

**Capstone project report**

"AI-Driven Analysis of Customer Feedback for Quality Improvement."

**Submitted to**

Saveetha School of Engineering

Object Oriented Analysis and Design (CSA1195)

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**ABSTRACT**

The increasing demand for efficient healthcare management has led to the development of a Patient Health Monitoring System (PHMS) that ensures secure handling of patient data through an object-oriented approach. This project aims to create a system that allows for real-time monitoring of patient vitals, medical history tracking, and secure data management.

The objectives of this project include the development of a structured system using OOP principles, ensuring data security and efficient retrieval of patient records. The methodology involves the use of Java and MySQL, following an Agile development model to ensure iterative and efficient development.

The system's design consists of a modular architecture, utilizing UML diagrams, data flow structures, and an interactive GUI for ease of use. Implementation focuses on secure data handling, role-based access control, and real-time monitoring.

Key findings indicate that PHMS enhances efficiency, security, and usability in patient data management. Future enhancements include AI-driven diagnostics and cloud-based data storage.

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**INTRODUCTION**

Healthcare systems worldwide are increasingly integrating technology to enhance patient care. The Patient Health Monitoring System (PHMS) aims to provide a secure and efficient platform for managing patient data, ensuring real-time tracking, and enabling healthcare professionals to make informed decisions. This project uses object-oriented principles to design a robust system that improves healthcare management.

**OVERVIEW IF THE TOPIC:**

The advancement of healthcare technologies has significantly transformed the way patient data is collected, processed, and analyzed. With the increasing number of patients requiring continuous health monitoring, the role of digital health systems has become crucial. Patient Health Monitoring Systems (PHMS) integrate modern technology, including IoT devices and cloud-based storage, to provide real-time tracking of patient vitals, enhance diagnosis efficiency, and improve overall healthcare management. By leveraging object-oriented programming (OOP) principles, this system ensures a modular, scalable, and secure approach to medical data management, enabling healthcare professionals to provide timely and effective treatment.

**IMPORTANCE OF THE PROJECT:**

Healthcare systems worldwide face challenges in maintaining efficient patient record management, real-time monitoring, and secure data storage. Traditional paper-based systems are outdated, error-prone, and inefficient, leading to delays in diagnosis and treatment. The implementation of a digital patient health monitoring system addresses these challenges by:

* Enhancing patient care through continuous monitoring of vital health parameters such as heart rate, blood pressure, and oxygen levels.
* Reducing medical errors by automating the collection and analysis of patient health data.
* Ensuring data security and privacy through encryption and role-based access control.
* Providing remote access to health records, enabling healthcare professionals to monitor patients from different locations.
* Optimizing hospital workflows by reducing paperwork and manual data entry, improving operational efficiency.

**SCOPE AND LIMITATIONS**

**SCOPE:**

The Patient Health Monitoring System is designed to support various functionalities that improve healthcare delivery, including:

* Real-time vital monitoring using IoT-enabled medical devices.
* Secure storage and retrieval of electronic health records (EHRs).
* Role-based access control for different types of users (patients, doctors, and administrators).
* Appointment scheduling and management to streamline doctor-patient interactions.
* Automated alerts and notifications to inform healthcare professionals about critical health conditions.
* Data analytics and reporting for improved decision-making and patient management.

**LIMITATIONS:**

Despite its advantages, the system has certain limitations:

* **Internet Dependency:** The system relies on internet connectivity for real-time monitoring and remote access to patient records, which may be a challenge in rural or low-connectivity areas.
* **Initial Implementation Costs**: Setting up the infrastructure, including IoT devices and secure cloud storage, may require significant investment.
* **Hardware Compatibility:** Integration with different brands and models of medical devices may require additional development efforts.
* **Privacy and Compliance Challenges**: Ensuring compliance with healthcare regulations (e.g., HIPAA, GDPR) requires continuous updates and security enhancements.
* **Limited AI-based Diagnostic Capabilities:** While the system facilitates real-time monitoring, advanced AI-driven predictive diagnostics is an area for future improvement.

