Empowering Hair Health with Intelligent Hair Disease Detection System.

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Department of Information Technology

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DECLARATION

I declare that this is my own work, and this proposal does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other university or Institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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ABSTRACT

By developing an intelligent system to detect hair diseases, this research effort offers a novel method for improving hair health. This system is capable of correctly identifying and diagnosing a variety of hair problems, such as alopecia and dandruff, by utilizing cutting-edge machine learning and image processing algorithms. The main objective is to enable people to actively manage their hair health by seeing possible problems early. The project entails building and constructing an intelligent detecting system as well as thoroughly verifying its efficiency.

The device also has a real-time monitoring capability that provides customers with the most recent data on the condition of their hair. This gives people the ability to continually monitor developments and take preemptive action. Professionals in the hair care industry may remotely check on their clients' hair health and provide insightful data. The usability of the system is further increased by the way it harvests and maintains prescription data, enables users to examine it as required, and creates reminders based on this data.

Furthermore, by taking patient allergies into account and tailoring healthcare solutions, the research presents a fresh method of therapy advice. In order to customize treatment suggestions, powerful machine learning algorithms are used to assess patient data, including ages, genders, allergies, and particular hair problems.

Finally, to anticipate future hair disorders, a predictive modeling system is created using patient history and symptoms. Early detection and treatment are the ultimate goals of this strategy, which should improve patient outcomes. The subject of managing illnesses and maintaining healthy hair has the potential to change thanks to the application of machine learning.

Keywords: -

Machine Learning, Neural Network, Natural Language process, IOT, Alopecia, dandruff, EasyOCR

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LIST OF ABBREVIATIONS

Internet of Things	IoT
User Interface	UI
Software Development Kit	SDK
Software Development Life Cycle	SDLC
Natural Language Processing	NLP
Deep Learning	DL
Machine Learning	ML
Application Programming Interface	API
Internet of Things	IOT
Optical Character Recognition	OCR

1. INTRODUCTION

1.1. Background

Hair and scalp issues are a serious and pervasive health issue that have a negative influence on people's physical appearance, self-esteem, and general quality of life. These conditions cover a wide range of illnesses, from mild problems like dandruff to more serious illnesses like alopecia areata, which causes hair loss. Due to the overlapping symptoms and the possibility of a delayed or incorrect diagnosis, which could result in the administration of the wrong or inefficient medications, the diagnostic environment for these illnesses is particularly difficult. In addition, patients frequently struggle to find the right medical practitioner to treat their particular hair issue, which adds to their uncertainty and distress. The already difficult process of obtaining the essential care and treatment for these disorders is made more difficult by the lack of knowledge and comprehension. As a result, it is clear that hair and scalp conditions are serious public health issues that demand creative solutions to enable patients and healthcare professionals to successfully address these issues.

The use of technology to address these issues has advanced significantly in recent years, particularly in the fields of artificial intelligence and machine learning, natural language processing, and the Internet of Things. Mobile applications and intelligent hair disease management systems have shown promise in improving the accuracy and accessibility of hair disease analysis, diagnosis, and treatment. various cutting-edge devices provide a holistic approach to treating various conditions by enabling precise diagnosis, individualized therapy suggestions, and real-time monitoring. Additionally, by making these tools easily available to the general public, this research aims to raise knowledge of the numerous hair illnesses and how to treat them, ultimately enabling people to take charge of their hair's health and wellbeing. In addition to potentially revolutionizing the industry, the integration of these intelligent systems and mobile applications offers hope to people seeking an accurate diagnosis, individualized treatment options, and ongoing monitoring as they battle these difficult conditions, greatly improving their quality of life.

1.2 Literature Review

Hair and scalp conditions have significant implications for individuals, affecting not only physical health but also mental well-being. Recognizing the complexity of diagnosing and treating these conditions, recent advancements in technology offer promising solutions. This literature survey delves into key areas of research, namely machine learning (ML), optical character recognition (OCR), and the integration of the Internet of Things (IoT), to explore how these technologies are shaping the landscape of hair disease detection.

