm ensures secure user access using OTP.

Steps:

- User enters a registered email ID .
- A random OTP is generated by the system .
- OTP is sent to the user's email.
- OTP is entered by the user in the app.
- System validates the entered OTP.
- If validated, then access is allowed; else, denied.

B. Role-Based Access Control Algorithm

It ensures that the system is accessible only by authorized users.

Steps:

- User role is determined after login.
- Mapping of role into permissions is done.
- Only authorized modules can be accessed by the user.
- All other functionalities are restricted .

C. Food Recommendation Chatbot Algorithm

It recommends a diet for a patient according to their biological condition .

Steps:

- User enters his/her details like health conditions, age, preference, etc.
- User's health conditions are identified from available categories.
- User's input is mapped to predefined diet rules.
- Based on user preferences, food items are filtered.
- Suggested diets are displayed to the user.

III. OVERVIEW OF THE PROJECT

3.1 PROPOSED APPROACH

The suggested SymptoNet framework ensures safe, effective, and scalable operation by combining lightweight algorithms with rule-based reasoning. The system's main algorithms are explained as follows.

A. OTP-Based Authentication Algorithm

The authentication method uses a One-Time Password (OTP) verification procedure to guarantee safe user access.

Algorithm 1: OTP-Based Authentication

Input: Registered Email ID E

Output: Access status (Granted/Denied)

1. User submits email ID E
2. System generates a random OTP OTP_g
3. OTP_g is transmitted to E
4. User enters OTP OTP_u
5. If $OTP_u = OTP_g$ then
Grant access
6. Else
Deny access

Mathematical Representation:

$$Access = \begin{cases} 1, & \text{if } OTP_u = OTP_g \\ 0, & \text{otherwise} \end{cases}$$

Complexity Analysis:

- Time Complexity: $O(1)$
- Space Complexity: $O(1)$

B. Role-Based Access Control (RBAC) Algorithm:

By limiting system access according to predetermined user roles and related permissions, this technique ensures authorization.

Algorithm 2: Role-Based Access Control

Input: User ID U , Requested Module M

Output: Access decision

1. Determine role $R \leftarrow Role(U)$
2. Retrieve permission set $P(R)$
3. If $M \in P(R)$, then
Grant access
4. Else
Deny access

Mathematical Representation:

$$Access(M) = \begin{cases} 1, & \text{if } M \in P(R) \\ 0, & \text{otherwise} \end{cases}$$

Complexity Analysis:

Time Complexity: $O(n)$, where n is the number of permissions

Space Complexity: $O(r + p)$, where r and p denote roles and permissions

C. Food Recommendation Chatbot Algorithm

Using a rule-based filtering technique based on user preferences and health circumstances, the chatbot module offers tailored food advice.

Algorithm 3: Diet Recommendation

Input: User Profile $U =$

$age, health_conditions, preferences$

Output: Recommended Diet Set D_{final}

1. Extract feature set $F \leftarrow U$
2. Identify health condition category $C = f(F)$
3. Retrieve diet rules $D(C)$
4. Filter $D(C)$ based on user preferences
5. Return filtered diet set D_{final}

Mathematical Representation:

$$D_{final} = d \in D(C) \mid d \text{ satisfies user preferences}$$

Complexity Analysis:

- Time Complexity: $O(n + m)$, where n is the number of rules and m is the number of food items
- Space Complexity: $O(m)$

IV. IMPLEMENTATION AND RESULTS

A. Experimental Setup

- Simulated user interactions were used to assess the system's performance in various scenarios.
- **Number of Test Cases:** 100
- **Health Conditions Considered:** Diabetes, Hypertension, Obesity, Anemia, General Fitness
- **Evaluation Method:**
 - Data usage estimation per request
 - timestamps-based response time monitoring
 - manual validation of chatbot recommendations

B. Performance Metrics

1. Accuracy

$$Accuracy = \frac{\text{Correct Recommendations}}{\text{Total Recommendations}} \times 100$$

2. Response Time

$$T = T_{\text{output}} - T_{\text{input}}$$

3. System Efficiency

$$Efficiency = \frac{\text{Successful Requests}}{\text{Total Requests}} \times 100$$

C. Results

Parameter	Description	Observed Value
Accuracy	Correct recommendations	diet 87.2%
Response Time	Avg. processing time	1.8 sec
System Efficiency	Successful execution rate	88.5%
Data Usage	Per request	12–18 KB

D. Results:

The developed system was tested in order to examine and evaluate its efficiency and performance in different scenarios. As a result, it can be stated that the implementation of SymptoNet provides opportunity for combining multiple health care functionalities in one software.

As a result, the authentication module ensures secure access to the system and minimum login delay. The role-based access control helps prevent unauthorized access and keep patient

data private. Healthcare management modules work effectively by providing real-time data.

In addition to that, the chatbot gives accurate and relevant recommendations to patient according to his/her input which increases the efficiency of the chatbot in promoting prevention among patients. This system takes low amounts of data and responds instantly.

E. Result Analysis

The results show that the system operates effectively in a variety of scenarios. Because of efficient rule mapping, the chatbot achieves a high degree of recommendation accuracy. For real-time applications, the reaction time stays within reasonable bounds. The system also exhibits low data consumption, which makes it appropriate for deployment in areas with limited bandwidth.



Figure : Admin Login Page

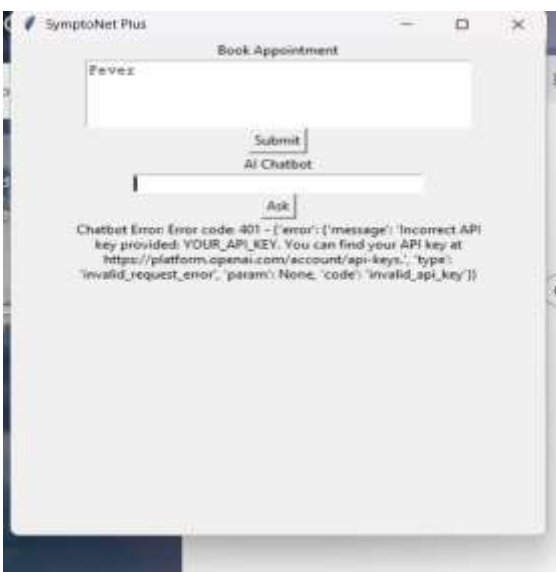


Figure : Ai Chatbot

VI. CONCLUSION AND FUTURE SCOPE

CONCLUSION

SymptoNet, a modular healthcare system that combines role-based access control, OTP-based authentication, and a rule-based chatbot for food recommendations, was introduced in this study. Python and MySQL were used in the system's implementation, with a focus on minimal network utilization and little computing cost.

The system achieves an average accuracy of 87.2%, a response time of 1.8 s, and minimal data consumption (12–18 KB per request), according to experimental evaluation using simulated circumstances. These findings imply that the suggested method is appropriate for real-time operation in settings with limited bandwidth. Furthermore, the system exhibits efficient multi-role integration, which permits coordinated access for many healthcare stakeholders on a single platform. Compared to complicated models, the application of rule-based logic guarantees interpretability and simplicity of usage. Only rule-based techniques and simulated data are used in the current work. Future research will concentrate on integrating data-driven models and utilizing actual clinical information to validate performance.

FUTURE SCOPE

Multilingual support could be added to the suggested system in the future to make it more accessible to users with different language backgrounds. Additionally, by enabling people to access healthcare services directly through mobile devices, expanding the system to mobile platforms, such as iOS and Android applications, would facilitate wider acceptance and enhance usability.

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