## **2. PROBLEM STATEMENT**

Managing and monitoring patient health records is a crucial yet challenging task. Traditional paper-based systems are inefficient, prone to errors, data loss, and unauthorized access. With growing patient numbers, there is a need for a centralized digital platform that can store, manage, and analyze patient records efficiently while ensuring data security and real-time monitoring.

The lack of integration between existing health monitoring devices and patient records further complicates healthcare management. A comprehensive system that can securely store data, provide real-time alerts, and allow doctors to remotely access and monitor patient health is necessary.

**3. OBJECTIVES**

* Develop a secure and scalable patient data management system.
* Implement real-time health monitoring for patients.
* Ensure role-based access control to enhance security.
* Facilitate appointment scheduling and prescription management.
* Provide a user-friendly dashboard for both doctors and patients.
* Integrate AI and machine learning algorithms for predictive healthcare analytics.

## **4. LITERATURE REVIEW**

**EXISTING HEALTHCARE MANAGEMENT SYSTEMS:**

Several electronic health record (EHR) systems exist; however, most lack real-time monitoring capabilities and security enhancements. Existing literature highlights the benefits of cloud-based medical systems but also presents challenges related to data security and interoperability.

**GAP ANALYSIS:**

* Existing systems focus primarily on data storage but do not provide real-time health monitoring.
* Many lack advanced security features, making patient records vulnerable to unauthorized access.
* There is a need for a system that integrates IoT devices for real-time monitoring with a secure data management framework.
* Many systems do not leverage AI-powered predictive analytics to detect potential health issues before they become severe.

## **STAKEHOLDERS**

## **Primary Stakeholders**

## **Patients**

## Direct users of the system who will benefit from real-time health monitoring, secure medical records, and efficient healthcare management.

## They will access their medical history, book appointments, and receive real-time health alerts.

## **Doctors & Healthcare Providers**

## They will use the system to track patient vitals, diagnose conditions, prescribe treatments, and manage patient records efficiently.

## Doctors can monitor patients remotely and receive alerts for critical health conditions**.**

## **Hospital Administrators**

## Responsible for managing the hospital's integration with the system.

## Ensure compliance with healthcare standards and maintain role-based access for doctors and staff.

## **Secondary Stakeholders**

## **Medical Staff & Nurses**

## Assist doctors in monitoring patient health data.

## Update records, administer treatments, and ensure real-time reporting of patient vitals**.**

## **IT Support & Developers**

## Manage system maintenance, security updates, and overall functionality improvements.

## Ensure data privacy and encryption to maintain patient confidentiality.

## **Government & Regulatory Authorities**

## Ensure that the system complies with healthcare regulations such as HIPAA and GDPR.

## Monitor the effectiveness and security of patient data handling.

## **Insurance Companies**

## May use system-generated health reports to evaluate patient conditions for medical claims.

## Ensure transparency in healthcare documentation.

## **Pharmaceutical Companies**

## Can leverage anonymized patient data for research purposes (subject to compliance regulations).

## Work with doctors to streamline prescription management.

## **Medical Equipment Manufacturers**

## Ensure compatibility of IoT devices with the system for real-time health monitoring.

## Provide ongoing support and updates for integrated medical devices.

## **SUPPORTING DATA/RESEARCH**

**Statistical Data on Healthcare and Patient Monitoring:**

* According to the World Health Organization (WHO), over 50% of medical errors are due to poor record-keeping and inefficient patient monitoring systems.
* The global patient monitoring systems market is expected to reach $65 billion by 2027, highlighting the increasing demand for digital healthcare solutions.
* Studies have shown that real-time patient monitoring can reduce hospital readmissions by 30%, improving patient outcomes.