1. Head Lice Infestations: Unveiling Predictive Insights with Machine Learning

Head lice infestations, particularly among school-aged children, have been a focal point of research aiming to leverage machine learning techniques [1]. Linear regression, a statistical tool, has proven its utility in predicting the efficacy of over-the-counter treatments based on patient-specific factors [1]. This methodology showcases the potential for ML in tailoring treatments for head lice, providing individualized approaches for better outcomes.

2. Hair Loss (Alopecia): Personalized Treatment Approaches with Machine Learning

The intricate nature of alopecia, characterized by hair loss, has prompted exploration into machine learning approaches for personalized treatment recommendations [2]. Linear regression models have been employed to assess the influence of hormonal imbalances and genetic factors on treatment responses [2]. This highlights how machine learning can quantify relationships between diverse factors, enabling the prediction of effective treatments for individuals experiencing hair loss.

3. Allergies as Influential Factors in Treatment Recommendations

Machine learning, specifically linear regression, has emerged as a powerful tool for modeling relationships between allergies, treatment options, and outcomes in the realm of hair diseases [3]. By incorporating allergy data into these models, a personalized treatment approach has been developed. This not only enhances the precision of treatment recommendations but also ensures that interventions are both effective and safe for individuals with specific allergies.

4. OCR in Healthcare: Catalyst for Digital Transformation

Optical Character Recognition (OCR) technology has played a transformative role in healthcare by digitizing paper-based documents [4]. Patient forms, prescriptions, and medical records have transitioned from physical to electronic formats, significantly enhancing data

administration and accessibility. The integration of OCR with machine learning and Natural Language Processing (NLP) presents an exciting frontier for more advanced data extraction and analysis in healthcare [4].

5. Integration of IoT in Hair Disease Detection Systems: Revolutionizing Assessment Methods

In the pursuit of innovative solutions for hair disease detection, the integration of Internet of Things (IoT) components has emerged as a game-changer. A sturdy and aesthetically appealing bucket hat serves as the foundation, housing key IoT components, including a Raspberry Pi 3, LED Flasher, 5MP wide-angle Sony camera, Ultrasonic sensor, and MCP3008. The Raspberry Pi acts as the system's brain, seamlessly processing data from sensors and the high-resolution Sony camera.

The Ultrasonic sensor is strategically employed to detect the wearing of the hat, providing crucial information about users' compliance with safety measures. The 5MP Sony camera, renowned for its sharp imaging capabilities, captures high-resolution hair images essential for accurate machine learning-based disease diagnosis. To address challenges in imaging under varying lighting conditions, an LED flash component has been included, ensuring high-quality image capture irrespective of ambient lighting. This holistic integration of IoT components elevates the system's functionality and user-friendliness, offering a comprehensive solution for accurate hair health assessment.

6. Machine Learning for Enhanced Disease Detection with IoT Integration

Several studies have explored the application of machine learning for hair disease detection, and the integration of IoT components adds a new dimension to these endeavors [8] [9]. The real-time data captured through IoT devices enhances the accuracy and efficiency of machine learning models in diagnosing hair conditions. Continuous monitoring, facilitated by IoT, allows for personalized interventions, presenting a holistic solution for hair health assessment that goes beyond traditional diagnostic approaches.

1.3 Research Gap

One interesting and mostly unexplored area of healthcare research is the integration of optical character recognition (OCR) with healthcare reminder systems. Future research should focus on better understanding the interactions between healthcare providers and patients with OCR-integrated reminder systems, with a particular focus on the system's ease of integration and user experience. Despite OCR's promise to simplify data extraction from medical records, this research is crucial because it can improve usability and user acceptance by identifying adoption barriers and refining the features of human-computer interaction. In order to guarantee patient safety and data quality, it is also imperative to address the accuracy of OCR technology, particularly in difficult scenarios such as unreadable handwriting or non-standard prescription formats. Research needs to concentrate on creating reliable error detection and correction processes and bringing digital data into compliance with industry standards in order to close this gap. Moreover, there is a dearth of knowledge on the long-term consequences of OCR-integrated reminders on patient health outcomes, which calls for comprehensive longitudinal research to uncover their long-term effects and potential to transform patient-centered care. In conclusion, by filling in these research gaps, we may improve the usability, precision, and security of OCR-integrated systems and learn more about the long-term consequences for patient-centered healthcare, which will ultimately lead to the development of more dependable and efficient medical procedures.

