Developing a Deep Learning-based Tool for Early Detection of Leptospirosis Infection

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*The candidates confirm that the work submitted is their own and appropriate credit has been given where reference has been made to work of others

Plagiarism Free Certificate

This is to certify that, I ____Hafsa Zulfiqar____ S/D of Muhammad Zulfiqar, group leader of FYP under registration no _____FYP-BCSM-F23-006_____at Computer Science Department, The Superior University, Lahore. I declare that my FYP report is checked by my supervisor.

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Project Report

Developing a Deep Learning-based Tool for Early Detection of Leptospirosis Infection

Change Record

Author(s)	Version	Date	Notes	Supervisor's Signature
Abdul Rehman, Hafsa Zulfiqar	1.0	01/08/2023	Original Draft	
Abdul Rehman, Hafsa Zulfiqar	1.1	15/11/2023	Updated the literature review to include more recent studies.	
Abdul Rehman, Hafsa Zulfiqar	1.2	01/02/2024	Revised the methodology section for clarity and detail.	
Abdul Rehman, Hafsa Zulfiqar	1.3	17/05/2024	Added more diagrams to the system architecture section.	
Abdul Rehman, Hafsa Zulfiqar	1.4	27/08/2024	Corrected typos and improved the formatting throughout the document.	

APPROVAL

PROJECT SUPERVISOR

Comments: _____

_____

Name:_____

Date:_____ Signature:_____

PROJECT MANAGER

Comments: _____

_____

Date:_____ Signature:_____

HEAD OF THE DEPARTMENT

Comments: _____

_____

Date:_____ Signature:_____

Dedication

I am deeply grateful for the immense assistance and unwavering faith of my supervisor, Fawad Nasim, throughout this assignment. His vast wisdom and skills have proved invaluable to my team and myself, allowing us to grow and develop. His uplifting encouragement kept our spirits high and our vision anchored in our goals. I really value his contributions and the opportunity to mentor as a mentor. Also, I sincerely appreciate my loved ones for their endless support and inspiration. Their unwavering belief in my abilities served as a beacon of inspiration throughout this journey. I am extremely grateful and indebted to them for their unwavering support that played a major role in helping me through the difficult journey, overcoming the many challenges and obstacles that came my way. I cannot emphasize enough how grateful I am for their presence and support.

Acknowledgements

My profound gratitude goes out to my supervisor, Fawad Nasim, for his considerate handling, wise counsel, and stringent equity standards during the project. Without his passion and encouragement, I could not have completed this. I want to express my appreciation to the distinguished faculty members who gave us expert instruction and all the information and abilities we required to finish this report. I am appreciative of the chance to pick their brains. I want to thank each and every one of my classmates for the wonderful time we had together and the encouragement we offered one another.

Executive Summary

Leptospirosis is a common and potentially fatal bacterial infection that is more common in areas like Pakistan with tropical climates and prone to flooding. The accuracy and turnaround time of the leptospirosis diagnostic procedures used today are both constrained. This study suggests creating a mobile app based on deep learning that can vastly increase the accuracy and efficiency of leptospirosis diagnosis and make it convenient for a common man use.

In Pakistan, first case of leptospirosis in human was discovered in March 2022, leaving the people worried about effects of this disease. People who are prone to this disease are the ones who engage in outdoor activities or live in the flood prone areas. These people are at higher risk of contracting leptospirosis because it is spread by getting in contact with the urine of infected animal. Leptospirosis seriously threatens public health in areas where agriculture is the main industry.

This tool is easy to use, quick and accurate as it can produce results with minimal clinical and laboratory data needed. It uses highly developed deep learning algorithms to analyze and classify data accurately and reliably. The goal of this project is to develop a deep learning based mobile application that can quickly and accurately identify leptospirosis infection. The application will use modern deep learning techniques and recurrent neural networks to analyze patient data including laboratory test results and symptoms. With the help of this application the early diagnosis and treatment of leptospirosis could be done which can potentially saves lives and halt the disease's spread. The architecture of this tool is based on deep learning concepts for the identification and categorization of leptospirosis infection. The application has a user-friendly design that allows healthcare providers and common people to utilize its capabilities. You don't need to be a technical person to use this application as the design is easy to use for anyone. The validity of the tool in real life will be defined by the range and number of times tests are performed. Finally, researching this deep learning-based smartphone application can promise to improve medical diagnostic by a large extent it can diagnose the leptospirosis infection on time and it will be more accurate and affordable leaving better outcomes with patients with reducing health costs and optimizing resources.

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Introduction

Chapter 1: Introduction

The outlined treatment takes into account the necessity of immediate and precise identification using an accurate pathogen detection technique that would allow early leptospirosis infection identification, which is a fata bacterial disease. Countries like Pakistan that have tropical climates and experience floods frequently are one of the Ke broader where leptospirosis is common. The geographical location is undoubtedly Pakistan's vulnerability to floods that lead to the spread of various diseases all over and they are a huge threat to its inhabitants. Early detection is necessary for the successful treatment of leptospirosis that healing based on proper outcomes to patients. This technique makes a smartphone application using deep learning technology to detect leptospirosis in apps and within seconds with high accuracy. And through analyzing the patient data such as symptoms and lab results, introducing advanced deep learning algorithms, including CNNs for comprehensive underpinning of this application, upon completion it will be capable of radically changing the way leptospirosis is detected and provide proper diagnostics to interrupt spreading an infection.

1.1. Background

The tendency towards leptospirosis is a very serious health concern especially in countries like Pakistan, predominantly used in the agricultural areas. The first human case reported in March, 2022 came to attract the prime focus of all by urging that the disease needed immediate action. Leptospirosis is caused by contact with urine from an animal source, which means that if one Must live within flood plains or indulge in sporting activities on the field during wet conditions, Then the risk of developing leptospirosis infection also increases.

1.2. Motivations and Challenges

Motivations

- **Impact on Public Health:** Basic leptospirosis is endemic to flood prone areas**.**
- **Resource Optimization:** The gadget aims at cutting costs and resources in the process

of optimizing diagnosis to recover some amount of money that was spent on this inspection.

●**Technological Advancements:** Modern deep learning is congruent to state-of the art technology applying in regards of health solutions.

● **Global Relevance:** The tool helps in fighting infectious diseases the world over through international operations that use it to aid and support various concerns from time to time.

Challenges

- ●**Data Quality:** The effective collecting of large and high-quality datasets with diverse characteristics seems to be one of the most serious problems in respect to the strong model training**.**
- **Algorithm Generalization:** It is very important to ensure that the algorithm applied is malleable enough to become applicable in different settings and populations.
- **Multidisciplinary Collaboration:** Creation of a connection between knowledge bases of data science and modern medicine allows making implementation effective.
- **Ethical Considerations:** There are several crucial elements, but in particular, one should take into consideration privacy issues and ethical issues regarding the utilization of patient data.
- **User Adoption:** Utilization of the instrument potentially involves trust from the side of healthcare professionals, which requires quality training and support.
- **Regulatory Complian**ce: A deployment is characterized by permissions and standards, that need to be managed.
- **Sustainability:** Stability, refit and upgrades over the life span of the project are essential in planning for long-term effect.

1.3. Goals and Objectives

Goals

Precision Diagnosis:

Even in the case of leptospirosis, a deep-learning application must be built to give an accurate

Diagnosis.

Efficient Resource Use:

Efficiently maximize diagnostics to minimize costs, and resource use.

Technological Healthcare Advancement:

Methods to show the potential of technology effective modern deep learning algorithms are Suggested.

Non-invasive Diagnosis:

Create a rapidly in its least amount of time that is non-invasive diagnosis too.

Deep Learning Implementation:

Leptospirosis is claimed to be analyzed with high accuracy through the help of recurrent neural Networks and convolutional neural networks.

User-Friendly Design:

Develop an intuitive graphical interface for a wide variety of health professionals**.**

Testing and Validation:

Verifiability of the tool in different scenarios.

Early Detection Impact:

Transform Leptospirosis Diagnosis so that the diagnosis is made immediately for.

Cost Reduction for Healthcare:

To reduce reliance on costly diagnostic tools**.**

Privacy and Ethical Considerations:

Touched on ethical and privacy issues regarding patient information.

Regulatory Compliance:

Adhere to the deployed rules and follow due direction.

