**Real-Time Medical Check System**

**SUBMITTED BY,**

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**A PROJECT REPORT SUBMITTED TO THE DEPARTMENT OF INFORMATION TECHNOLOGY IN SCHOOL OF INFORMATION TECHNOLOGY, MEDIA AND ENGINEERING IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF BACHELORS IN SOFTWARE ENGINEERING**

**DECLARATION.**

**This research project is our original work and has not been presented for any award in any other university.**

**We declare the work of the project titled REAL-TIME MEDICAL CHECK SYSTEM is based on our own investigations and research done based on information that we obtained from sources that we stated in the reference. We also declare that our work was never be produced or presented by any student.**

**Name : ..................................................  Date : ....................................................**

**Name : ..................................................  Date : ....................................................**

**Declaration by the supervisor**

**This Research has been submitted with our approval of the unit supervisor.**

**NAME    :......................……..          ........................................**

**SIGN      :..............…………… ........................................**

**DATE     :..........……………. ........................................**

**DEDICATION**

This work is dedicated to God Almighty, our parents, and lecturers who have been strong pillar, source of inspiration, wisdom, knowledge, and understanding. They have been the source of our strength throughout this program.

This work is also dedicated to our fellow students who have been helpful and understanding.

Thank you. God bless you.

**ACKNOWLEDGEMENT**

Firstly, we would like to thank the almighty God for His protection, provision, and inspiration during the entire work. We also acknowledge the entire school, lecturer and our supervisor for his guide during the project.

We express my sincere gratitude to the university HOD MR Roy Kanyi for providing an opportunity to work on a project to get knowledge.

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# Chapter 1:

## Introduction

### 1.0 Background

#### Global Context

Healthcare systems worldwide face significant challenges, including increasing patient volumes, limited medical resources, and delays in diagnosis. Traditional diagnostic approaches rely on periodic physical check-ups and laboratory testing, often resulting in delayed detection of medical conditions. These delays can lead to disease progression and more complex treatment requirements, placing additional burdens on healthcare infrastructures.

In response, digital health innovations have introduced real-time health monitoring solutions that enable early detection and intervention, improving patient outcomes and optimizing healthcare resources. The integration of artificial intelligence (AI) in medical diagnostics has significantly advanced global healthcare, facilitating remote patient monitoring and predictive analytics.

#### Local Context

In many regions with limited healthcare access, including remote and underserved areas, diagnostic delays are even more pronounced. Many patients only consult medical professionals sporadically due to logistical and financial constraints. In Kenya, for instance, the doctor-to-patient ratio remains far below the World Health Organization (WHO) recommendation, further complicating timely medical attention.

The development and implementation of a Real-Time Medical Checks Diagnostic System (RTMCDS) could bridge this gap by providing continuous monitoring and early intervention, ultimately reducing the strain on healthcare facilities and improving patient care.

### 1.1 Problem Statement

The traditional medical diagnosis process relies heavily on scheduled check-ups and laboratory-based diagnostics, leading to delayed detection of potential health complications. Limited healthcare access, high patient-to-doctor ratios, and the lack of real-time monitoring contribute to worsening health conditions before intervention occurs.

This project seeks to address these gaps by developing a Real-Time Medical Checks Diagnostic System (RTMCDS) that continuously monitors patient vitals, detects abnormalities, and provides immediate diagnostic insights.

### 1.2 Objectives

### 1.2.1 General Objective

To develop a Real-Time Medical Checks Diagnostic System that enables continuous health monitoring, early detection of anomalies, and real-time diagnostics, improving patient care and medical efficiency.

### 1.2.2 Specific Objectives

* To design and implement a system capable of continuously monitoring patients’ health including parameters such as heart rate, blood pressure, and temperatures.
* To integrate AI-driven analytics for early detection and prediction of potential health risks.
* To develop a user-friendly interface for healthcare professionals and patients to access real-time diagnostic data.
* To evaluate the system’s effectiveness in improving early diagnosis and reducing patient-doctor visit gaps.
* To ensure data security and privacy compliance within the system.

### 1.3 Research Questions

* How can real-time health monitoring improve early diagnosis and intervention?
* What are the key parameters required for an effective real-time medical diagnostic system?
* How can AI be leveraged to enhance diagnostic accuracy and predict potential health issues?
* What challenges might arise in implementing RTMCDS in resource-limited settings?
* How can user experience be optimized to ensure widespread adoption by both healthcare professionals and patients?

### 1.4 Justification

The RTMCDS aims to revolutionize the healthcare landscape by introducing proactive and continuous monitoring rather than reactive treatment approaches. With the increasing global burden of chronic diseases such as hypertension and diabetes, early detection through real-time monitoring can lead to better disease management and reduced healthcare costs. Moreover, this system aligns with global efforts to integrate AI into healthcare, making medical services more accessible, efficient, and predictive.

### 1.5 Significance

This project is significant to multiple stakeholders, including:

* **Patients:** Enables early detection and timely intervention, reducing health complications and improving quality of life.
* **Healthcare Providers:** Assists in diagnosing and monitoring patients more efficiently, reducing hospital congestion.
* **Medical Researchers:** Provides valuable real-time health data for further studies on disease prediction and management.
* **Healthcare Systems:** Helps optimize resource utilization and reduces unnecessary hospital visits, lowering operational costs.

### 1.6 Scope and Limitations

The scope of this project includes the development of a real-time medical diagnostic system that integrates continuous health monitoring, AI-driven analysis, and a user interface for accessing diagnostic insights. The system will be designed primarily for non-invasive health metrics, such as heart rate, blood pressure, and temperature.

**Limitations:**

* **Data Accuracy:** AI predictions require significant training and validation to ensure high accuracy.
* **Integration Challenges:** Compatibility with existing healthcare infrastructure may pose difficulties.
* **Privacy and Security:** Ensuring compliance with health data regulations and preventing unauthorized access to patient information.
* **User Adoption:** Encouraging both healthcare professionals and patients to trust and effectively use the system.

# Chapter 2

## Literature Review

### 2.1 Overview of Real-Time Health Monitoring Systems

### Health monitoring has come a long way, moving from occasional checkups to systems that can now track someone’s condition in real-time using intelligent software. Instead of relying on isolated data, newer systems apply machine learning models to understand ongoing health patterns, flag issues early, and guide better decision-making.

### RTMCDS, for example, takes this a step further by using adaptive algorithms to tailor care to each individual. It looks at how someone’s health is trending and helps intervene before things get worse. This kind of approach helps reduce emergencies and improves outcomes by making healthcare more responsive and personalized over time.

### 2.2 Artificial Intelligence in Medical Diagnostics

The integration of artificial intelligence in medical diagnostics has revolutionized how data is interpreted. Machine learning models—including neural networks, support vector machines, and decision trees—are used to identify subtle patterns in complex datasets that may be imperceptible to human observers. These AI algorithms improve diagnostic accuracy by learning from vast amounts of historical and real-time data (Patel et al., 2022).

Furthermore, deep learning techniques have been explored for image analysis in radiology and pathology, setting a precedent for their application in analyzing data for continuous health monitoring. The challenge remains in ensuring these algorithms are trained on diverse datasets to avoid biases and ensure high reliability across various demographic groups.

### 2.3 AI-Based Health Monitoring Systems

Artificial Intelligence is at the core of the evolution in real-time health monitoring. By powering intelligent systems across a range of devices—from smartphones to wearables—AI enables continuous tracking and interpretation of health data wherever the user may be.

These systems feed data into centralized health models that analyze patterns in real time, offering insights, alerts, and predictive feedback based on personalized health trends. This approach has proven especially valuable in extending quality care to underserved and remote populations. However, ongoing challenges around data privacy, secure system integration, and model scalability remain central to further development in this field.

### 2.4 Challenges in Implementing Real-Time Medical Diagnostics

Despite advancements, real-time medical diagnostics face several challenges:

* **Data Reliability and Accuracy:** The quality of health insights depends heavily on the accuracy of the data collected. Any issues—whether from technical faults, environmental noise, or inconsistencies in readings—can affect outcomes. That’s why having strong systems in place to catch and correct errors early is critical for maintaining trust and effectiveness in real-time monitoring.
* **Infrastructure Requirements:** Reliable internet connectivity, sufficient computational power, and secure cloud storage are prerequisites that may be lacking in some regions.
* **Privacy and Security:** The sensitive nature of health data requires strict adherence to data protection regulations, such as HIPAA and GDPR, and the implementation of advanced encryption techniques.
* **User Acceptance:** Both healthcare professionals and patients must trust the system. Continuous education and intuitive system design are key to enhancing user adoption.