The creation and application of an intelligent hair disease detection system that is accessible, accurate, and reliable for a variety of population groups while also guaranteeing the efficacy and safety of its treatment forms the core research problem of this project. The initiative will have to overcome many obstacles in order to do this, such as following moral and legal guidelines to safeguard the rights and privacy of users. Furthermore, steps need to be taken to guarantee the system's cost and accessibility, especially for people living in distant or low-income areas. The project's crucial component is the system's smooth integration into the current healthcare frameworks, which encourages coordinated care and broad adoption. In addition to creating a state-of-the-art system for detecting hair disorders, this research project is expected to yield important insights into the underlying causes and risk factors of hair diseases. These discoveries may influence upcoming public health initiatives and regulations. The project has the potential to make significant contributions to the field of hair health

monitoring and treatment by methodically addressing these complex research concerns. This could lead to improved outcomes and accessibility for a wider range of patients.

The development of complete solutions for improving smart systems in hair care has been facilitated by the expansion of mobile technology. With the use of this cutting-edge method, patients can develop prediction models based on their symptoms and medical history to help forecast and diagnose hair illnesses. The process starts with the patient outlining their initial symptoms, after which they are led through a series of symptom-related questions by an approachable chatbot. The mobile app then shows the diagnosed hair illness and offers information about possible future symptoms the patient might encounter. Notably, this integrated method is a unique and multidimensional solution because it makes it easier to find specialized doctors relevant to the identified ailment and their corresponding locations through Google Maps.

This mobile app is unique in the industry because it integrates multiple necessary features in an easy-to-use manner.

- Hair condition diagnosis by interaction with a chatbot based on symptoms.
- Potential future symptoms linked to the identified hair illness are projected.
- Information regarding doctors that treat hair disorders is available.
- location-based services that let you use Google Maps to find the doctors' offices.

Because it combines several disparate elements into a single mobile application, this all-encompassing strategy is unique and successfully fills a need in the market for intelligent hair care products.

1.4 Research Problem

Hair and scalp are both affected by frequent health issues called "hair diseases." These range from mild conditions like dandruff to more serious ones like the hair loss condition alopecia areata. People are frightened by these factors to even interact with society. Girls are more likely to get hair disorders. In addition, boys are totally cut off when they lose their hair.

- **Extracting patient prescription data using easyOCR and Analyzing those data using NLP**

Both the accurate extraction of prescription data—which is commonly provided in handwritten or other printed formats—and the utilization of this information to create effective medication reminders pose significant problems. This study intends to address the problem of smoothly integrating Optical Character Recognition (OCR) technology with reminder systems in healthcare in order to enhance patient outcomes. By improving user experience, boosting data extraction precision, safeguarding data privacy and security, and strengthening user privacy and security, it does this. This research challenge also considers the ethical and legal implications of managing private patient data by bridging the gap between the theoretical benefits of OCR-based prescription data extraction and the practical implementation of reminder systems.

- **Hair Disease Treatment and Medicine Recommendations**

i. Efficacy and safety of treatment options:

The long-term effects and potential adverse effects of current treatments for common hair diseases (such as alopecia, dandruff, and hair thinning), including drugs, therapies, and surgery, need to be determined.

ii. Incorporation of Allergy Information:

Incorporation of Allergy Information: Although some studies, such as Wolff et al. (2016), have addressed the diagnosis and treatment of hair and scalp diseases, they often overlook the crucial factor of patient allergies in treatment recommendations. Allergic reactions to medications and topical agents can significantly impact treatment outcomes and patient safety. The research gap is evident: How can machine learning models, such as those discussed by Roy and Protity (2023), incorporate allergy data to enhance the safety and effectiveness of treatment recommendations.