User Adoption and Training:

Start a training program that is also designed to encourage adoption and trust.

Long-term Sustainability:

Create a future to make maintenance and scalability plans for lengthy impression.

1.4. Literature Review/Existing Solutions

The diagnostic techniques that have been demonstrated with the methods of leptospirosis such as MAT and PCR lead to accuracy. The literature reveals the opportunity or potential for deep learning, including CNNs and RNNs in medical diagnostics which serve as a source of creative solutions. Applications of deep learning in leptospirosis, however still to be known. There is a requirement for diagnostic ways with good efficacy, which can be applied easily in the countries and in areas where floods occur as this causes water-borne diseases. This study aims to meet this gap by the Usage of deep learning to develop a mobile application which will overcome current diagnostic Limitations and expand the area of infectious disease diagnosis.

1.5. Gap Analysis

Looking at the current tendencies, there are very few technologically advanced approaches to Disease diagnostics specifically in terms of making fast and accurate judgments using deep Learning. Lacking in the field of quick, easily accessible instruments which dissect distinctive Challenges related to leptospirosis prevailing in tropics as well as flood-hit regions. In addition, Little research has been done on the possibilities of deep learning applications to address Leptospirosis particularly and missing numerous opportunities to implement innovative Algorithms such as CNNs and RNNs for the computational diagnostics of infectious diseases. The Current study aspirates to address these gaps by designing the mobile-based application which Provides rapid, non-invasive and context sensitive leptospirosis tests.

1.6. Proposed Solution

The proposed treatment is building an application installed on smartphones, which will employ Deep learning to drive the conversion of leptospirosis detection into one. This innovative approach Will analyze medical information with much precision and speed under the influence of deep Learning technologies using Convolutional Neural Networks (CNN’s).

- Prompt diagnostic performance.
- the concept of precision healthcare that allows for the provision of detailed solution with

Minimal clinical and laboratory data.
The patient may be diagnosed with the leptospirosis disease in a timely manner thus making it Easy to treat and manage as most patients respond wel to treatment due to early diagnosis. In Order to conduct it, the tool uses deep learning technoogies. Provided that the solution is Convenient in terms of architecture, several groups of clinical practitioners relate to such a level of technical competence. The adaptation to implement it widely is easily done because one can Combine it with current health care settings and defined processes.
In conclusion, the proposed method helps fill-in the need for a prompt and reliable leptospirosis Detection tool. This mobile program, which can apply the deep learning technology into practice To some degree in order to accomplish leptospirosis efficacy for diagnostic and treatment Clinically, saving lives and costs in healthcare.

1.7. Project Plan

We have divided the project in such a way that we are working on it's backend first and completing its documentation and then in the second phase our final product will be launched.

1.7.1. Work Breakdown Structure

1. Project Management

1.1 Work Breakdown Structure (WBS) – Hafsa Zulfiqar
1.2 Roles & Responsibility Matrix – Hafsa Zulfiqar
1.3 Change Control System – Hafsa Zulfiqar

2. Reports / Documentation

2.1 Final Documentation Introduction – Hafsa Zulfiqar
2.2 Literature / Market Survey – Hafsa Zulfiqar

2.3 Requirements Analysis – Hafsa Zulfiqar

2.4 System Design – Hafsa Zulfiqar, Abdul Rehman

2.5 Implementation – Abdul Rehman

2.6 Testing & Performance Evaluation – Abdul Rehman

2.7 Conclusion & Outlook – Abdul Rehman

2.8 End User Documentation – Abdul Rehman

2.9 Application Administration Documentation – Hafsa Zulfiqar

3. System

3.1 Development Environment – Hafsa Zulfiqar, Abdul Rehman

3.1.1 IDE – Abdul Rehman

3.1.2 Version Control – Abdul Rehman

3.1.3 Server – Abdul Rehman

3.1.4 Database – Hafsa Zulfiqar

3.2 Presentation Layer – Hafsa Zulfiqar

3.2.1 Deliverable 1 – Hafsa Zulfiqar

3.2.2 Deliverable 2 – Hafsa Zulfiqar, Abdul Rehman

This deliverable will contain the front-end of the application.

3.3 Business Logic Layer – Abdul Rehman

3.3.1 Deliverable 1 – Abdul Rehman

3.3.2 Deliverable 2 – Hafsa Zulfiqar, Abdul Rehman

This deliverable will contain the back-end of the application.

3.4 Data Management Layer – Hafsa Zulfiqar

3.4.1 Deliverable 1 – Hafsa Zulfiqar

3.4.2 Deliverable 2 – Hafsa Zulfiqar, Abdul Rehman

This deliverable will showcase the database capability of the application.

3.5 Physical Layer

3.5.1 Deliverable 1 – Hafsa Zulfiqar, Abdul Rehman

3.5.2 Deliverable 2 – Hafsa Zulfiqar, Abdul Rehman

This deliverable will contain the overall application.

1.7.2. Roles & Responsibility Matrix

WBS#	WBS Deliverable	Activity to Complete the Deliverable	Duration (# of Days)	Responsible Team Member(s) & Role(s)
1.1	Work Breakdown Structure (WBS)	Define the project's WBS structure		Hafsa Zulfiqar
1.2	Roles & Responsibility Matrix	Create a roles and responsibilities matrix		Hafsa Zulfiqar
1.3	Change Control System	Establish a change control system for the project		Hafsa Zulfiqar
2.1	Final Documentation Introduction	Write the introduction for the final documentation		Hafsa Zulfiqar
2.2	Literature / Market Survey	Conduct literature and market survey		Hafsa Zulfiqar
2.3	Requirements Analysis	Perform requirements analysis		Hafsa Zulfiqar
2.4	System Design	Collaborate on system design		Hafsa Zulfiqar, Abdul Rehman
2.5	Implementation	Implement the system		Abdul Rehman
2.6	Testing & Performance Evaluation	Conduct testing and performance evaluation		Abdul Rehman
2.7	Conclusion & Outlook	Write project conclusion and outlook		Abdul Rehman

2.8	End User Documentation	Create end user documentation		Abdul Rehman
2.9	Application Administration Documentation	Prepare application administration documentation		Hafsa Zulfiqar
3.1	Development Environment	Set up the development environment		Hafsa Zulfiqar, Abdul Rehman
3.1.1	IDE	Choose and set up the integrated development environment		Abdul Rehman
3.1.2	Version Control	Establish version control system		Abdul Rehman
3.1.3	Server	Configure the server		Abdul Rehman
3.1.4	Database	Set up the database		Hafsa Zulfiqar
3.2	Presentation Layer	Develop the presentation layer		Hafsa Zulfiqar
3.2.1	Deliverable 1	Complete Deliverable 1		Hafsa Zulfiqar
3.2.2	Deliverable 2	Complete Deliverable 2		Hafsa Zulfiqar, Abdul Rehman
3.3	Business Logic Layer	Back End Development		Abdul Rehman
3.3.1	Deliverable 1	Complete Deliverable 1		Abdul Rehman
3.3.2	Deliverable 2	Complete Deliverable 2		Hafsa Zulfiqar, Abdul Rehman
3.4	Data Management Layer	Develop the data management layer		Hafsa Zulfiqar
3.4.1	Deliverable 1	Complete Deliverable 1		Hafsa Zulfiqar
3.4.2	Deliverable 2	Complete Deliverable 2		Hafsa Zulfiqar, Abdul Rehman

3.5	Physical Layer	Work on the physical layer		Hafsa Zulfiqar, Abdul Rehman
3.5.1	Deliverable 1	Complete Deliverable 1		Hafsa Zulfiqar, Abdul Rehman
3.5.2	Deliverable 2	Complete Deliverable 2		Hafsa Zulfiqar, Abdul Rehman

1.7.3. Gantt Chart

	Task	Assigned To	Start	End	Dur	%	2023			2024							
							Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
	Project		10/9/23	8/15/24	221												
1	Requirements Gathering	Hafsa Zulfiqar	10/9/23	12/11/23	44												
2	System Design	Hafsa Zulfiqar, Abdul Rehman	12/1/23	2/15/24	54												
3	Implementation	Abdul Rehman	2/16/24	3/28/24	30												
4	Testing & Performance Evaluation	Abdul Rehman	3/29/24	5/7/24	28												
5	Conclusion & Outlook	Abdul Rehman	5/8/24	6/12/24	26												
6	End User Documentation	Abdul Rehman	6/13/24	7/29/24	33												
7	Application Administration Documentation	Hafsa Zulfiqar	8/1/24	8/15/24	11												

Figure 1

1.8. Report Outline

Leptospirosis is a bacterial illness that causes serious health problems, particularly in tropical areas prone to floods. This project report outlines the development of a deep learning-based diagnostic tool aimed at the early detection of leptospirosis. The tool leverages convolutional neural networks to analyze clinical data, offering a non-invasive, rapid, and accurate diagnosis method.