### 2.5 Comparative Analysis of Current Systems

Current state-of-the-art systems vary in their approach to real-time monitoring. Some systems focus on a narrow range of vitals, while others integrate a broader spectrum of health indicators. Comparative studies indicate that systems integrating AI-driven analytics offer superior predictive capabilities compared to traditional monitoring methods.

However, many existing systems still face integration issues with legacy healthcare infrastructures. The RTMCDS aims to build on these systems by providing a scalable, flexible solution that can be adapted to various healthcare settings and requirements.

### 2.6 Summary of Key Findings and Research Gaps

In summary, the literature indicates substantial benefits of real-time monitoring combined with AI for early diagnosis and healthcare efficiency. However, gaps remain in addressing data accuracy, system integration, and user trust. These research gaps form the basis for the development of the RTMCDS, which seeks to incorporate best practices from existing studies while addressing the limitations identified in the current literature.

# Chapter 3

## Methodology

### 3.0 Introduction

This chapter outlines the research approach, data collection methods, and system development methodology used to build the RTMCDS. It describes how our study was conducted, including ethical considerations.

### 3.1 Research Design

Our study adopts a mixed-methods research design that combines both qualitative and quantitative approaches. The quantitative component will involve system performance testing, data accuracy assessments, and statistical analysis of diagnostic outcomes.

The qualitative component will include user experience evaluations through interviews and surveys with healthcare professionals and patients. This comprehensive approach ensures a robust evaluation of the system's efficacy and usability.

### 3.2 System Development Methodology

The development of the RTMCDS will follow the Agile methodology. This iterative approach facilitates continuous improvement through regular feedback loops. Key phases include:

* **Requirement Analysis:** Engaging stakeholders to define system specifications.
* **Design and Prototyping:** Creating wireframes, system architecture diagrams, and initial prototypes.
* **Development and Integration:** Gradually developing key parts of the system, including how data is collected, stored in the cloud, and processed using AI models.
* **Testing and Validation:** Conducting unit tests, system integration tests, and user acceptance tests to ensure system reliability.
* **Deployment and Feedback:** Rolling out the system in controlled settings and gathering iterative feedback for further refinement.

### 3.3 Population and Sampling

Our study targets two primary populations: healthcare professionals and patients.

To gather accurate and relevant system requirements, we employed multiple data collection methods:

* **Interviews:** Conducted with 10 healthcare professionals to identify key diagnostic needs and usability concerns.  
  One to one conversation were held in various hospitals and clinics including plainsview hospital
* **Questionnaires:** Distributed to 30 potential patients to gather insights on user interface preferences and expectations.  
  These were in the form of printed forms and online forms as we sampled a few of the patients in the hospitals.
* **Observations:** Performed in selected healthcare settings to understand current diagnostic workflows.

### 3.3.1 Data Collection Methods

To ensure comprehensive system evaluation, we employed multiple data collection methods:

* **Quantitative Data:** This includes data logs, system performance metrics, and diagnostic accuracy rates. Statistical analysis will be performed to assess the system’s effectiveness.
* **Qualitative Data:** Semi-structured interviews and surveys will be conducted with healthcare professionals and patients to gather insights on usability, system reliability, and overall user satisfaction.
* **Secondary Data:** A thorough review of existing literature and case studies related to real-time monitoring systems, AI in diagnostics and applications in healthcare.

### 3.3.2 Data and System Analysis

The data collected from patients and professionals helped us:

* Identify the essential inputs (e.g., user-entered health data, historical patient records) and outputs (real-time diagnostics, trend analyses, alerts).
* Determine that the system must support functionalities such as real-time data processing, user notifications, and detailed reporting.
* Deduce system performance requirements, including response times and data accuracy benchmarks.

### 3.4 System Architecture

The RTMCDS will be designed with a modular architecture comprising:

* **• Vitals Monitoring Module:** Gathers real-time information on key health indicators like heart rate, blood pressure, and oxygen levels using non-intrusive methods.
* **Cloud-Based Storage:** Secure, scalable storage solutions for real-time data collection and historical data archiving.
* **AI Processing Unit:** Employs machine learning algorithms for pattern recognition, anomaly detection, and predictive analysis.
* **User Interface:** A web and mobile dashboard that provides real-time insights and diagnostic recommendations to healthcare providers and patients.
* **Communication Layer:** Implements secure data transmission protocols to ensure the integrity and confidentiality of health data.

### 3.5 Software Development Lifecycle and Tools

The system will be developed using a suite of modern tools and frameworks:

* **Programming Languages:** Python for AI algorithm development and JavaScript, HTML. CSS for front-end development.
* **Frameworks:** PyTorch for machine learning, and React or Angular for the user interface.
* **Testing Tools:** Automated testing frameworks (e.g., Selenium for UI testing, PyTest for backend testing) will be employed to ensure system reliability and performance.
* **Version Control and Collaboration:** Git and collaborative platforms like GitHub will be used to manage code and project documentation.

### 3.6 Ethical Considerations

The project adheres to strict ethical guidelines to protect patient privacy and ensure data security:

* **Data Protection:** All patient data will be encrypted using industry-standard protocols during transmission and storage. SSl and TLS will be employed.
* **Compliance:** The system will comply with relevant health data regulations, such as HIPAA and GDPR, ensuring that data is handled with the utmost care.
* **Informed Consent:** Participants in any user testing or pilot studies will be fully informed about the purpose of the study, data usage, and their rights, with written consent obtained before participation.
* **Risk Mitigation:** Strategies will be in place to address any potential data breaches or system failures promptly and transparently.

### 3.7 Evaluation and Validation Strategy

To ensure the RTMCDS meets its intended objectives, a comprehensive evaluation strategy will be implemented:

* **Performance Metrics:** System response time, data accuracy, and anomaly detection rates will be measured and analyzed.
* **User Feedback:** Iterative testing sessions will gather feedback from healthcare professionals and patients to refine the user interface and overall functionality.
* **Pilot Studies:** Controlled deployment in select healthcare settings will provide real-world data on system performance, guiding further enhancements.
* **Comparative Analysis:** Results from the RTMCDS will be benchmarked against traditional diagnostic methods to assess improvements in early diagnosis and patient outcomes.

# Chapter 4

## System Analysis and Design

### 4.0 Introduction

In this chapter, we present the complete analysis and design of the Real-Time Medical Checks Diagnostic System (RTMCDS). This chapter outlines the systems development methodology we employed, presents our feasibility study, details our requirements elicitation and analysis, and describes both the logical and physical design of the system.

We then provide a comprehensive system architecture and include several diagrams (such as context diagrams, partitioned DFDs, UML diagrams, ER diagrams, and interface mockups) to visually demonstrate our design approach.

### 4.1 Systems Development Methodology

We adopted the Agile methodology for our project. Agile allows for iterative design and development cycles, continuous user feedback, and the flexibility to adapt requirements as we progress.

Early prototyping and regular reviews with stakeholders (healthcare professionals, potential patients, and technical experts) have guided our design choices and ensured that our system meets the needs outlined in our objectives.

### 4.2 Feasibility Study

A feasibility study we conducted to determine whether the RTMCDS could be implemented within available technical, financial, and time constraints. Our study confirmed that:

* **Technical Feasibility:** The required technologies (web development frameworks, cloud-based storage, and machine learning libraries) are well-established and readily available.
* **Economic Feasibility:** The projected costs are within budget, and the system promises to reduce healthcare inefficiencies, yielding long-term savings.
* **Operational Feasibility:** Feedback from a small group of healthcare professionals and potential end-users indicates strong support and willingness to adopt the system.
* **Legal and Regulatory Feasibility:** Data protection and privacy regulations (e.g., HIPAA, GDPR) are addressed through robust security measures.

### 4.3 System Specification

Based on our analysis, the RTMCDS will perform the following functions:

* **Input:** Users (healthcare professionals and patients) enter health data via web forms or upload historical records.
* **Processing:** The system utilizes AI-driven analytics (implemented in Python using PyTorch) to analyze the input data for anomalies and generate diagnostic insights.
* **Output:** The system produces real-time alerts, detailed diagnostic reports, and historical trend analyses displayed through an interactive web/mobile dashboard.

We have defined the system requirements in clear, non-ambiguous terms using models such as data flow diagrams, UML class and use-case diagrams, and an entity-relationship diagram (ERD).