- **Predicting Hair Diseases through Patient History and Symptom.**

The problem that the topic of predicting hair diseases through patient history and symptom-based predictive modeling and recommending doctors seeks to address is the difficulty in accurately diagnosing and treating hair-related disorders. Genetics, hormonal imbalances, infections, autoimmune illnesses, and dietary inadequacies are all potential causes of hair problems. These disorders' symptoms can also vary greatly, making it difficult for healthcare providers to appropriately diagnose the problem and give appropriate therapy. And also, it can take a lot of money and time to find out what the symptoms of each disease are. Some symptoms are not what people think they are. Therefore, many people today suffer from hair diseases. Despite various diagnostic tools, many hair problems are left untreated or misdiagnosed, resulting in ineffective therapy and frustration among patients. This underscores the need for more reliable and efficient hair diagnostic methods.

- **Smart Hair Health Monitoring.**

The proposed research project aims to address gaps in current hair health monitoring and treatment by developing an intelligent hair disease detection system using an IOT device to collect data and provide personalized treatment. However, several research issues must be addressed to ensure the success and impact of this project. First, the system must be tailored to meet the specific hair health needs of different population groups to ensure its accuracy and effectiveness. Second, ethical and legal considerations must be taken into account to protect the privacy and rights of individuals using the system. Third, measures should be taken to ensure accessibility and affordability of the system for people in low-income or remote areas. Fourth, the system should be integrated into existing healthcare systems to facilitate coordinated care and adoption. Ultimately, data from the system can be used to generate new insights into the underlying causes and risk factors of hair disease and inform future public health interventions and policies. By addressing these research issues, this project has the potential to make significant contributions to the field of hair health monitoring and treatment.

2. OBJECTIVES

2.1 Main Objective

- **Intelligent Hair Disease Detection System:**

Creating an IoT device to collect thorough data on several facets of hair health, such as moisture levels, scalp health, and vitamin shortages, in order to create a novel hair illness detection system. This method will serve as the cornerstone for the accurate and individualized diagnosis and treatment of hair diseases.

- **Machine Learning-Powered Personalized Treatment:**

Appling cutting-edge machine learning algorithms to the data gathered to enable the development of a thorough and individualized approach to the diagnosis and treatment of hair problems. Age, gender, allergies, and the particular hair problem identified will all be taken into account when making treatment recommendations, closing the current gap in tailored care.

- **OCR-Based Prescription Data Extraction System:**

Develop and implementing an optical character recognition (OCR) system that can reliably extract prescription data from various sources, including printed and handwritten prescriptions, containing medication names, dosages, and frequency information.

- **Patient History and Symptom-Based Predictive Modeling:**

Using patient data a create a precise and effective method for diagnosing hair and scalp issues. Based on the medical histories, symptoms, and demographic data of the patients, this method will forecast the likelihood of hair illnesses. Additionally, it will reveal how the illness will develop in the future. this for using a chatbot system.

2.2 Specific Objectives

Specific Objectives need to be fulfilled in achieving the main objective.

1. Create a scalable IoT device that can gather information in real-time on aspects of hair health including moisture levels, scalp health, and vitamin shortages.
2. To ensure the secure transfer of gathered data to a centralized server for analysis, establish a secure data transmission protocol.

3. Establish a database management system to store and manage the information gathered on hair health.
4. Use machine learning techniques to analyze the data and create a model for detecting hair diseases.
5. Create a user-friendly user interface so that users can interact with the system and get information about the state of their hair.
6. Finding the best OCR technology to properly extract prescription data from a variety of sources.
7. Create preprocessing methods to improve the quality of prescriptions that have been scanned or photographed.
8. To reliably recognize drug names, dosages, and frequency information, train and fine-tune the OCR system.
9. Integrating the OCR system with the main database for simple storing and retrieval of prescription data.
10. To guarantee reliable performance, especially with handwritten prescriptions, provide error handling techniques.
11. Assemble and preprocess a broad collection of patient demographics, medical histories, and symptoms.
12. Increase the efficiency and user-friendliness of the symptom collecting process by integrating a chatbot to assist patients.
13. Incorporation of Allergies in Treatment Recommendations.
14. Data Collection for the treatment.
15. Develop machine Learning Model for treatment.