1.9. Empathy Map

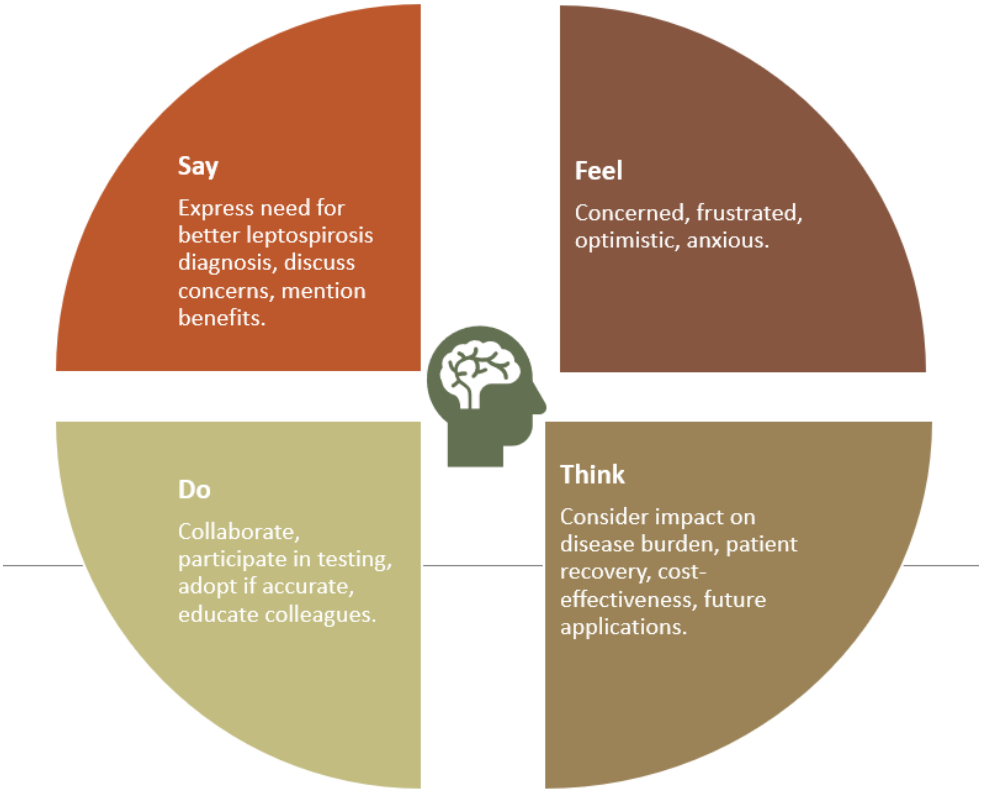

Figure 2

Chapter 2

Software Requirement Specifications

Chapter 2: Software Requirement Specifications

2.1. Introduction

2.1.1. Purpose

This document helps explain why and how we're making a special app to find a sickness called leptospirosis early. Leptospirosis is a common and harmful infection, especially in places like Pakistan. The document talks about why the current ways of finding this sickness have problems, and how our app using smart technology can do it better and faster.

We want to make sure our app is easy for doctors to use and helps them and patients by saving time and money. This document also talks about testing the app a lot to make sure it works well everywhere. We care about privacy and doing things the right way, so we talk about that too.

In the end, we want to show how this app can really help doctors and patients, and we might even make it better in the future.

2.1.2. Document Conventions

For this document, we're using simple and clear rules to make everything easy to read and understand. We're writing all the main text in Calibri font, size 12, which is a nice, easy-to-read style. Also, we're putting a little extra space between the lines - 1.5 times the normal space - so that everything doesn't look too squished together. When we write titles and other important bits, we're making sure they stand out by using formatting like bold or italic. This way, it's easy for anyone reading to spot the important parts and follow along without getting lost.

2.1.3. Intended Audience and Reading Suggestions

This documentation is crafted for academic evaluators, technical stakeholders, healthcare professionals, and general readers.

Reading Suggestions:

- **Abstract**: Quickly grasp project objectives and impact.

- **Executive Summary**: Understand the project's background and goals.

- **Introduction**: Gain insights into leptospirosis context and diagnostic challenges.
- **Methodology**: Explore research design, data collection, and testing procedures.
- **Results and Discussion**: Examine outcomes, analyses, and interpretations.
- **Ethical Considerations**: Review commitment to privacy and ethical standards.

Conclusion and Recommendations: Conclude with key findings and future directions.

2.1.4. Product Scope

● The product portfolio determines what deep learning-based field of application is used and for what purpose.

●Diagnostic Features: Find out how the device lands disease with accuracy in leptospirosis.

●User interaction: Find out how healthcare professionals at various technological levels work and live.

●This is some of the minimal clinical and laboratory data which should be provided for optimal instrument

Data requirements state the performance features.

●Environmental Compatibility: Forces the attention to focus on the ability of the tool to function consistently.

●Constraints: Controls limits or boundaries on the inter operability of the tool.

Briefly, provided specifics on how tools perform in the product range

offered as assurance that the given tool’s purpose and limitations.

1.1. Overall Description

1.1.1. Product Perspective

The deep learning-based tool for early leptospirosis detection is conceived as a stand-alone, innovative product designed to revolutionize diagnostic procedures.thiWithin the broader healthcare context, this tool operates independently, enhancing the early identification of leptospirosis.

The Leptospirosis Tool interfaces with the broader healthcare system, receiving relevant data for analysis and providing diagnostic outputs. This clear delineation ensures the tool's autonomy while contributing valuable insights to the larger healthcare framework.

1.1.2. Product Functions

Here's a brief precis of what our app can do:

Early Detection: The app can quick become aware of leptospirosis in sufferers.

Data Analysis: It can examine affected person information to assist make a diagnosis.

User-Friendly Interface: The app is simple for docs and healthcare workers to use.

Privacy and Security: It keeps patient statistics secure and stable.

Reporting: The app can create reviews on patient diagnoses.

Updates and Feedback: There's a function for updating the app and giving comments.

1.1.3. User Classes and Characteristics

This part determines the main user training predicted to take advantage of using the deep gaining knowledge about-based device for early detection of leptospirosis under consideration, primarily based on various elements together with frequency of use, technical information, and specific capabilities.

1. **Healthcare Professionals:**

- **Frequency of Use**: Regular use for diagnosing leptospirosis cases.
- **Technical Expertise**: Varied, ranging from seasoned medical practitioners to less technically proficient healthcare providers.
- **Characteristics**: Require accurate and timely diagnostic information for effective patient care.

- **Frequency of Use**: Periodic involvement in analyzing system performance and optimizing algorithms.
- **Technical Expertise**: High proficiency in data analysis and algorithm optimization.
- **Characteristics**: Focus on ensuring the tool's continuous improvement and optimal functionality.

2. System Administrators:

- **Frequency of Use**: Regular monitoring and maintenance of the tool.
- **Technical Expertise**: High technical proficiency in system administration.
- **Characteristics**: Responsible for system updates, security, and overall system health.

3. **End Users (Patients):**

- **Frequency of Use**: Infrequent, as end users receive diagnostic results.
- **Technical Expertise**: Limited technical knowledge.
- **Characteristics**: Rely on the tool for accurate and understandable diagnostic information.

Distinguishing user classes helps prioritize and tailor specific requirements to meet the diverse needs and characteristics of each group.

1.1.4. Operating Environment

The device works flawlessly through the devices many forms for the best part supporting Android. It is integrated with necessary deep learning libraries, thus making it flexible and at the same time optimized for execution power. It is focused on security, understanding compliance the rules and regulations as well as in many different settings related to health care.

Design and Implementation Constraints

Inside this part, there is a brief on product innovations and trends in the design fields that are accepted and rejected.

