Analysis Report

1. Introduction

This analysis report examines the requirements, limitations, and design considerations of the AI Health System for Doctors and Patients, a web-based medical support platform that integrates artificial intelligence into healthcare workflows. The goal of this report is to analyze the problem domain, evaluate existing solutions, and clearly define the functional and nonfunctional requirements of the proposed system.

The system is designed to assist—not replace—medical professionals by providing AI-supported diagnostic insights from medical images and simplified symptom-based guidance for patients. Given the sensitive nature of medical data and decision-making, the analysis places strong emphasis on ethical AI use, regulatory compliance, data security, and user role separation. This report forms the foundation for the system design and implementation phases by clearly identifying system expectations and constraints.

2. Current system (if any)

At the current stage of the project, no fully implemented system exists. The AI Health System is currently in the analysis and design phase, during which system requirements, architectural decisions, and module responsibilities are being defined.

While no operational software or deployed architecture is available yet, preliminary design activities have been completed, including requirement analysis, role-based user definitions, high-level architectural planning, and identification of core system components such as the frontend, backend, AI inference modules, and data management layer.

This analysis report therefore focuses on defining the expected behavior, constraints, and requirements of the proposed system, which will serve as the foundation for subsequent design and implementation stages.

3. Proposed system

3.1 Overview

The proposed system is a web-based, AI-assisted medical support platform with two clearly separated user roles: Doctor and Patient. It integrates computer vision models for medical image analysis and natural language processing (NLP) models for symptom interpretation.

Key characteristics of the system include:

- Role-based interfaces and outputs
- Cloud-based deployment with GPU support
- AI models tailored to specific diagnostic tasks
- Ethical filtering and disclaimer enforcement for patient-facing outputs
- Secure data storage and regulatory compliance (GDPR, KVKK, HIPAA)

The system operates as a decision-support tool, ensuring that final diagnosis and treatment decisions remain the responsibility of licensed medical professionals.

3.2 Functional Requirements

Based on the problem analysis and system goals, the proposed system shall fulfill the following functional requirements:

Doctor-Oriented Functions

- The system shall allow doctors to upload medical images (X-ray, CT, MRI, ultrasound).
- The system shall analyze uploaded images using task-specific deep learning models.
- The system shall provide AI-generated diagnostic insights, confidence scores, and visual explanations.
- The system shall allow doctors to review symptom analyses and lab result interpretations.
- The system shall maintain a secure history of past analyses and interactions.
- The system shall allow doctors to provide feedback or annotations on AI outputs.

Patient-Oriented Functions

- The system shall allow patients to enter symptoms using natural language.
- The system shall generate simplified, non-alarming health suggestions for patients.

- The system shall append a clear medical disclaimer to all patient-facing outputs.
- The system shall prevent patients from accessing technical or high-risk diagnostic details.
- The system shall present information using non-technical language and user-friendly visuals.

System-Level Functions

- The system shall enforce role-based access control (RBAC).
- The system shall support multimodal analysis when both image and symptom inputs are available.
- The system shall log all interactions and AI inferences for audit and traceability.
- The system shall support bilingual operation (Turkish and English).

3.3 Nonfunctional Requirements

The system must also satisfy the following nonfunctional requirements to ensure safety, performance, and reliability:

Performance

- AI-based image analysis results shall be delivered to doctors within 10 seconds.
- Symptom-based suggestions for patients shall be generated within 5 seconds.
- The system shall support at least 100 concurrent users without performance degradation.

Accuracy & Safety

- Overall diagnostic accuracy shall be at least 90%.
- False Negative Rate (FNR) for critical illnesses shall not exceed 5%.
- Model confidence thresholds shall suppress uncertain or ambiguous outputs.

Security & Privacy

- All stored data shall be encrypted using AES-256.
- All data in transit shall be secured using TLS.
- The system shall comply with GDPR, KVKK, and HIPAA regulations.
- All access to sensitive data shall be logged and auditable.

Availability & Reliability

- The system shall maintain at least 99.5% uptime.
- Automatic failover and monitoring mechanisms shall be in place.
- The system shall support graceful degradation during partial failures.

Usability & Accessibility

- The system shall provide intuitive, role-specific user interfaces.
- The system shall be accessible via modern web browsers without installation.
- All user-facing content shall be available in Turkish and English.

Ethical AI Constraints

- Patient-facing outputs shall be ethically filtered to avoid unnecessary anxiety.
- Content moderation accuracy shall be at least 95%.
- The system shall clearly communicate that AI outputs are supportive, not diagnostic.

3.4 Pseudo requirements

Pseudo requirements describe informal system expectations that guide design decisions but are not strict functional constraints.

- The system should behave predictably and consistently across similar inputs
- The system should prioritize patient safety over diagnostic completeness
- The system should avoid generating misleading or alarming information
- The system should provide meaningful feedback to doctors without increasing cognitive load
- The system should remain responsive even when AI inference services are temporarily unavailable
- The system should present confidence levels to support human decision-making
- The system should maintain transparency regarding AI limitations

3.5 System models

The AI Health System follows a modular system model consisting of interconnected components that communicate through secure interfaces.