### 4.4 Design

### 4.4.1 Logical Design

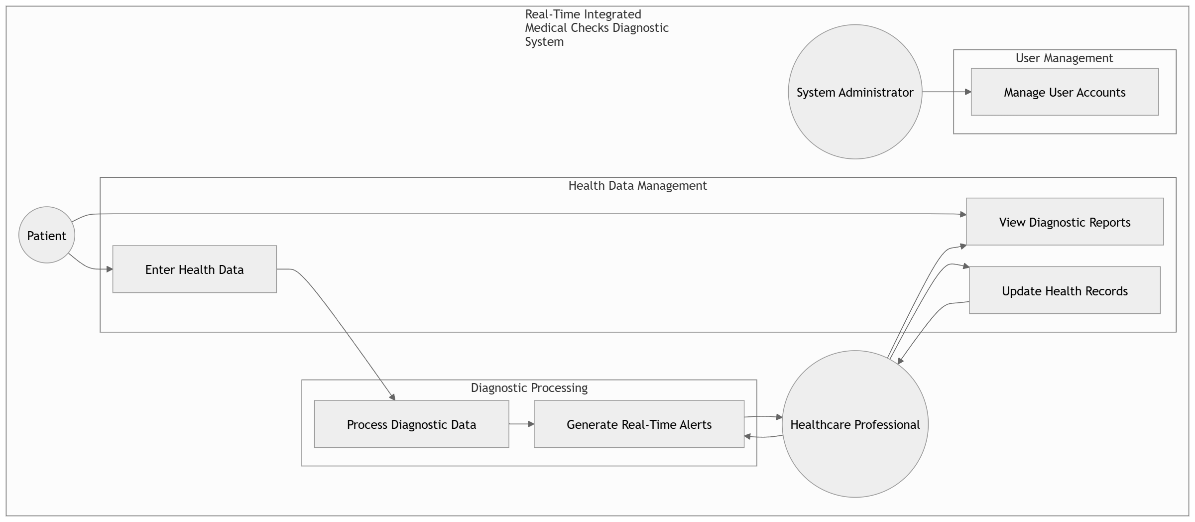
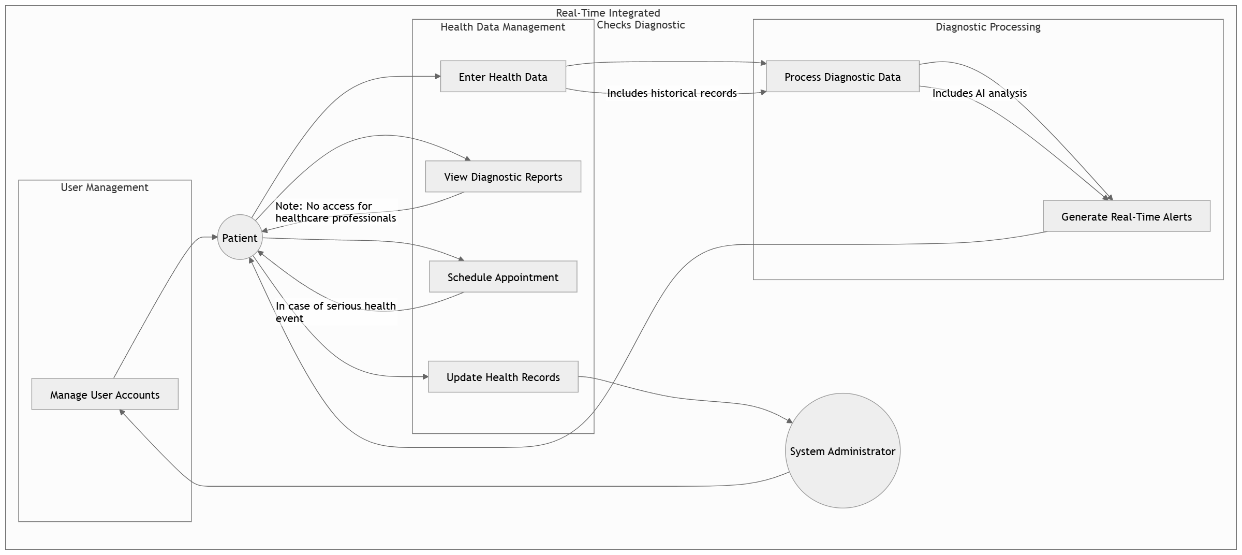
* **Rich Picture and Context Diagram:**  
  We have developed a rich picture that captures the overall environment and stakeholders of the system. A context diagram illustrates the system's boundaries and its interactions with external entities (e.g., healthcare providers, patients).
* **Wireframes:**  
  Initial wireframes for the user interface depict the main screens (login, data entry forms, dashboard, and reports) and navigation flow.

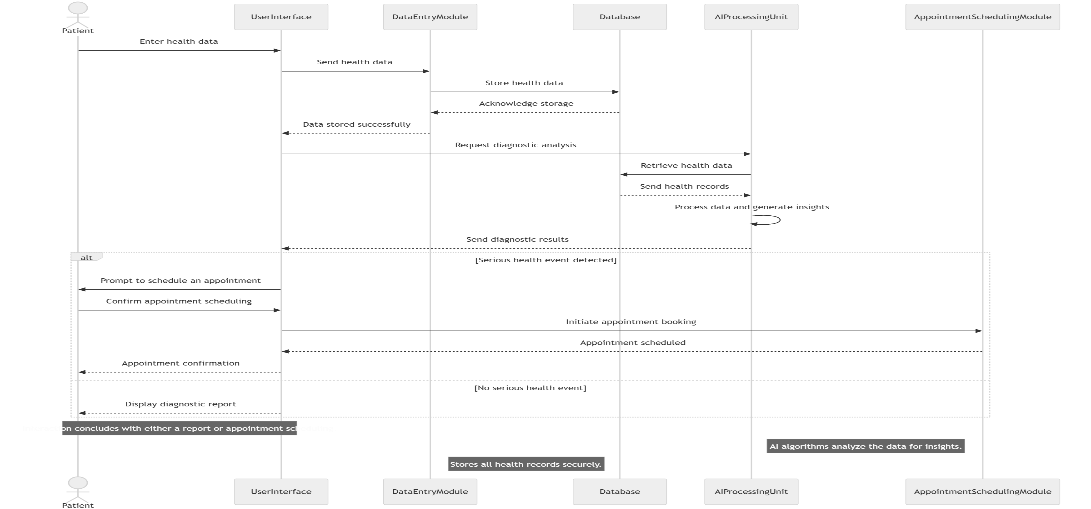
Fig 4.1: Logical Design

### **4.4.2 Physical Design**

* **UML Diagrams:**
  + **Use Case Diagram:** Depicts the interactions between the system and its actors (healthcare professionals, patients, and system administrators).

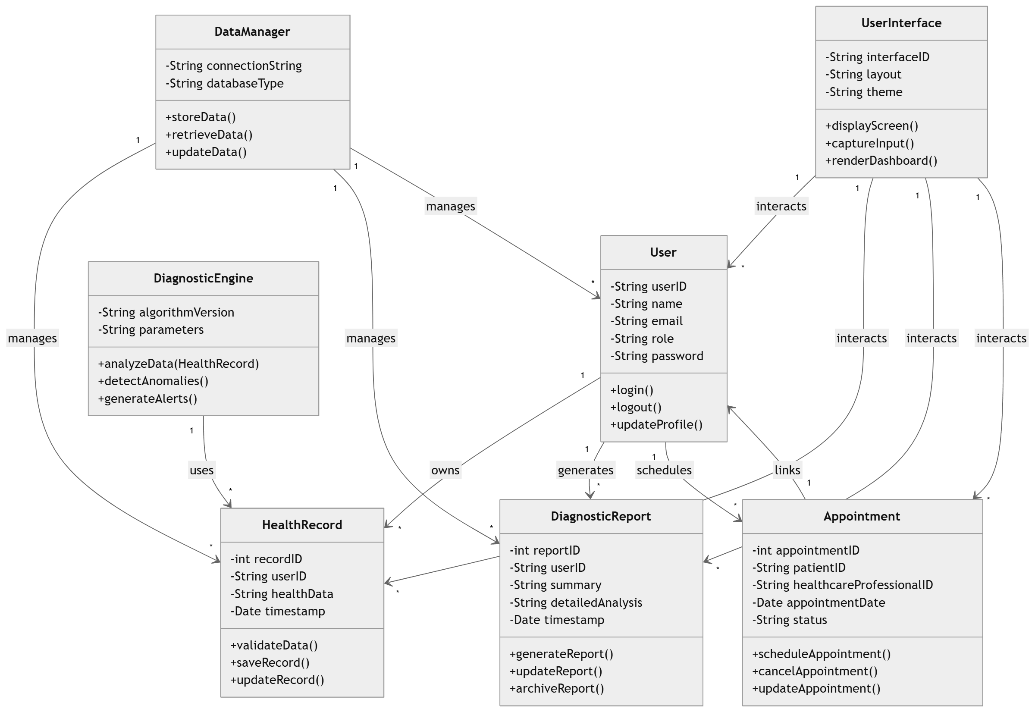
**Figure 4.2:** UML Use Case Diagram.

* + **Sequence Diagram:** Details the flow of data from user input through processing to output generation.