Regulatory Compliance:

Some further limitations to healthcare policy and safety standards for records can be linked 763 Deontological aspects of the positive layout to undertake compliance with criminal and ethical standards.

Hardware Limitations:

Varied operating configurations may also set boundaries among timing and memory there are numerous factors applicable, which require optimization of these applications for large number of computing environments.

Interfacing Requirements:

Interfaces with different healthcare packages may additionally impose constraints, requiring compatibility and seamless integration with current structures.

Technological Dependencies:

Specific deep learning libraries and programming languages, which include TensorFlow and Python, are integral to the device's capability, restricting flexibility in generation choices.

Security Considerations:

Robust security protocols and compliance necessities can also limit sure layout options to make certain patient data confidentiality.

Maintenance Responsibility:

Where the customer's agency is responsible for keeping software, then their ways of operations may be intensified by components such as conventions and programming standards.

guidelines.

These limitations influence the improvement technique, which implies that the tool is congruous with the legal regulation, satisfies standards, interfaces efficiently with healthcare systems besides functioning well.

1.1.5. User Documentation

For our app, we plan to provide these user documentation components:

User Manual: A detailed guide on how to use the app, with step-by-step instructions.

On-line Help: Accessible within the app, providing quick answers and tips.

Tutorials: Interactive learning tools to help users get familiar with the app.

FAQ Section: Commonly asked questions with clear, concise answers.

These materials will be available in digital formats, easy to access and navigate. We will adhere to standard documentation practices to ensure clarity and ease of use.

1.1.6. Assumptions and Dependencies

Assumptions

Third-Party Components:

Assumes consistent availability and compatibility with third-party components, such as deep learning libraries and programming languages. (e.g., TensorFlow, Python).

Regulatory Environment:

Assumes a stable regulatory environment, with no significant changes in healthcare or data protection regulations impacting the tool's development.

Stable Operating Conditions:

Assumes relatively stable operating conditions for hardware and software components, minimizing unforeseen disruptions during tool deployment.

Dependencies

External Software Components:

Based on how the external software components seamlessly integrated with the health care. system, therefore requiring efficient communication and adaptability.

Data Availability:

Depends on availability of appropriate clinical and laboratory data to provide accurate analytical knowledge, depend on consistency in availability of data sources.

Organizational Compliance:

Presumes compliance with organizational policies and practices if the organization of their customer states that are responsible to uphold the delivered software.

1.2. External Interface Requirements

1.2.1. User Interfaces

Healthcare Professional Interface:

- Characteristics: Intuitive design with clear navigation.
- Layout Constraints: Adherence to standard screen layouts for consistent user experience.
- Error Handling: Clear and standardized error messages for efficient troubleshooting.

Data Analyst Interface:

- Characteristics: Advanced data visualization tools for in-depth analysis.
- GUI Standards: Adherence to established GUI standards for consistency.
- Functionality Buttons: Standardized functions for data manipulation and optimization.

System Administrator Dashboard:

- Characteristics: Centralized dashboard for system monitoring and maintenance.
- Style Guides: Follows product family style guides for uniformity.
- Help Function: Standardized help functions for ease of system administration.

End User (Patient) Dashboard:

- Characteristics: Simple and clear interface for understanding diagnostic results.
- Screen Images: Sample screen images for visual reference.
- Accessibility: Adherence to accessibility standards for a broader user audience.

1.2.2. Hardware Interfaces

Supported Device Types:

- Logical Characteristics: Compatibility with standard computing devices, including Mobiles, desktops, laptops, and servers.
- Physical Characteristics: Adaptability to varied hardware configurations, ensuring seamless operation.

Data and Control Interactions:

- Analytical Features: Description Effective data transmission and control interactions across software and hardware components.
- Physical Characteristics: Timely processing of diagnostic data, ensuring optimal control and functionality.

Communication Protocols:

Logical Characteristics: Implementation of secure communication protocols.
Physical Characteristics: Reliable and secure data transmission between the software and connected hardware.

1.2.3. Software Interfaces

2. The tool works on logistic regression for model training, supports Android for now, interacts securely with healthcare software via APIs for patient data exchange, and seamlessly retrieves data from clinical and lab databases, ensuring compatibility and standardized communication.

2.1.1. Communications Interfaces

For the communication functions of our tool, we'll be using several methods:
APIs: It uses Application Programming Interfaces (APIs) for secure and efficient data exchange with external healthcare databases and systems.
Data Encryption: All data transfers will be encrypted to ensure security.
Data Synchronization: The tool will include mechanisms for reliable data synchronization, ensuring data consistency across different platforms.
These interfaces and protocols ensure secure, efficient, and user-friendly communication for the tool.

2.2. System Features

2.2.1. System Feature 1

Data Input and Validation

2.2.1.1. Description and Priority

High priority. This feature enables the input of patient data and ensures its accuracy and suitability for analysis.

2.2.1.2. Stimulus/Response Sequences

User inputs data -> System validates and confirms data format and completeness.

2.2.1.3. Functional Requirements

REQ-SF1-1: System accepts various data types including text and numerical values.

REQ-SF1-2: Implementation of data validation checks for errors or inconsistencies.

REQ-SF1-3: Preprocessing algorithms to standardize data for analysis.

2.2.2. System Feature 2

Machine Learning Analysis

2.2.2.1. Description and Priority

High priority. Core feature using logistic regression to analyze patient data and predict leptospirosis infection.

2.2.2.2. Stimulus/Response Sequences

processed data is fed into the model -> System analyzes data and generates a prediction.

2.2.2.3. Functional Requirements

REQ-SF2-1: Integration of logistic regression for pattern identification in data.

REQ-SF2-2: Use of python libraries for handling sequential data elements.

REQ-SF2-3: System updates models regularly with new data and research findings.

2.2.3. System Feature 3

Result Interpretation and display

Description and Priority

Medium priority. This feature interprets the analysis outcome and displays it in an understandable format.

Stimulus/Response Sequences

Analysis is completed -> System displays diagnostic results.

Functional Requirements

REQ-SF2-1: Clear, user-friendly display of the diagnostic outcome.

REQ-SF2-2: Supplementary details such as confidence levels and recommendations.

REQ-SF2-3: Functionality to export or print results

2.3. Other Nonfunctional Requirements

2.3.1. Performance Requirements

- The system should deliver diagnostic results within a specific time frame (e.g., less than 5 seconds) to ensure prompt decision-making.
- It should handle a minimum number of simultaneous users (e.g., 50 users) without performance degradation.

2.3.2. Safety Requirements

- The system must comply with healthcare safety standards and regulations relevant to medical diagnostic tools.
- Implement safeguards against misdiagnosis, including secondary verification processes.

2.3.3. Security Requirements

Strict adherence to data privacy laws and regulations (e.g., GDPR, HIPAA).

User authentication measures to ensure secure access.

Data encryption both in transit and at rest.

2.3.4. Software Quality Attributes

we focus on the quality of our tool. We want it to be really good and easy to use. Here are some things we care about:

Easy to Use: The app should be simple for everyone to understand.

Works Well and Doesn't Crash: It needs to be reliable, so it always works when doctors need it.

Easy to Fix and Update: If there's a problem, we should be able to fix it fast. And we can add new things to the app without trouble.

Safe to Use: It must be safe so that it doesn't give wrong information.

2.3.5. Business Rules

Who Can Use It: We need to decide which doctors or hospital staff can use the app.

How to Use It Right: There will be rules about the right way to put in information and read the results.

Keeping Information Safe: We have rules to make sure patient information is private and secure.

2.4. Other Requirements

Here, we write about something else we need to consider for the app:

Storing Information: We want an excellent way to preserve all of the affected person facts safe and organized.

Working in Different Countries: The app needs to work properly in unique locations, even in different international locations.

Following the Law: We ought to ensure the app follows all of the legal guidelines about healthcare and privateness.

Making the App Better in the Future: We must reflect on consideration on how we are able to hold improving the app afterward.

Chapter 3

Use Case Analysis

Chapter 3: System Analysis

This chapter presents the results of our comprehensive evaluation of the application of a deep Learning-based tool for the early detection of leptospirosis. This review will detail the many Ways in which users interact with systems, with an overview of the main features and contexts In which the tool is used. The aim is to explore where it can results and opportunities for this Research development to provide a clearer picture of how actors interact with the system Furthermore, it helps to visualize the working of the system. It provides a starting point for Designing a user centered, efficient, and intuitive tool.