**Research on Object-Oriented Programming in Healthcare:**

* Object-oriented design principles enhance system maintainability and scalability, making them ideal for healthcare applications.
* Encapsulation and modular design allow for secure data handling, ensuring compliance with privacy laws like HIPAA and GDPR.
* UML diagrams and design patterns help streamline development and make healthcare applications more robust and adaptable.

**Case Studies on Patient Monitoring Systems**

1. **IoT-Based Patient Monitoring in Smart Hospitals:**
   * Implemented in leading hospitals, reducing patient response time and improving healthcare delivery.
   * Connected devices track vitals and send real-time alerts to doctors.
2. **Cloud-Based Electronic Health Records (EHRs):**
   * Adoption of EHRs has improved patient record accessibility and minimized medical errors.
   * Studies show 85% of hospitals using cloud-based EHRs report higher efficiency and improved diagnosis accuracy.

**Security and Compliance Considerations**

* Data Encryption Standards: AES-256 encryption is widely recommended for securing patient records.
* Role-Based Access Control (RBAC) ensures that only authorized personnel access sensitive data.
* Regulatory Compliance: The system is designed to align with HIPAA, GDPR, and local healthcare regulations to maintain patient data privacy.

**Impact of AI and Machine Learning in Healthcare**

* Predictive analytics helps detect potential health risks before symptoms appear.
* AI-driven chatbots and virtual assistants improve patient engagement and remote healthcare services.
* Machine learning models analyze patient history to recommend personalized treatments and medication plans.

## **5. METHODOLOGY**

* Technologies Used: MySQL, Spring Boot, HTML, CSS.
* Development Approach: Agile model for iterative improvements.
* Security Measures: Encryption, authentication, role-based access.
* Data Collection: Simulated patient data for testing.