Main system components include:

- User Interface Layer (Doctor and Patient dashboards)
- Application Backend
- AI Inference Services
- Data Storage Layer
- Security and Logging Services

Each module operates independently but communicates through APIs. This modular structure supports scalability, maintainability, and clear separation of responsibilities.

3.5.1 Scenarios

Scenario 1 – Doctor Image Analysis

A doctor logs into the system and uploads a patient's chest X-ray. The system preprocesses the image and forwards it to the appropriate AI model. The model returns a prediction with confidence score and visual explanation. The doctor reviews the output and adds personal annotations before saving the report.

Scenario 2 – Patient Symptom Input

A patient enters symptoms such as headache and fever. The system analyzes the text using NLP models and generates a simplified suggestion indicating possible common conditions, along with a medical disclaimer encouraging consultation with a doctor.

Scenario 3 – Low Confidence Case

If the system detects insufficient image quality or low confidence prediction, it returns a neutral response indicating uncertainty and advises professional evaluation without displaying speculative results.

3.5.2 Use case model

The system includes two primary actors:

- Doctor
- Patient

Doctor use cases

- Login to system
- Upload medical images
- View AI diagnostic output
- Review confidence and explanations
- View analysis history
- Provide feedback or annotations

Patient use cases

- Login or access symptom interface
- Enter symptoms
- View simplified health guidance
- Read medical disclaimer

System use cases

- Enforce role-based access
- Log interactions
- Apply ethical content filtering
- Manage AI inference requests

3.5.3 Object and class model

At the analysis stage, the object and class model is defined at a conceptual level to identify the main entities involved in the system and their general relationships.

The primary objects in the system are:

- User: Represents individuals who interact with the system.
- Doctor: A user authorized to upload medical images and review AI-supported analysis results.
- Patient: A user who provides symptom information and receives simplified health guidance.
- Medical Image: Represents uploaded diagnostic images such as X-rays, CT scans, or MRI images.
- Symptom Input: Text-based descriptions provided by patients.
- Analysis Result: AI-generated output containing observations and confidence information.
- System Log: Records system activities for security and audit purposes.

These objects interact to support the main system workflow, where users provide input data, the system processes the data using AI models, and appropriate outputs are generated based on user roles.

3.5.4 Dynamic models

The dynamic behavior of the system follows these steps:

1. User authentication and role verification
2. Data input submission (image or text)
3. Preprocessing stage
4. AI inference execution
5. Confidence evaluation
6. Ethical filtering
7. Role-based output generation
8. Logging and audit storage

State transitions ensure that no output is shown to users before passing validation and safety checks.

3.5.5 User interface - navigational paths and screen mock-ups

The system interface is divided into two navigation flows :

Doctor → Login
→ Dashboard
→ Upload Image
→ View Analysis Report
→ Review History

Patient → Login/Home
→ Enter Symptom Input
→ Result Page
→ Disclaimer Display

Navigation is linear and minimal to reduce cognitive load. The interface avoids technical terminology and emphasizes clarity and safety.

We do not have any screen mock-ups yet.

4. Glossary

- **AI**
- **Computer Vision**
- **Natural Language Processing**
- **Inference**
- **True Positive**
- **False Negative**
- **Confidence Score**
- **Ethical AI**

5. References

Esteva, A., Robicquet, A., Ramsundar, B., Kuleshov, V., DePristo, M., Chou, K., ... & Dean, J. (2019). A guide to deep learning in healthcare. Nature Medicine, 25(1), 24–29. https://doi.org/10.1038/s41591-018-0316-z

Topol, E. (2019). High-performance medicine: The convergence of human and artificial intelligence. Nature Medicine, 25(1), 44–56. https://doi.org/10.1038/s41591-018-0300-7

Rajpurkar, P., Chen, E., Banerjee, O., & Topol, E. J. (2022). AI in health and medicine. Nature Medicine, 28(1), 31–38. https://doi.org/10.1038/s41591-021-01614-0

European Parliament. (2016). General Data Protection Regulation (GDPR). Regulation (EU) 2016/679.

T.C. Resmî Gazete. (2016). Kişisel Verilerin Korunması Kanunu (KVKK), Kanun No: 6698.

U.S. Department of Health & Human Services. (1996). Health Insurance Portability and Accountability Act (HIPAA).

Beauchamp, T. L., & Childress, J. F. (2019). Principles of Biomedical Ethics (8th ed.). Oxford University Press.

Obermeyer, Z., & Emanuel, E. J. (2016). Predicting the future—big data, machine learning, and clinical medicine. New England Journal of Medicine, 375(13), 1216–1219.

American Medical Association. (2022). Augmented intelligence in health care: AMA policy and principles.