3.1. Use Case Model

Patient Data Entry

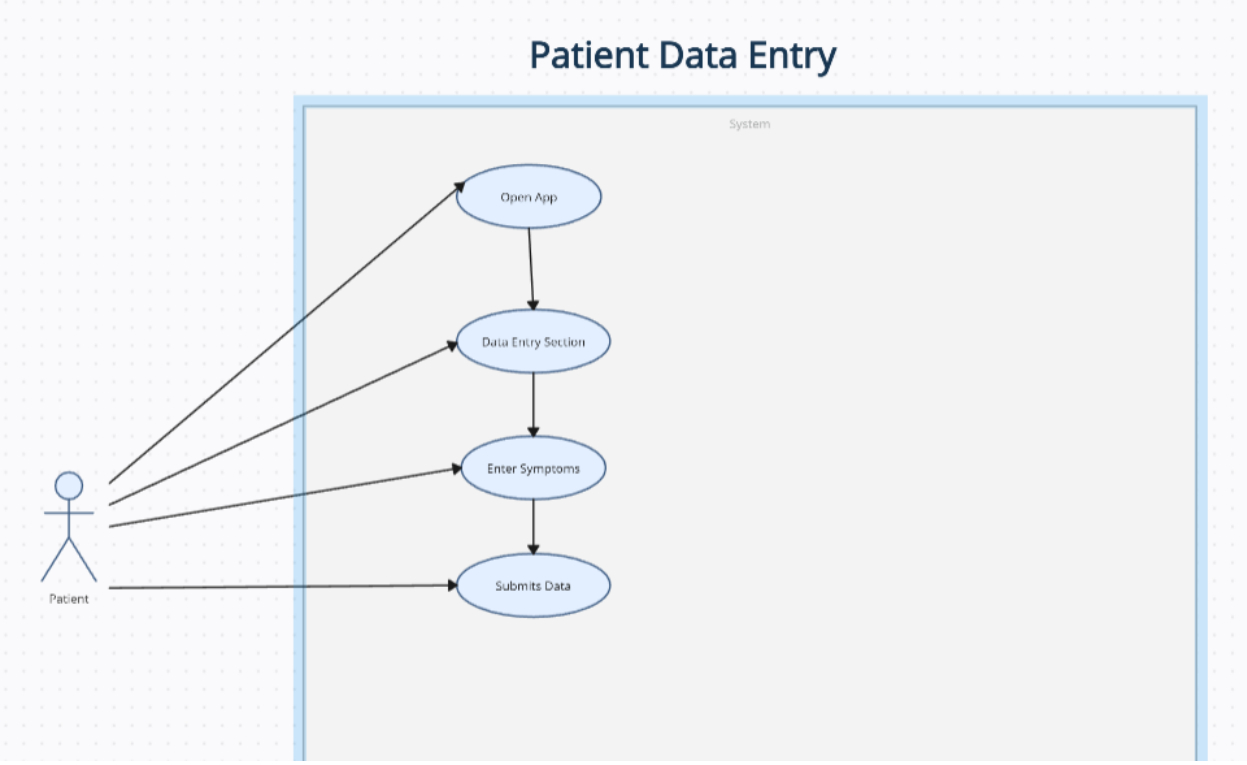

Figure 3

Primary actor: Patient
Flow:

- Patient open app

- Patient navigates to data entry section
- Patient will then enter symptoms
- Patient submits data

Diagnostic Analysis

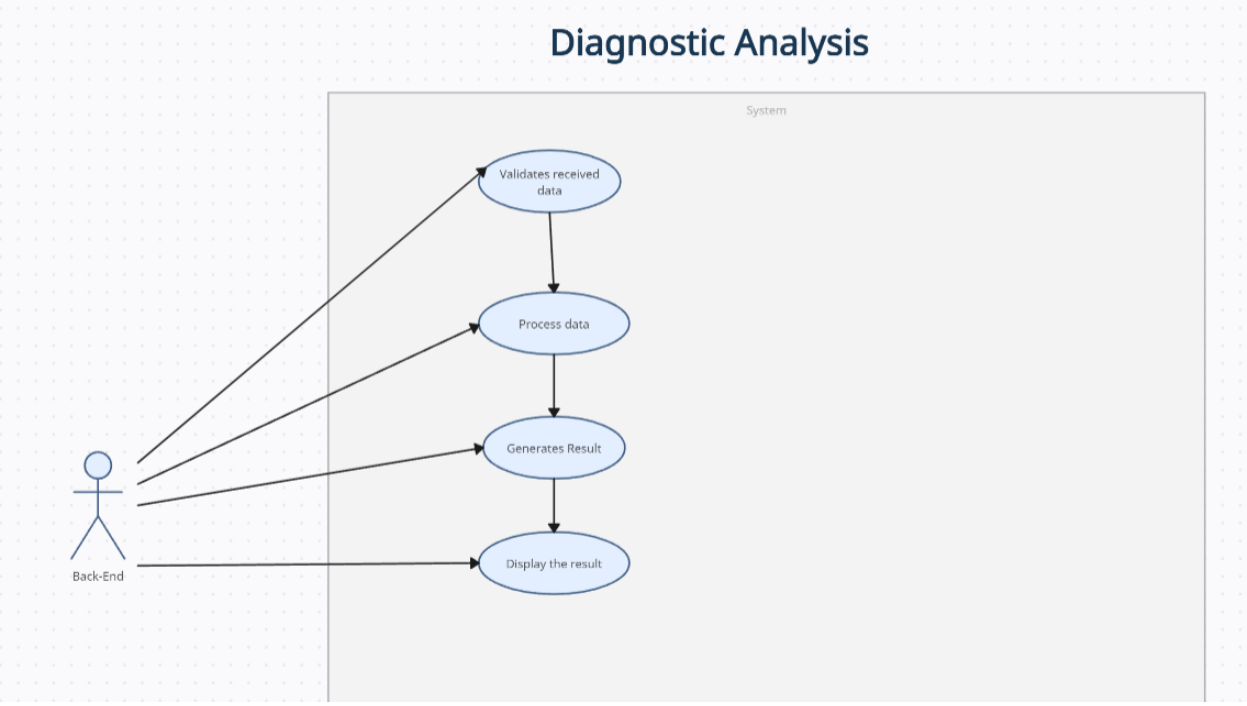

Figure 4

Primary actor: App's back-end system

Flow:

- System validates received data
- Process data
- System generates result based on data
- Displays the result