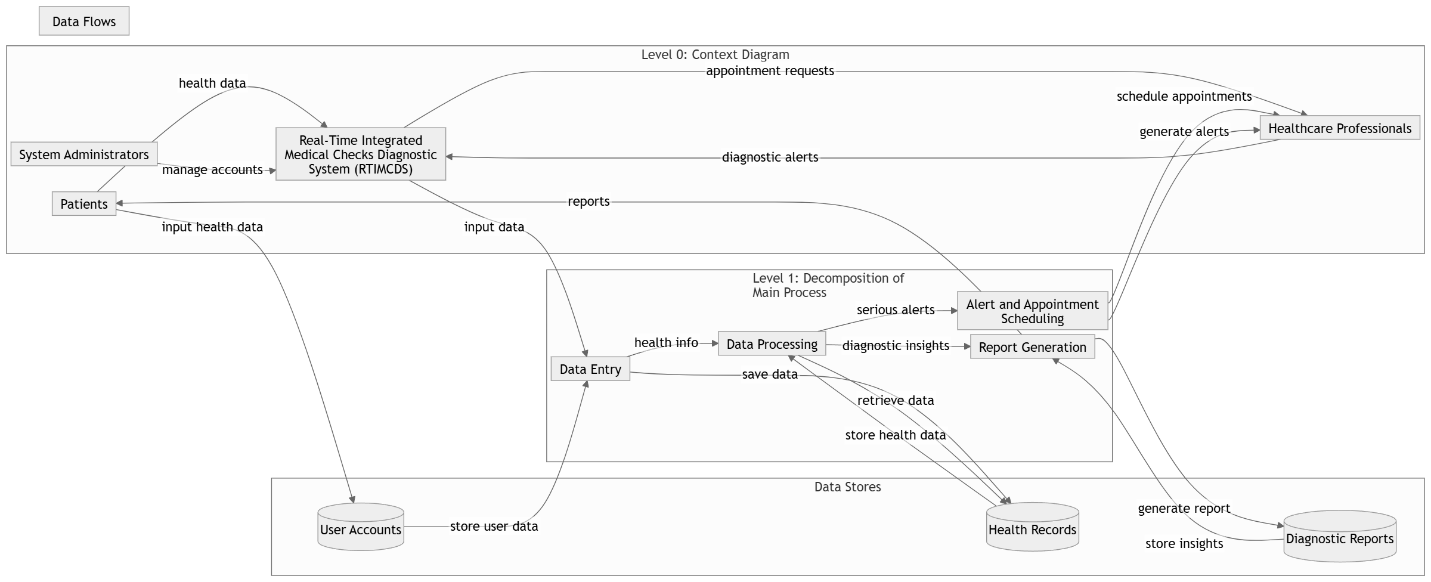
**Figure 4.3:** UML Use sequence Diagram.

* + **Class Diagram:** Defines the key classes (e.g., User, HealthData, DiagnosticEngine, ReportGenerator) and their relationships.

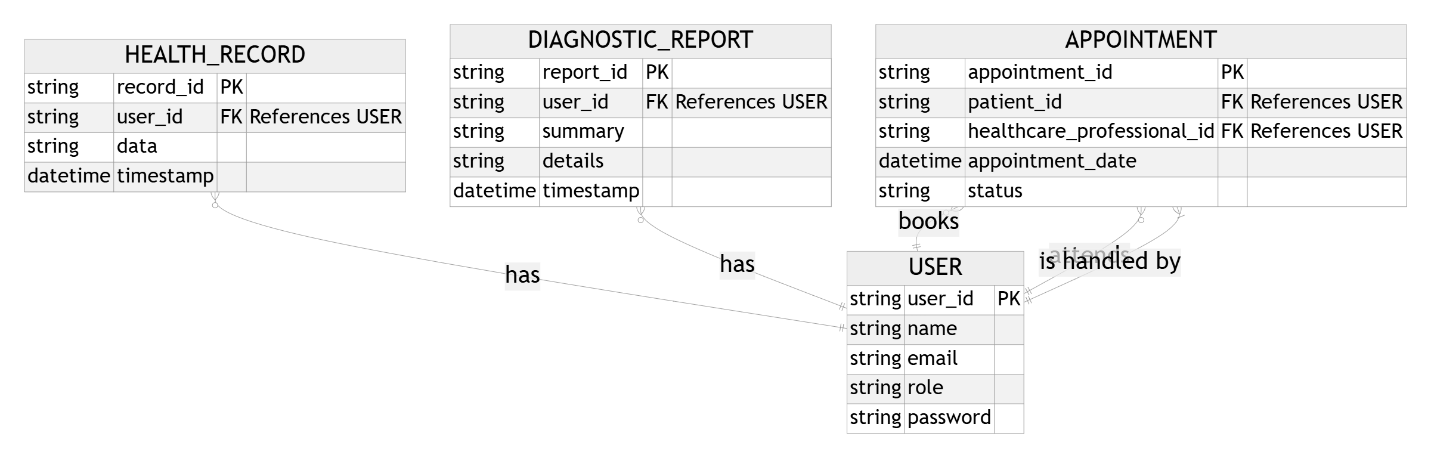
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**Figure 4.4:** UML Use Class Diagram.

* **Data Flow Diagrams (DFDs):**  
  A partitioned DFD shows the flow of data from input to processing and output, ensuring that every requirement is mapped to a process within the system.

**Figure 4.5:** Partitioned Data Flow Diagram.

* **Entity Relationship Diagram (ERD):**  
  Illustrates the major entities (User, HealthRecord, DiagnosticReport) and their attributes, ensuring a normalized database design.

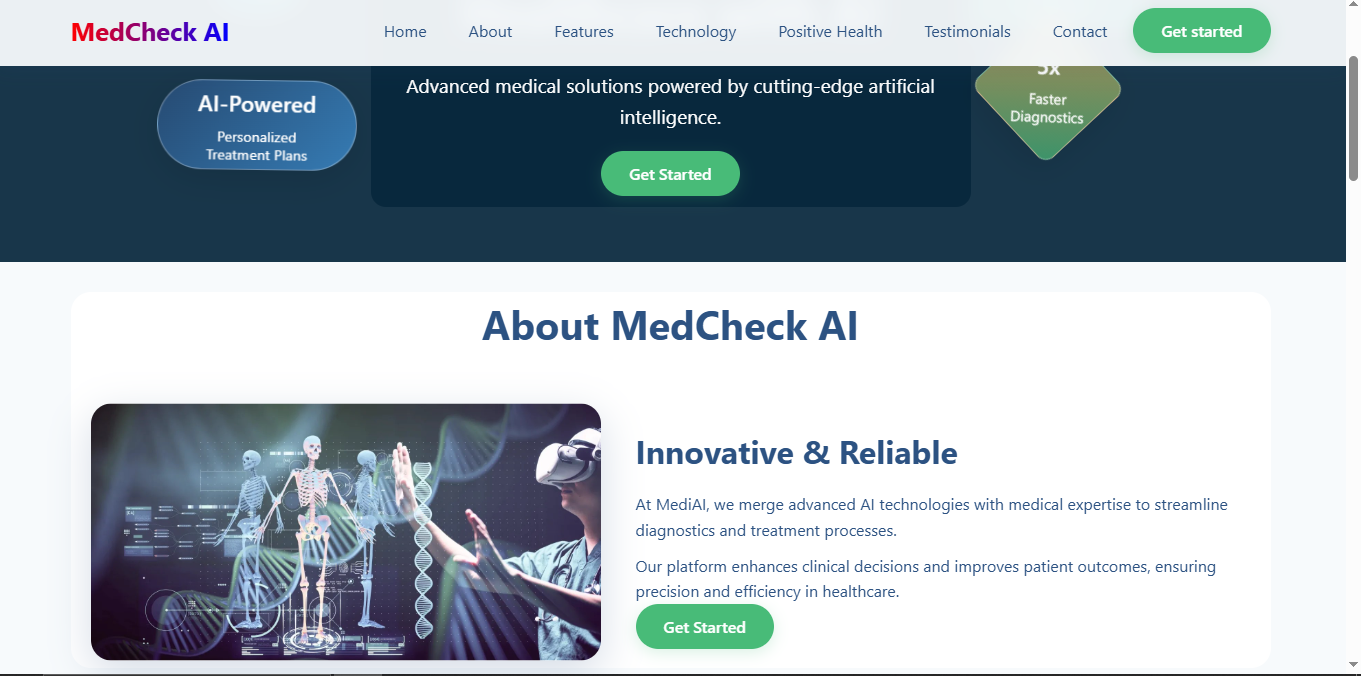


**Figure 4.5:** ER Diagram for the database.

* **Interface Design:**  
  Mockups of the user interface (forms and dashboards) are provided to demonstrate how users will interact with the system.