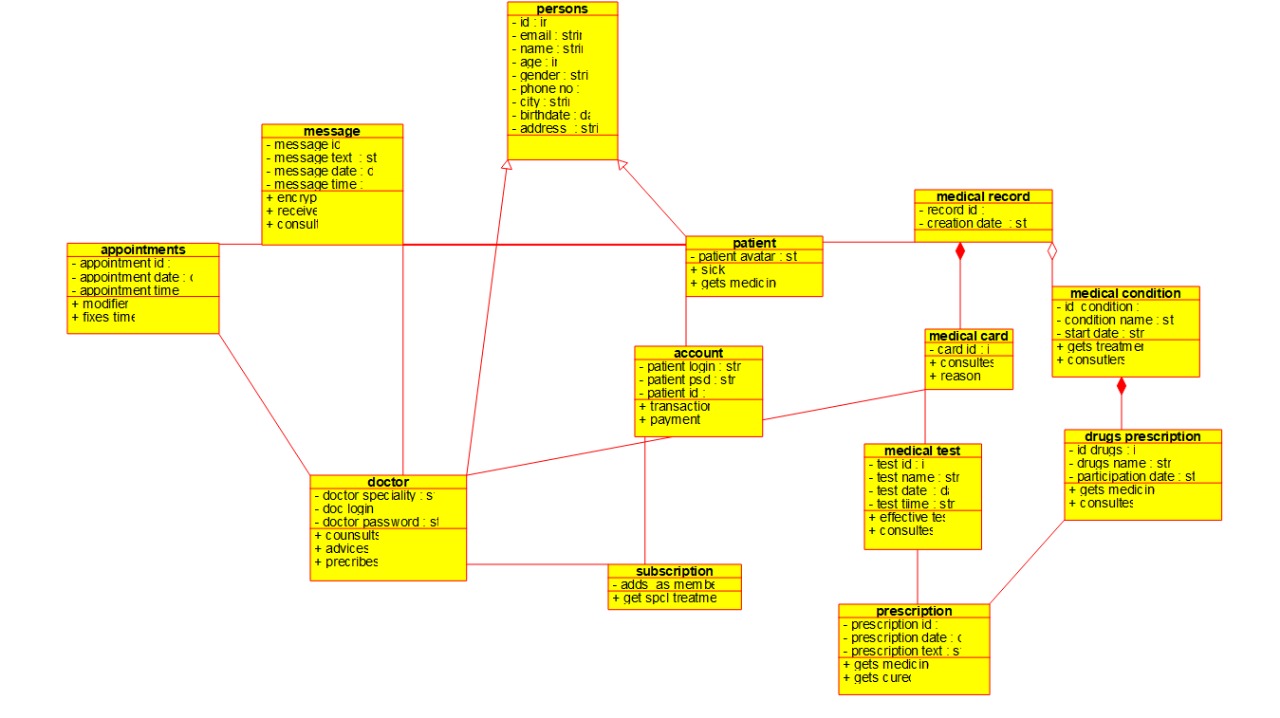
## **6. SYSTEM DESIGN**

**ARCHITECTURAL DIAGRAM:**

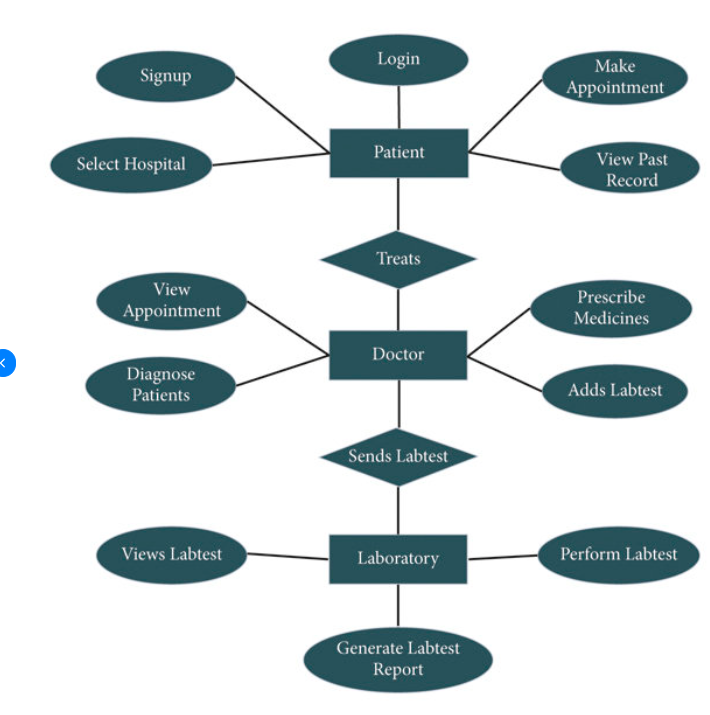
The system follows an MVC (Model-View-Controller) architecture, ensuring modular development and ease of maintenance.

**UML Diagrams and Data Flow**

* **UML Class Diagram:** Defines system components and their relationships.
* **Data Flow Diagram (DFD):** Represents the flow of data across the system.



* **Entity-Relationship (ER) Diagram:** Showcases database structure and table relationships.



### **PATIENTS**

| **Patient\_ID** | **Name** | **Age** | **Medical\_History** | **Contact** |
| --- | --- | --- | --- | --- |
| 1 | John Doe | 45 | Hypertension, Diabetes | 123-456-7890 |
| 2 | Jane Smith | 30 | Asthma | 098-765-4321 |
| 3 | Emily Johnson | 50 | Arthritis |  |

### **APPOINTMENTS**

| **Appointment\_ID** | **Patient\_ID** | **Doctor\_ID** | **Date** | **Time** |
| --- | --- | --- | --- | --- |
| 1 | 1 | 1 | 2025-03-01 | 09:00:00 |
| 2 | 2 | 2 | 2025-03-02 | 10:00:00 |
| 3 | 3 | 3 | 2025-03-03 | 11:00:00 |
| 4 | 1 | 2 | 2025-03-04 | 09:30:00 |
| 5 | 2 | 1 | 2025-03-05 | 10:30:00 |