Result

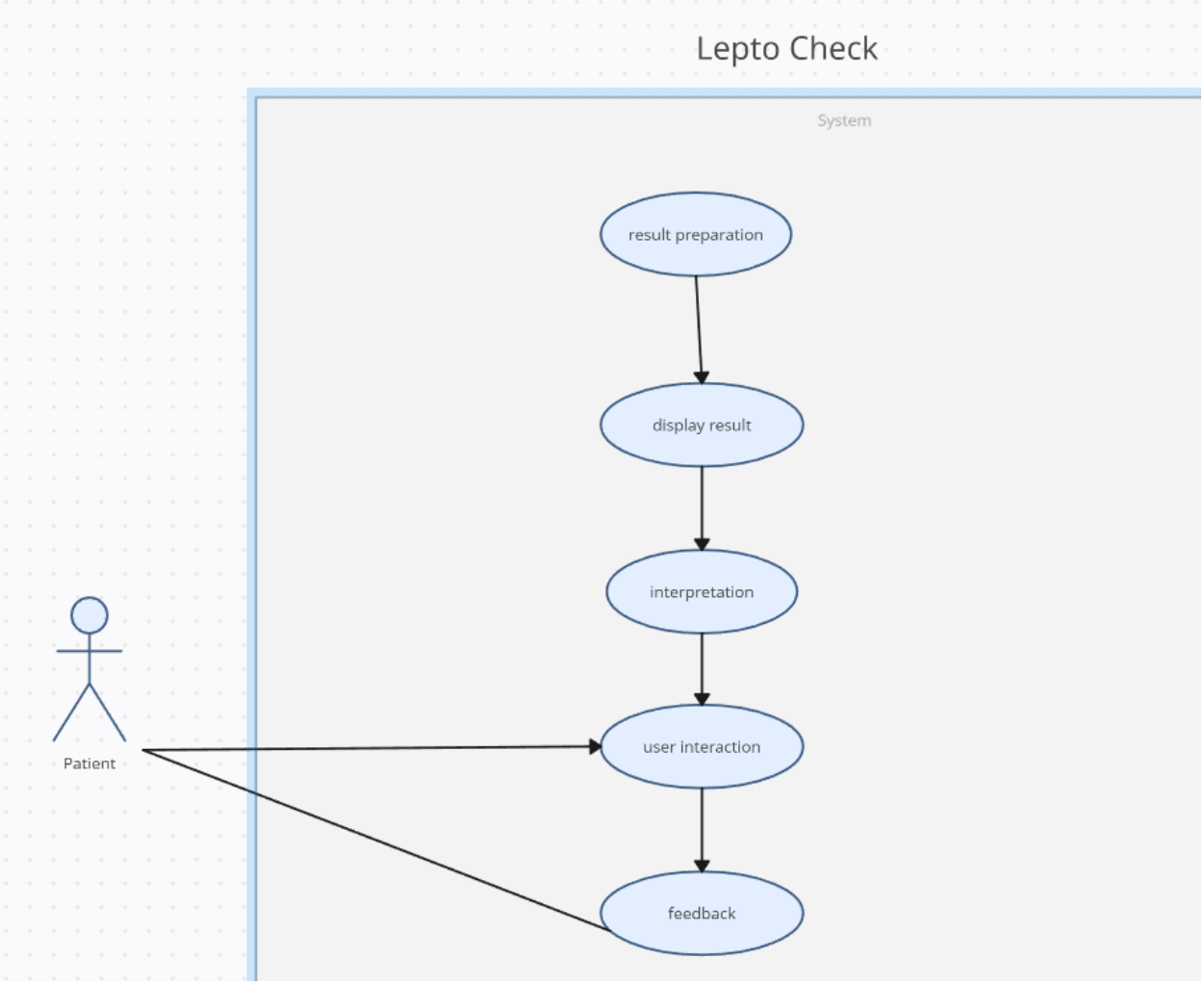

Figure 5

Primary actor: Patient

Flow:

- Displays result
- Patient views output
- System my provide general advice
- Displays the result
- Feedback

Chapter 4

System Design

Chapter 4: System Design

This chapter will address the system's infrastructure needs, specifying hardware and software requirements, third-party services, and integration points with existing healthcare systems. Through diagrams, code snippets, and narrative descriptions, the System Design chapter provides a comprehensive roadmap for the development and deployment of the diagnostic tool.