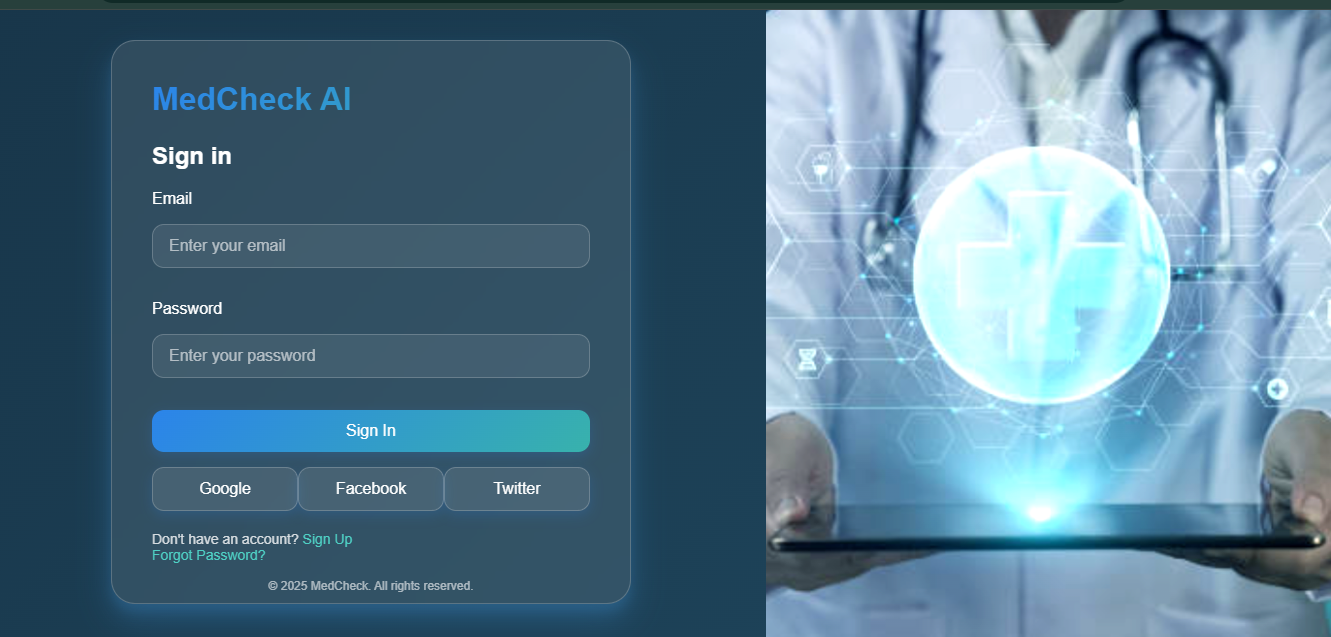
1. **Landing page**

This page consists of all the necessary information about the project well detailed