3. METHODOLOGY

3.1 System Overview

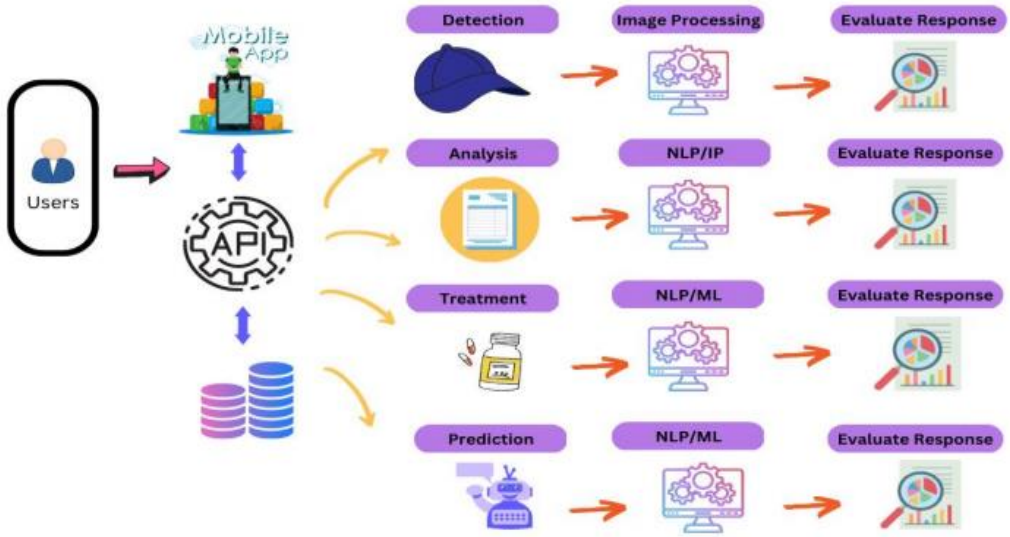


Figure 1 - System Overview

In response to the growing need for advanced solutions in healthcare, particularly in the domain of hair health, our research introduces a revolutionary intelligent hair illness detection system. This system is meticulously designed to leverage cutting-edge technologies, amalgamating predictive modeling, data analysis, chatbot development, and a robust referral system, all aimed at enhancing the efficiency and efficacy of diagnosing and managing hair-related conditions.

At its core, the system initiates its functionality through a comprehensive data collection process. By defining precise data requirements, ranging from patient demographics to intricate details of medical histories and symptoms, the system ensures a holistic and nuanced understanding of individual cases. Patient data, including age, gender, and pertinent medical history, is meticulously gathered, while a systematic approach is employed to capture intricate symptom details. Crucially, the system places paramount importance on data privacy and security, adhering to stringent measures to protect patient information in accordance with prevailing privacy laws.

Upon the culmination of data collection, the system seamlessly transitions into a robust data analysis phase. This pivotal step involves a thorough exploration of the dataset, employing

statistical summaries, visualizations, and exploratory data analysis (EDA). By discerning correlations, trends, and linkages within the data, the system gains valuable insights into the multifaceted influences leading to the manifestation of hair diseases. This analytical prowess forms the bedrock for the subsequent stages of the system's operation.

One of the distinctive features of our intelligent system is the integration of a sophisticated chatbot. This component serves as a user-friendly interface, facilitating the efficient collection of symptoms from patients. Prior to its development, the chatbot's objectives are meticulously defined, aligning with the overarching goals of the system, which include seamless symptom collection and an interface that prioritizes user experience. A judicious selection of a chatbot framework, such as Microsoft Bot Framework, Dialogflow, Rasa, or OpenAI, is made, depending on the project's unique needs.