4.1. Architecture Diagram

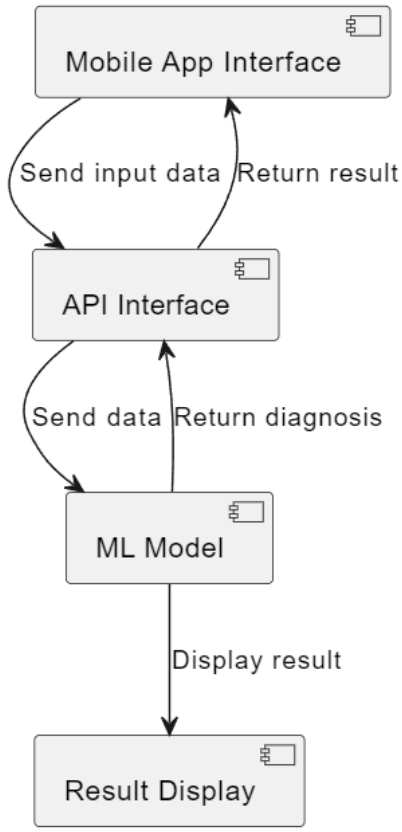

Figure 6

4.2. Domain Model

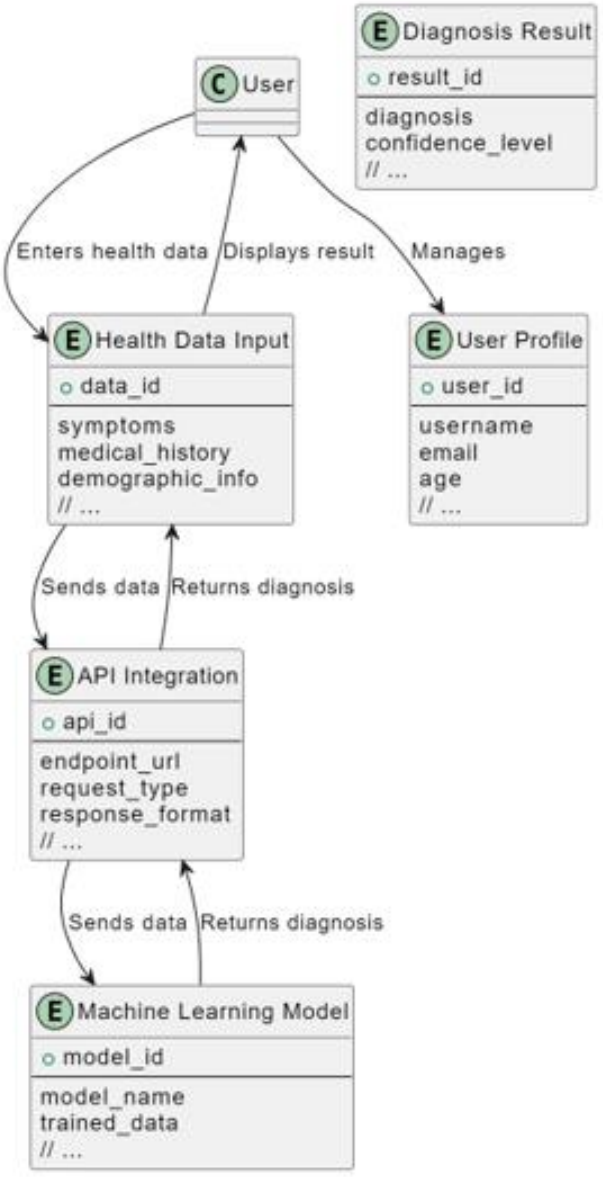

Figure 7

4.3. Entity Relationship Diagram with data dictionary

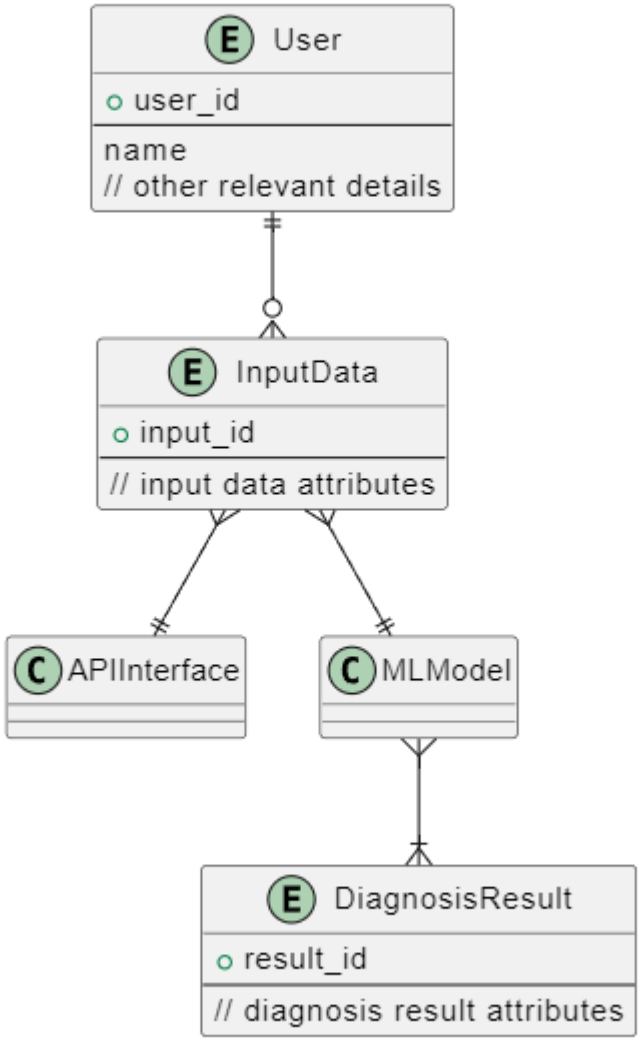

Figure 8

4.4. Class Diagram

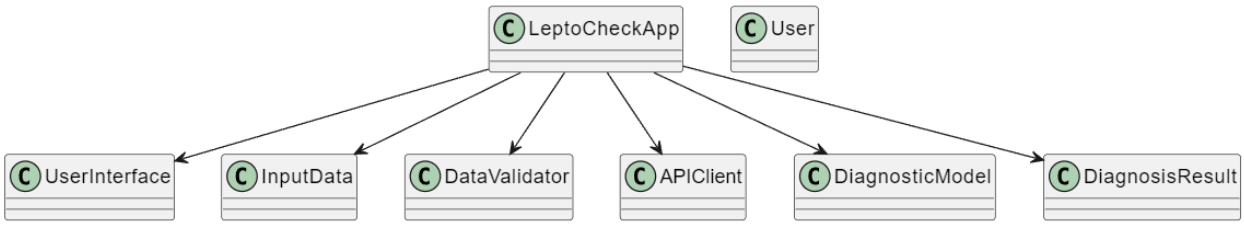

Figure 9

4.5. Sequence / Collaboration Diagram

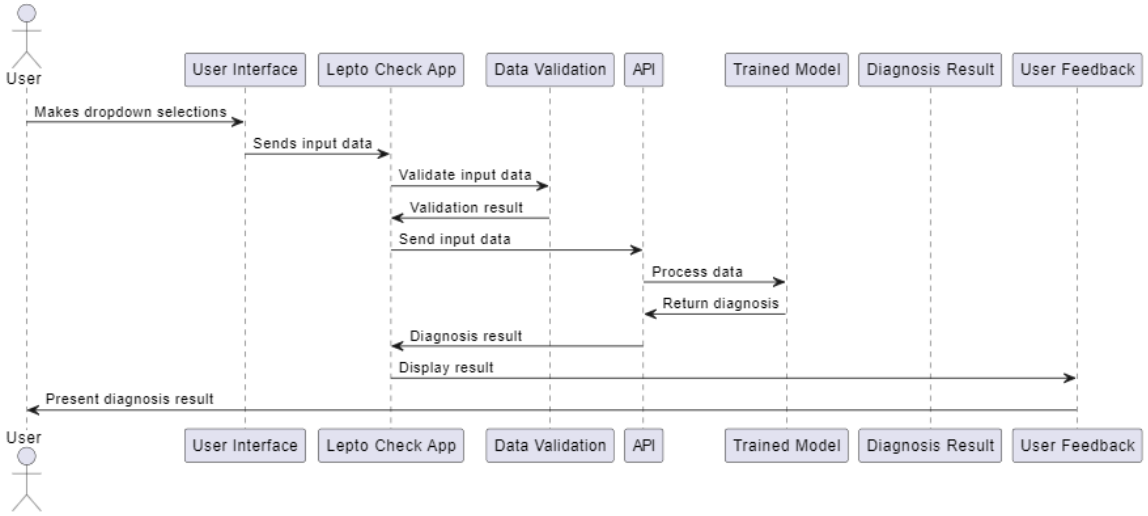

Figure 10

4.6. Operation contracts

Operation: ConductDiagnosticTest(testID, patientID)

Preconditions:

Patient (patientID) is registered.

Healthcare worker initiates test request.

Postconditions:

New Diagnostic Test record created.

Test record associated with patientID.

Test status set to 'In Progress'.

Deep Learning Model analyzes data.

Test Result generated and stored.

Test status updated to 'Completed'.