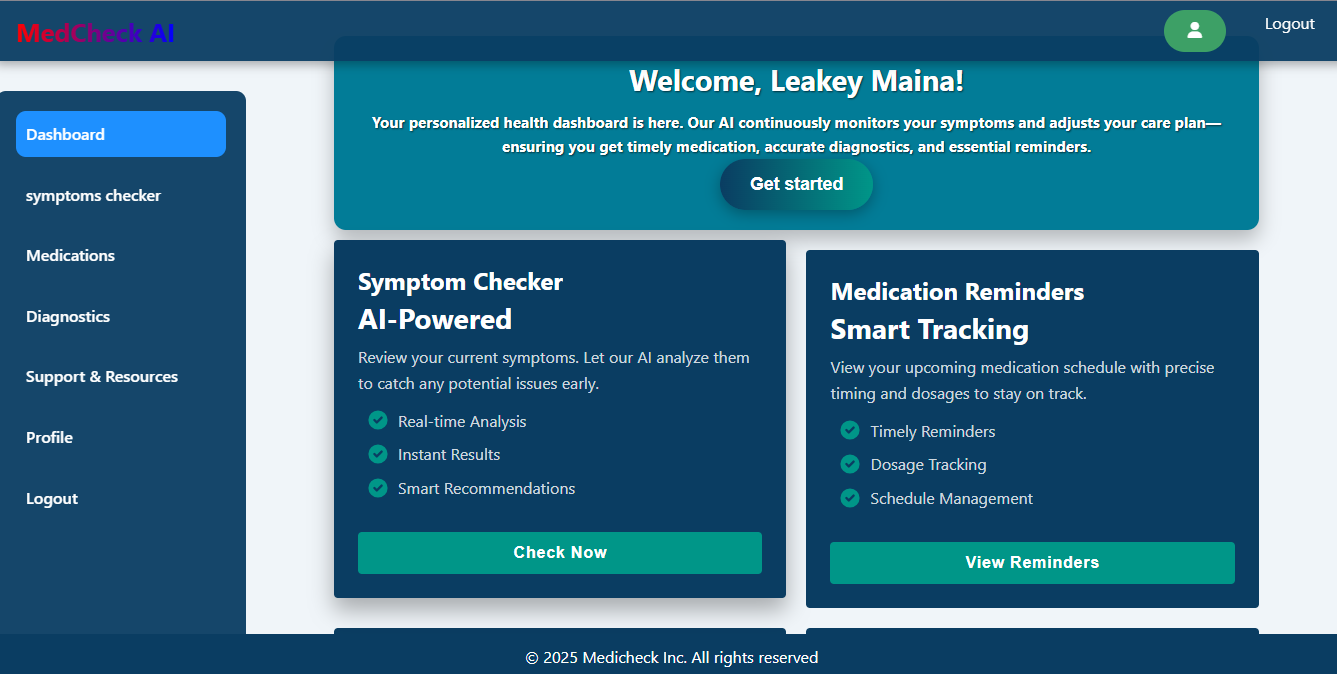
**Image 1;Landing page**

1. **Authentication page**

****This page consists of the login and sign up interface

**Image 2; Authentication page**

1. **Dashboard page :** The page that enables users to access the whole system

****

**Image 3;Dashboard**

1. **Diagnostics And Analysis page**

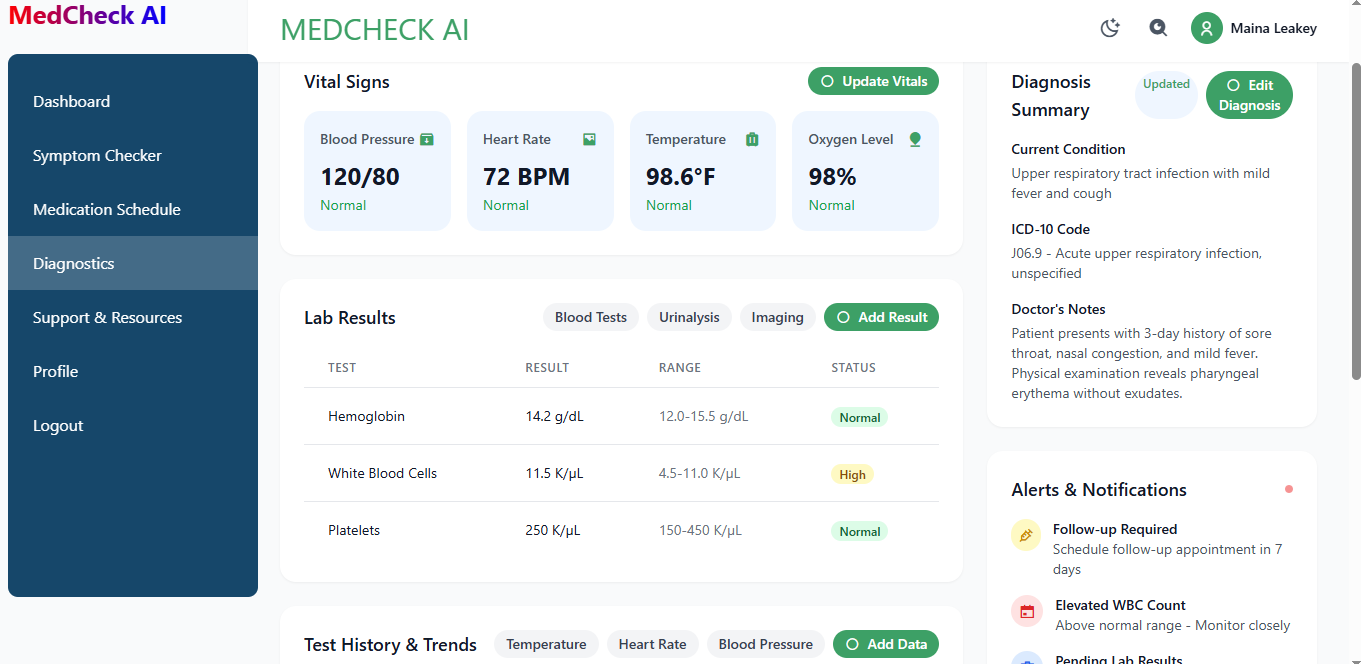
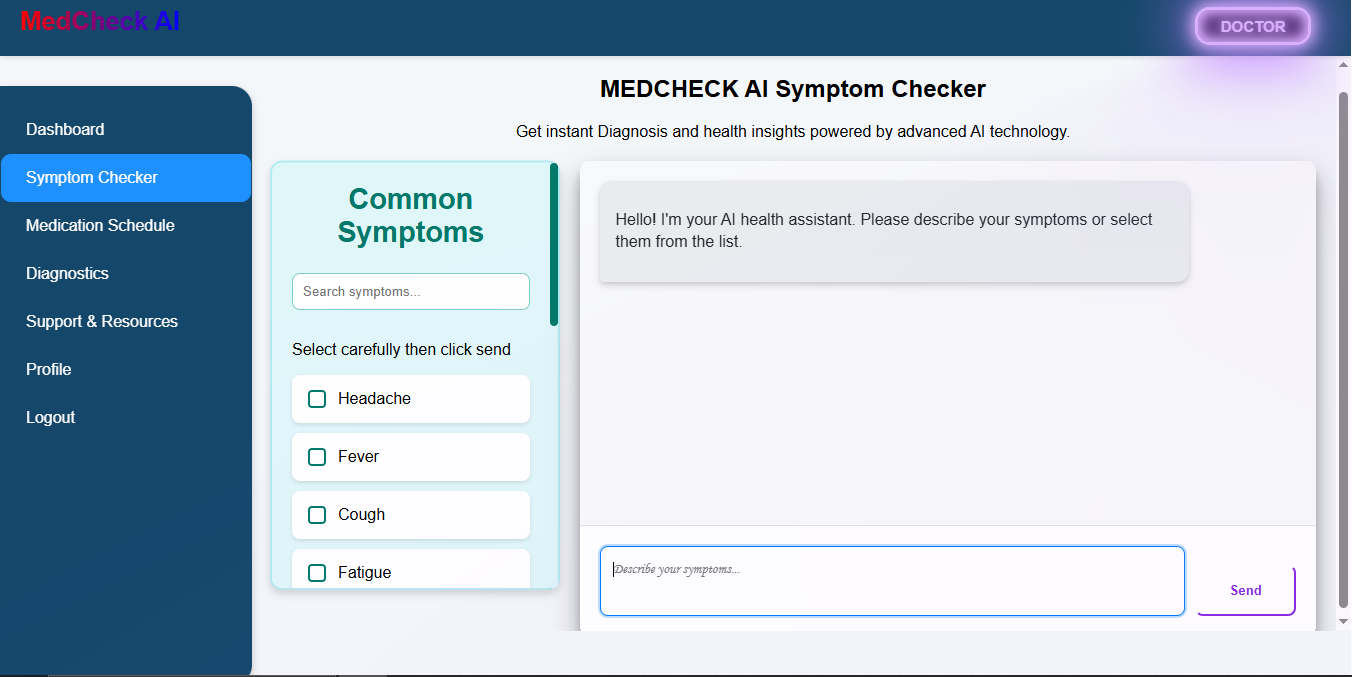
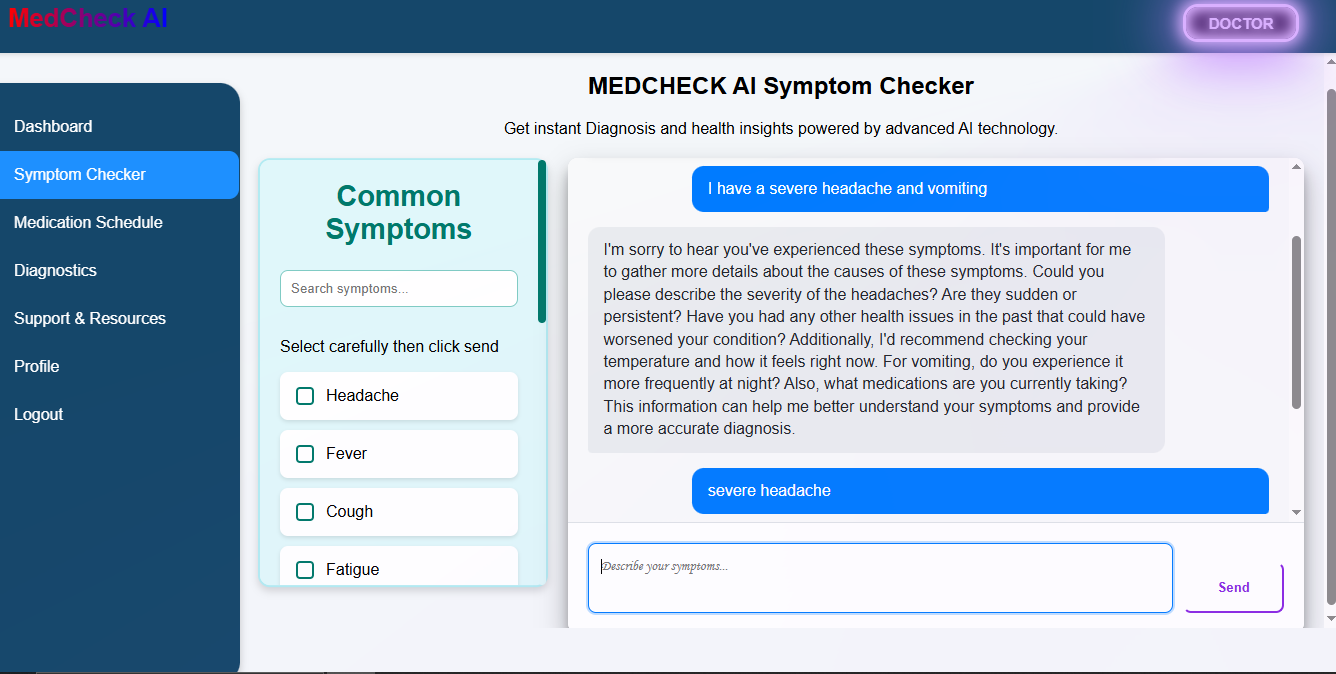
This page gives real time analytics to the user

Image 4; Diagnostic analysis page

1. Symptoms checker page

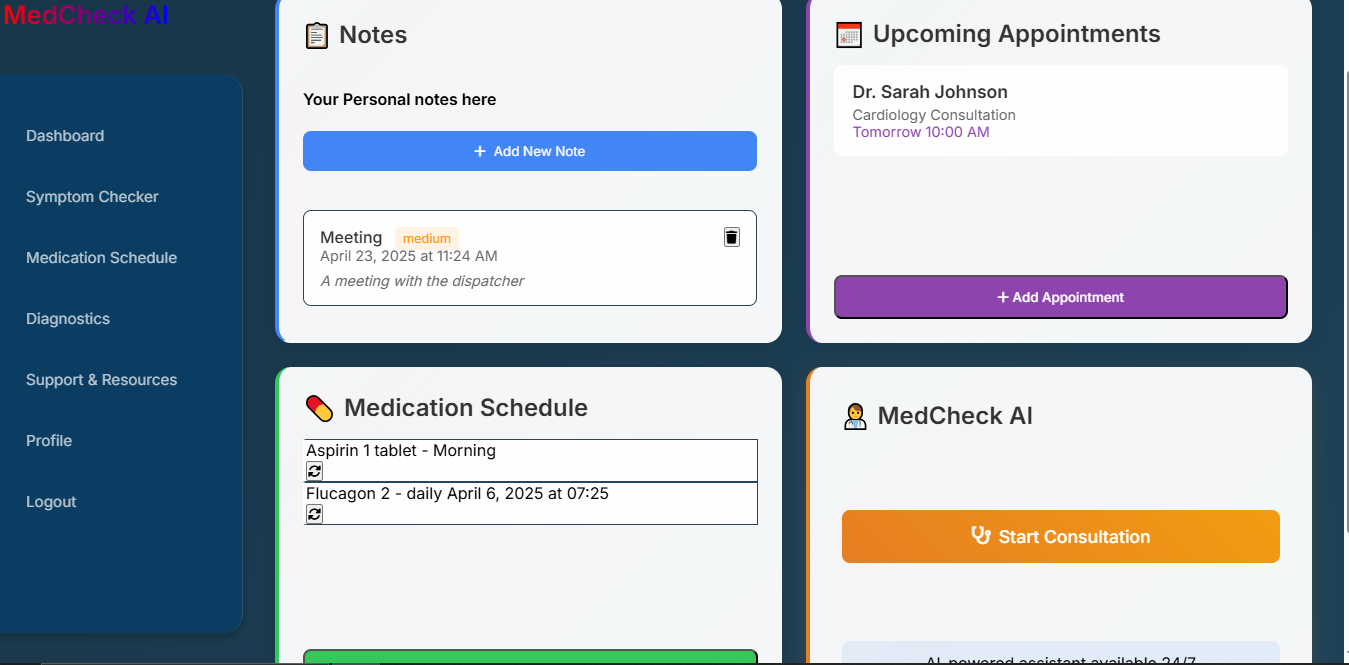
A page that asks for the users symptoms and provides diagnosis and recommendations