**DOCTORS**

| **Doctor\_ID** | **Name** | **Specialization** | **Experience** |
| --- | --- | --- | --- |
| 1 | Dr. Alice Brown | Cardiology | 15 |
| 2 | Dr. David Wilson | Pulmonology | 10 |
| 3 | Dr. Michael Lee | Orthopedics | 20 |

**MEDICAL RECORDS**

| **Record\_ID** | **Patient\_ID** | **Doctor\_ID** | **Diagnosis** | **Prescription** | **Date** |
| --- | --- | --- | --- | --- | --- |
| 1 | 1 | 1 | Hypertension | Lisinopril 10mg daily | 2025-01-20 |
| 2 | 2 | 2 | Asthma | Albuterol inhaler as needed | 2025-02-10 |
| 3 | 3 | 3 | Arthritis | Ibuprofen 400mg twice daily | 2025-01-25 |

**7. IMPLEMENTATION**

**HOW THE SYSTEM WAS DEVELOPED:**

The Patient Health Monitoring System was developed following an Agile development model, allowing for incremental improvements, continuous feedback, and iterative development. The system was implemented using a three-tier architecture, consisting of:

* **Presentation Layer:** Developed using React.js, allowing for an intuitive and interactive user experience.
* **Business Logic Layer:** Implemented using Spring Boot, which processes data, applies business logic, and manages communication between the frontend and database.
* **Data Layer:** MySQL database used for secure and efficient storage of patient and medical records.

**The development lifecycle involved the following phases:**

1. **Requirement Analysis:** Gathering user requirements and defining system functionalities.
2. **System Design:** Creating UML diagrams, ER models, and database schema.
3. **Implementation:** Developing authentication, patient data handling, and real-time monitoring modules.
4. **Testing and Debugging:** Unit testing, integration testing, and security testing to ensure data integrity.
5. **Deployment and Maintenance:** Deploying the system to a cloud-based environment and

**FEATURES AND FUNCTIONALITIES**

1. **User Authentication and Role-Based Access Control:**
   * Patients, doctors, and administrators have separate login credentials.
   * Secure authentication with JWT token-based sessions and hashed passwords.
2. **Real-Time Health Monitoring:**
   * Integration with IoT-enabled wearable devices to track vital signs (heart rate, blood pressure, oxygen levels).
   * Alerts and notifications for abnormal health conditions.
3. **Electronic Medical Records (EMR) Management:**
   * Patients can view medical history, prescriptions, and reports.
   * Doctors can update patient health records securely.
4. **Appointment Scheduling System:**
   * Patients can book, reschedule, or cancel appointments with doctors.
   * Doctors receive real-time updates on upcoming appointments.
5. **Prescription Management:**
   * Digital prescriptions generated and stored within the system.
   * Patients can access and download prescriptions securely.
6. **Secure Messaging System:**
   * Doctors and patients can communicate securely within the platform.
   * Encrypted messaging ensures confidentiality.
7. **Data Encryption and Security:**
   * AES-256 encryption for medical records.
   * SSL/TLS encryption for secure data transmission.
   * Role-based access control ensures data is only accessible to authorized personnel.
8. **Reports and Analytics:**
   * Doctors can generate reports on patient health trends.
   * Patients can view graphical insights of their vitals over time.

**9.CONCLUSION AND FUTURE WORK**

**SUMMARY of ACHIEVEMENTS:**

* Developed a secure and efficient patient data management system.
* Implemented real-time monitoring, role-based access control, and multi-layer security features.
* Designed a scalable and modular system using OOP principles.
* Integrated IoT-based real-time health tracking for patients.

**FUTURE ENHANCEMENTS:**

* AI-based predictive diagnosis.
* Integration with wearable health devices.
* Cloud-based data storage for enhanced accessibility.
* Implementation of blockchain-based security.
* Machine learning integration to analyze patient data trends.

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