Figure 11

4.7. Activity Diagram

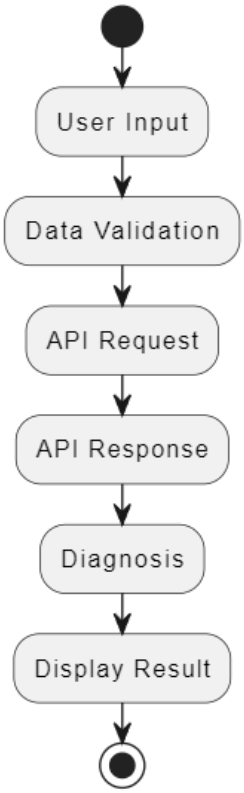

Figure 12

4.8. State Transition Diagram

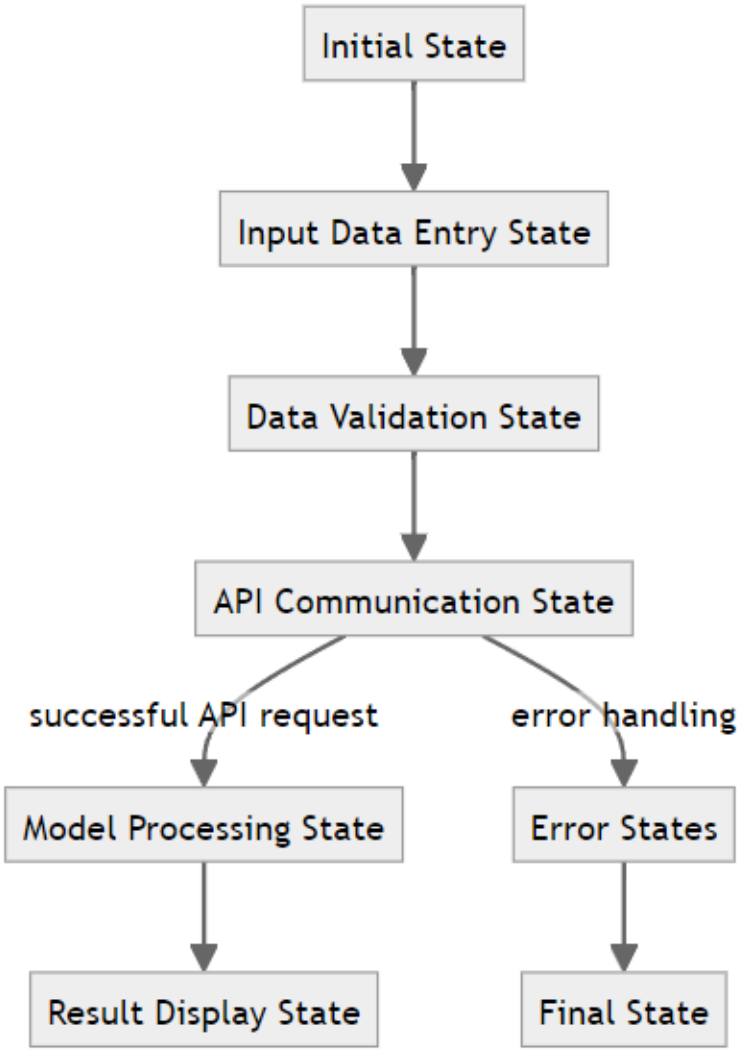

Figure 13

4.9. Component Diagram

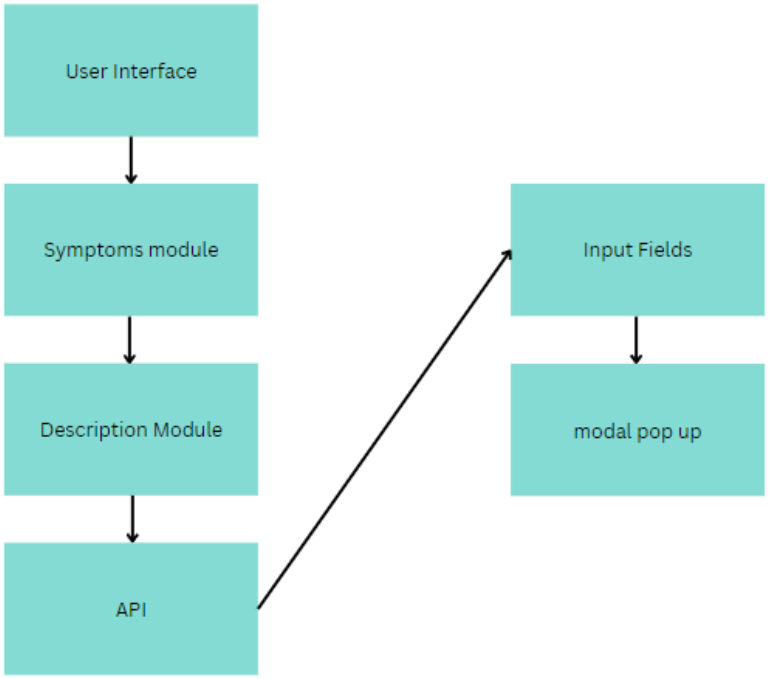

Figure 14

4.10. Deployment Diagram

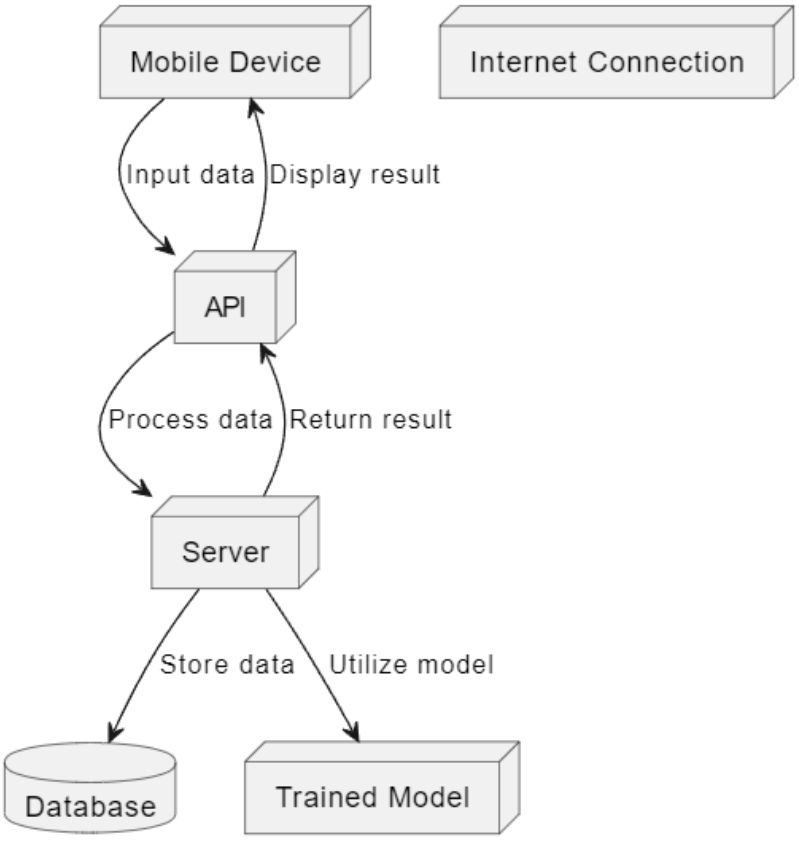

Figure 15

Chapter 5

Implementation

Chapter 5: Implementation

5.1. Important Flow Control

In this explanation, we cover the important flow control methods and pseudo-codes that determine how our deep learning diagnostic tool functions. These structures offer insight into the logic and decision-making processes that support the tool's operation.

Data Collection and Preprocessing

Data collection is the process that is usually done in different involvements which including data acquisition, cleaning, and augmentation. Pseudo-code for data preprocessing:

5.2. Components, Libraries, Web Services and stubs

We used special computer codes called libraries that help with learning from data. These libraries are like helpers that make our app smart at finding the sickness. We also used web services, which are like bridges that let our app talk to other computer systems to get and share information. Plus, we used something called stubs in testing our app. Stubs are like placeholders for parts of the app that we haven't made yet or that come from outside our app. They help us test to make sure everything works well together.

5.3. Deployment Environment

Requirements:

Hardware: Mobile phone.

Software: Compatible with Android, IOS. Requires Python 3.x, TensorFlow.

Storage: Adequate space.

Web Server (Optional): For web deployment.

Considerations: User accessibility, data security, scalability, deployment models.

Installation: Clear instructions, dependencies.

Maintenance: Plans for updates and support.

5.4. Tools and Techniques

Development Environments: Utilized Jupyter Notebook, a popuar interactive development environment for Python, and Anaconda, a versatile data science platform, for efficient coding, experimentation, and model development.

5.5. Best Practices / Coding Standards

Coding Style Guide

We strictly followed the proper coding style guide for Python throughout our project. Adhering to this widely accepted standard ensured consistent code formatting and readability, contributing to maintainability.

Naming Conventions

We strictly followed the proper coding style guide for Python throughout our project. Adhering to this widely accepted standard ensured consistent code formatting and readability, contributing to maintainability.

5.6. Version Control

We employed Git and GitHub for version control. This facilitated code tracking, collaboration, and issue management. Git branches allowed independent development, code reviews ensured quality, and continuous integration automated testing. Documentation and project files were also managed using Git.

Chapter 6

Testing and Evaluation

Chapter 6: Testing and Evaluation

This chapter outlines various testing methodologies, including use case, equivalence partitioning, boundary value, data flow, unit, integration, performance, and stress testing. Each method is meticulously applied to ensure the tool's accuracy, efficiency. The focus is on identifying and solving potential problems, improving performance, and ensuring the reliability and effectiveness.

6.1. Equivalence partitioning

Here we divided input data into different classes to reduce test cases and focus on key areas. This approach helped identify how the tool responds to various ranges of data inputs, ensuring consistent accuracy.

6.2. Boundary value analysis

We focused on testing extremes in the input data range. It was important that the tool handled the data accurately within the constraints, where errors are most likely to occur.

6.3. Data flow testing

We have examined how data flows through the system, ensuring accuracy. This step was necessary to confirm that patient data was handled correctly, with no loss or compromise.

Each step was tested in every necessary way to make the app more reliable and to ensure the flow of the data.

6.4. Unit testing

In this phase, we tested the individual components of the system in isolation. This step was essential to guarantee functionality and reliability before integrating each part of the system.

Figure 16

6.5. Integration testing

After unit exams, we checked how these gadgets labored collectively. This became vital for making sure seamless interplay among exclusive components of the gadget and green average performance

6.6. Performance testing

We evaluated the device's efficiency, which includes response instances and aid utilization. This checking out ensured the device plays nicely below ordinary operational situations. The app is performing well on even low-end devices as it does not need higher specification of hardware and software.

6.7. Stress Testing

We pushed the system beyond normal limits to test its behavior under extreme conditions. This was important to understand the tool's resilience and how it handles high-stress scenarios. We have tested the app under every condition to check if it gets slower or gets irresponsive. The app has behaved well in every testing scenario.

Testing the app repeatedly has produced the same expected result, which mean our app can perform well under load situations.

Chapter 7

Summary, Conclusion and Future Enhancements

Chapter 7: Summary, Conclusion & Future Enhancements

7.1. Project Summary

We advanced a deep studying-based device for the early detection of leptospirosis. Any person with the doubt of having leptospirosis can use our tool to at least get to the state where he/she will be able to know to whether if they should be worried about their condition or not. The tool integrates logistic regression and consumer-friendly interfaces, ensuring ease of use in diverse healthcare settings. In short, this tool can help the patients with similar symptoms to diagnose themselves with leptospirosis.

7.2. Achievements and Improvements

The main achievement of this work was the accuracy of the diagnosis of leptospirosis, which surpassed the existing methods. Furthermore, the adaptability of the system represents a significant improvement over traditional diagnostic tool. It also stands out for speed and efficiency in data processing and analysis

7.3. Critical Review

The challenge efficaciously met maximum of its goals, though demanding situations have been encountered in statistics series and algorithm optimization. The machine’s performance beneath varied conditions showed its capacity in real-global applications

7.4. Lessons Learnt

Working on this project was like going on a big adventure. we learned a lot. One important thing we've learned is that it's really important to plan and try things over and over again. Also, hearing what people think about my work helps me improve it. We found that making anything really smart but easy for anyone to use. This project wasn't just about making a cool tool. It was about

creating something that everyone could easily use. Developing a tool to help people is always a fun challenge.

7.5. Future Enhancements/Recommendations

Thinking about what comes next for my project, we have some fun ideas. First, we can make the tool smarter by teaching it with more information from different places and people. This will help it make better guesses. Then, we want to learn more about AI and how to make the tool think faster and better. In the future, we also think it would be great if my tool could help find different kinds of sicknesses, not just one. That would be really helpful for more people.

For future, we have also planned a feedback module where user can give feedback about the app and give us suggestions to make the app more reliable and more attractive.

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