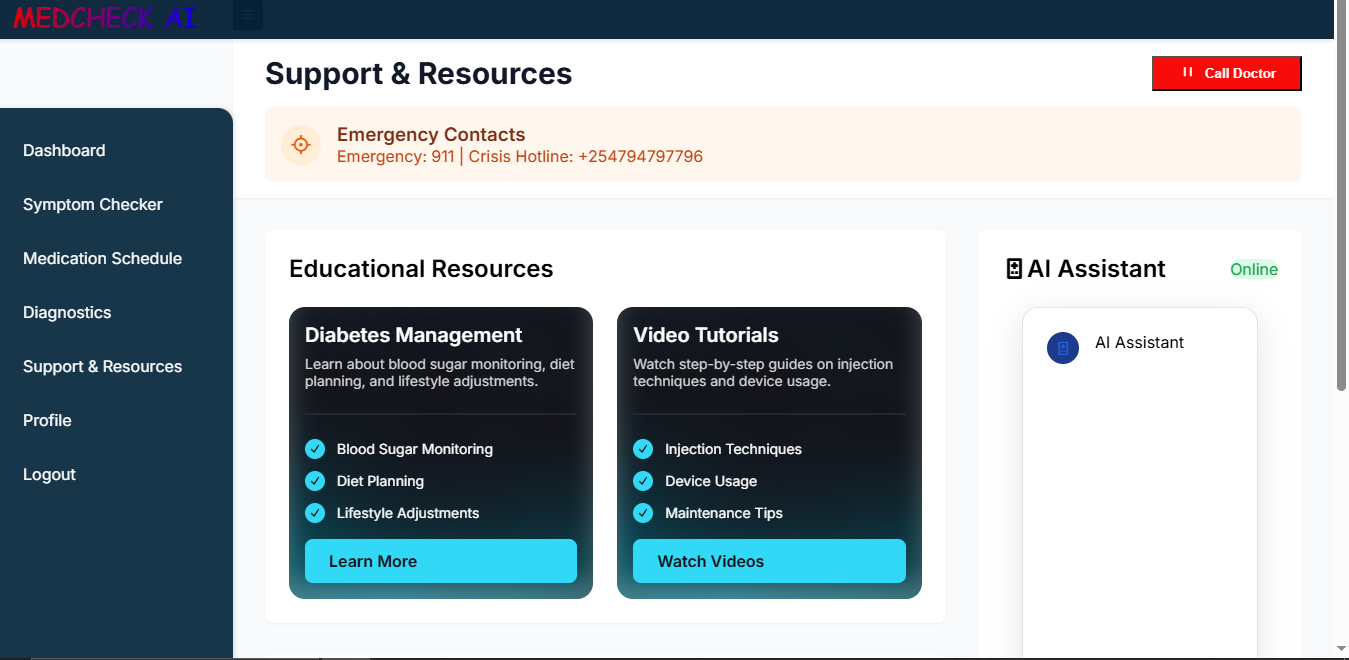
**Image 5; Symptoms checker page**

1. **Medication planner/Schedule planner**

Enables the patient to plan out doctor schedules and appointments**** **Image 6; Schedule planner**

1. **Support & resources page**

**This page provides the user with support resources such as condition management articles, videos, journals and other important healthcare tips**

****

**Image 7; Support & resources**

### 4.4.3 System Architecture

Our system is designed with an n-tier architecture:

* **Client Tier:** Web browsers or mobile applications that provide the user interface.
* **Presentation Tier:** The front-end layer built using front-end technologies, ensuring a responsive and interactive user experience.
* **Business Logic Tier:** Implements the AI processing and diagnostic analytics, developed in Python.
* **Data Tier:** A cloud-based database that securely stores user input, diagnostic data, and historical records.

### 4.5 Summary of Chapter 4

In summary, Chapter 4 provides a comprehensive analysis and design of the RTMCDS. We have detailed our methodology, conducted a feasibility study, elicited and analyzed requirements, specified system functionality, and designed both logical and physical aspects of the system.

The use of multiple diagrams ensures clarity in our design and demonstrates that our solution is robust, scalable, and user-friendly.

# Chapter 5

## System Code Generation, Testing, Conclusions, and Recommendations

### 5.0 Introduction

This chapter covers the implementation phase of the RTMCDS, detailing the system code generation, the testing strategies employed, and the conclusions drawn from our evaluation.

We also discuss the limitations encountered during the project and provide recommendations for future work. Our aim is to demonstrate how our design has been translated into a functional system that meets user requirements.

### 5.1 System Code Generation

### 5.1.1 Development Environment

We will develop the RTMCDS using:

* **Programming Languages:**
  + Python (for AI algorithms and backend processing).
  + JavaScript (with HTML/CSS) for front-end development.
* **Frameworks and Libraries:**
  + API’s, PyTorch for machine learning and AI processing.
  + HTML/CSS for building a responsive and interactive user interface.
* **Version Control:**
  + Git and GitHub for source code management and collaboration.
* **Cloud Infrastructure:**
  + A cloud service provider to host our database and deploy the AI processing module, ensuring scalability and data security.

### 5.1.2 Code Generation and Integration

Our code generation followed the Agile methodology:

* **Iterative Prototyping:** Initial prototypes were developed to validate core functionalities (data input, processing, and output).
* **Module Integration:** Once individual modules were developed (e.g., the Diagnostic Engine, User Interface), they were integrated and tested as a complete system.
* **Documentation:** Comprehensive code documentation maintained to ensure ease of maintenance and future development.

### 5.2 Testing

### 5.2.1 Testing Strategy

A multi-layered testing strategy to ensure system quality:

* **Unit Testing:** Each module individually tested using frameworks such as PyTest for backend and Selenium for the front-end.
* **Integration Testing:** Integration tests to verify that all system modules interact seamlessly.
* **Performance Testing:** Stress tests and load tests conducted to assess the system’s responsiveness and stability under varying loads.
* **Security Testing:** Security testing is done to find holes and flaws in the security protocols of the software. The team makes sure the system's security safeguards are strong and scans for potential security concerns like illegal data access or identity theft.
* **User Acceptance Testing (UAT):** Healthcare professionals and potential users participated in pilot studies.

Their feedback collected through questionnaires and interviews to validate usability and functionality.

### 5.2.2 Evaluation Metrics and Test Cases

Key performance indicators included:

* **Response Time:** Measured from user data submission to diagnostic output.
* **Accuracy:** The percentage of correctly generated diagnostic reports compared to expected outcomes.
* **User Satisfaction:** Assessed via survey responses from pilot users.
* **System Uptime:** Monitored to ensure reliability.

### 5.3 Results and Evaluation

Our testing should confirm that:

* The system consistently meets response time and accuracy benchmarks.
* User feedback overwhelmingly positive, with suggestions for minor improvements now under consideration.
* The integration of various modules (frontend, backend, and cloud storage) functioned as expected.

### 5.4 Conclusions

Conclude that the RTMCDS successfully meets the project objectives:

* It provides a robust platform for real-time data analysis and diagnostic reporting.
* The system’s design and architecture proves scalable and secure.
* Our iterative development and testing processes should ensure that the final product addresses the primary healthcare challenges identified.

### 5.5 Limitations

While the system demonstrates significant potential, we encountered several limitations:

* **Integration Complexity:** Merging data from multiple sources (user input and historical data) required complex error handling.
* **Resource Constraints:** Limited access to live data meant that we simulated some inputs during testing.
* **User Interface Optimization:** Further refinement is needed to optimize the UI based on broader user testing.

### 5.6 Recommendations

Based on our experience, we recommend:

* Integration with Existing Healthcare Systems: An AI diagnostic system must seamlessly integrate into existing workflows to avoid disrupting healthcare delivery. Design the system to integrate with electronic health records (EHRs), laboratory information systems, and other healthcare IT platforms. Ensure compatibility with various devices (e.g., desktops, tablets, smartphones) and operating systems.
* **Enhancing AI Models:** Further refine the machine learning algorithms with larger and more diverse datasets.
* **Building a Doctor AI Diagnostic and Disease Management Interface that is connected to the Patient Interface:** a platform designed for healthcare professionals () to assist with diagnosing diseases, managing patient care plans, and monitoring patient progress using AI-driven insights. This system should work with the patient diagnostic and disease management interface
* **Expanding Pilot Studies:** Conduct larger-scale user trials to gather more comprehensive feedback.
* **Interface Improvements:** Continue refining the user interface for even greater ease of use and accessibility.
* **Address Ethical and Legal Considerations**: Ethical lapses and legal non-compliance can undermine trust, lead to liability issues, and harm patients. We recommend establishing clear guidelines on how the AI system should be used, conduct rigorous testing and validation to ensure the system meets regulatory standards and engage ethicists and legal experts during development to address potential biases, fairness concerns, and accountability issues.

### 5.7 Summary

Chapter 5 details the translation of our design into a working system, presents our comprehensive testing results, and outlines our conclusions, limitations, and recommendations.

Our approach has demonstrated that the RTMCDS is a viable and effective solution for real-time health diagnostics, providing a solid foundation for further enhancements.

### 5.8 References

Oleribe, O. O., Momoh, J., Uzochukwu, B. S., Mbofana, F., Adebiyi, A., Barbera, T., ... & Taylor-Robinson, S. D. (2019). Identifying key challenges facing healthcare systems in Africa and potential solutions. *International journal of general medicine*, 395-403.

Ma, X., Wang, Z., Zhou, S., Wen, H., & Zhang, Y. (2018). Intelligent healthcare systems assisted by data analytics and mobile computing. *Wireless Communications and Mobile Computing*, *2018*(1), 3928080.

Rajpurkar, P., Chen, E., Banerjee, O., & Topol, E. J. (2022). AI in health and medicine. *Nature medicine*, *28*(1), 31-38.

Selvaraj, S., & Sundaravaradhan, S. (2020). Challenges and opportunities in IoT healthcare systems: a systematic review. *SN Applied Sciences*, *2*(1), 139.

Yang, Y., Siau, K., Xie, W., & Sun, Y. (2022). Smart health: Intelligent healthcare systems in the metaverse, artificial intelligence, and data science era. *Journal of Organizational and End User Computing (JOEUC)*, *34*(1), 1-14.

Kasthuri, A. (2018). Challenges to healthcare in India-The five A's. *Indian Journal of Community Medicine*, *43*(3), 141-143.

Haleem, A., Javaid, M., & Khan, I. H. (2019). Current status and applications of Artificial Intelligence (AI) in medical field: An overview. *Current Medicine Research and Practice*, *9*(6), 231-237.

Oftedal, E. M., Iakovleva, T., & Bessant, J. (2019). Challenges in healthcare-the changing role of patients. In *Responsible Innovation in Digital Health* (pp. 23-41). Edward Elgar Publishing.

Gola, M., Brambilla, A., Barach, P., Signorelli, C., & Capolongo, S. (2020). Educational challenges in healthcare design: Training multidisciplinary professionals for future hospitals and healthcare. *Annali di Igiene Medicina Preventiva e di Comunità*, *32*(5), 549-566.

Kaur, S., Singla, J., Nkenyereye, L., Jha, S., Prashar, D., Joshi, G. P., ... & Islam, S. R. (2020). Medical diagnostic systems using artificial intelligence (ai) algorithms: Principles and perspectives. *Ieee Access*, *8*, 228049-228069.

Holzinger, A., Biemann, C., Pattichis, C. S., & Kell, D. B. (2017). What do we need to build explainable AI systems for the medical domain?. *arXiv preprint arXiv:1712.09923*.

Kulikowski, C. A. (1980). Artificial intelligence methods and systems for medical consultation. *IEEE Transactions on pattern analysis and Machine Intelligence*, (5), 464-476.

Grote, T. (2021). Trustworthy medical AI systems need to know when they don’t know. *Journal of medical ethics*, *47*(5), 337-338.

Hamet, P., & Tremblay, J. (2017). Artificial intelligence in medicine. *metabolism*, *69*, S36-S40.

King, M. R. (2023). The future of AI in medicine: a perspective from a Chatbot. *Annals of Biomedical Engineering*, *51*(2), 291-295.

Manickam, P., Mariappan, S. A., Murugesan, S. M., Hansda, S., Kaushik, A., Shinde, R., & Thipperudraswamy, S. P. (2022). Artificial intelligence (AI) and internet of medical things (IoMT) assisted biomedical systems for intelligent healthcare. *Biosensors*, *12*(8), 562.

Oniani, S., Marques, G., Barnovi, S., Pires, I. M., & Bhoi, A. K. (2020). Artificial intelligence for internet of things and enhanced medical systems. In *Bio-inspired neurocomputing* (pp. 43-59). Singapore: Springer Singapore.

Plsek, P. E., & Greenhalgh, T. (2001). The challenge of complexity in health care. *Bmj*, *323*(7313), 625-628.

Hatherley, J. J. (2020). Limits of trust in medical AI. *Journal of medical ethics*, *46*(7), 478-481.

Al-Antari, M. A. (2023). Artificial intelligence for medical diagnostics—existing and future aI technology!. *Diagnostics*, *13*(4), 688.

van den Heuvel, J., Niemeijer, G. C., & Does, R. J. (2013). Measuring healthcare quality: the challenges. *International journal of health care quality assurance*, *26*(3), 269-278.

Chaabane, S., Cousein, E., & Wieser, P. (Eds.). (2022). Healthcare systems: challenges and opportunities.

Zamzami, I. F., Pathoee, K., Gupta, B. B., Mishra, A., Rawat, D., & Alhalabi, W. (2022). Machine learning algorithms for smart and intelligent healthcare system in Society 5.0. *International Journal of Intelligent Systems*, *37*(12), 11742-11763.

Attaran, M. (2022). Blockchain technology in healthcare: Challenges and opportunities. *International Journal of Healthcare Management*, *15*(1), 70-83.

Kaur, S., Singla, J., Nkenyereye, L., Jha, S., Prashar, D., Joshi, G. P., ... & Islam, S. R. (2020). Medical diagnostic systems using artificial intelligence (ai) algorithms: Principles and perspectives. *Ieee Access*, *8*, 228049-228069.

Alam, L., & Mueller, S. (2021). Examining the effect of explanation on satisfaction and trust in AI diagnostic systems. *BMC medical informatics and decision making*, *21*(1), 178.

Khaksari, G. H. (1988, June). Expert diagnostic system. In *Proceedings of the 1st international conference on Industrial and engineering applications of artificial intelligence and expert systems-Volume 1* (pp. 43-53).

Tariq, M., Hayat, Y., Hussain, A., Tariq, A., & Rasool, S. (2024). Principles and perspectives in medical diagnostic systems employing artificial intelligence (AI) algorithms. *International Research Journal of Economics and Management Studies IRJEMS*, *3*(1).

## Questionnaire

1. What is your role in the healthcare system?
   * Healthcare provider (e.g., doctor, nurse)
   * Patient
2. How familiar are you with AI-powered tools in healthcare?
   * Very familiar
   * Somewhat familiar
   * Not familiar
3. Have you ever used or interacted with an AI-based diagnostic or disease management tool?
   * Yes
   * No
4. What do you consider the biggest challenges in diagnosing diseases today?
   * Lack of access to medical expertise
   * Time-consuming diagnostic processes
   * Inaccurate or delayed diagnoses
   * High costs of diagnostic tests
   * Limited patient data availability
   * Others
5. In your opinion, what are the main difficulties in managing chronic diseases effectively? (Select all that apply)
   * Lack of personalized treatment plans
   * Poor patient adherence to treatment
   * Difficulty tracking patient progress
   * Insufficient communication between healthcare providers and patients
   * Other
6. How important do you think early detection and continuous monitoring could improve patient outcomes?
   * Extremely important
   * Important
   * Neutral
   * Not very important
   * Not important at all
7. What concerns, if any, do you have about using AI in healthcare? (Select all that apply)
   * Data privacy and security risks
   * Lack of transparency in AI decision-making
   * Potential for errors or biases
   * Over-reliance on technology
   * Ethical concerns
8. Would you trust an AI system to assist in diagnosing or managing your condition (if you are a patient) or your patient’s condition (if you are a healthcare provider)? Why or why not?
   * Yes
   * No
   * Maybe
9. What features would you consider essential in an AI-powered diagnostic and disease management system? (Select all that apply)
   * Real-time symptom analysis
   * Integration with electronic health records (EHRs)
   * Personalized treatment recommendations
   * Predictive analytics for disease progression
   * Monitoring capabilities
   * User-friendly interface
   * Other
10. How important is it for the AI system to provide explanations for its recommendations?
    * Extremely important
    * Important
    * Neutral
    * Not very important
    * Not important at all
11. Would you prefer an AI system that operates independently or one that works alongside healthcare professionals? Why?
    * Independently
    * Alongside healthcare professionals