The conversation flow within the chatbot is intricately designed to ensure the systematic gathering of relevant information. Natural Language Processing (NLP) techniques are seamlessly integrated, endowing the chatbot with the capability to understand and interpret patients' natural language responses. This incorporation of NLP not only enhances the flexibility of interactions but also provides a more human-like engagement. Through a meticulous symptom collection process, the chatbot interacts with patients, eliciting detailed information about the severity of symptoms and relevant medical history.

In parallel, the system embarks on the development of a referral system that incorporates relevant medical expert data for each identified hair condition. A machine learning model is then trained to discern and recommend suitable doctors based on the patient's location and medical history. This integration ensures that the system goes beyond diagnosis, extending its functionality to propose actionable steps for patients to seek professional medical advice.

For enhanced user convenience, the system integrates with Google Maps to display the locations of suggested doctors, simplifying the process of finding medical professionals. This

seamless linkage between the digital interface and real-world medical services adds a tangible dimension to the system's user-centric approach.

As a comprehensive solution, our proposed system transcends traditional paradigms by harnessing the power of the Internet of Things (IoT), wearable technologies, machine learning algorithms, and natural language processing techniques. By bridging the gap between data-driven insights and personalized medical recommendations, the system stands as a beacon of innovation in the realm of healthcare, specifically tailored to revolutionize the diagnosis and treatment of hair-related illnesses.

3.2. Resources Needed

3.2.1. Software Boundaries

Android

Android is a powerful and widely used operating system for mobile devices, developed by Google. Since its initial release in 2008, Android has become the backbone of the mobile technology revolution, dominating the global smartphone market. It provides a versatile platform for developing a wide range of applications, from social media and entertainment apps to productivity and utility tools.

What makes Android exceptional is its open-source nature, allowing developers to create innovative applications using the Android Software Development Kit (SDK). With Android, developers can craft software tailored to various devices, including smartphones, tablets, smartwatches, and even smart TVs. This flexibility and diversity have contributed to Android's immense popularity.

Android is built on the Linux kernel, which provides robust security, stability, and multitasking capabilities. It supports a multitude of programming languages, with Java and Kotlin being the most commonly used for Android app development. The Android ecosystem is also complemented by the Google Play Store, which serves as a central hub for distributing and downloading applications.

With a massive global user base, Android offers a vast market for developers and businesses to reach a wide audience. The open nature of the platform, combined with Google's continuous innovation, ensures that Android remains at the forefront of mobile technology. Whether you're a developer looking to create cutting-edge apps or a user seeking a diverse range of mobile experiences, Android is a dynamic and ever-evolving platform that continues to shape the mobile landscape.

Figure 2 - Android

Java Language

Java is a versatile, high-level, and widely-used programming language known for its 'write once, run anywhere' capability. It was first introduced by Sun Microsystems in the mid-1990s and later acquired by Oracle Corporation. Java has since become one of the most popular and enduring programming languages, used in a wide range of applications, from mobile apps and web development to large-scale enterprise systems.

What sets Java apart is its platform independence, achieved through the use of the Java Virtual Machine (JVM). Java source code is compiled into bytecode, which can be executed on any device or operating system that has a compatible JVM. This portability makes Java a valuable choice for developing cross-platform applications, reducing the need to rewrite code for different environments.

Java is renowned for its robustness, security, and object-oriented programming features. It offers a rich library of standard classes and APIs, making it a practical language for a variety of applications. Java's strong type system and automatic memory management (garbage collection) enhance program reliability and reduce the risk of memory-related errors.

The language's widespread adoption and extensive community support have led to a vast ecosystem of tools, frameworks, and libraries. It's the foundation for Android app development, powering the majority of mobile devices, and it's also a favored choice for building web applications and backend services. Java's versatility and scalability make it ideal for both small-scale projects and large enterprise systems.

With its longevity and consistent updates, Java continues to be a compelling language for developers, making it a valuable skill for anyone entering the field of software development. Whether you're a beginner learning to program or an experienced developer working on complex applications, Java's reliability and versatility have secured its place as a programming language that stands the test of time.

Figure 3 - Java

Torch Library

The Torch library, often referred to as PyTorch, is a powerful and popular open-source machine learning framework that has gained significant traction in the field of deep learning. Initially developed by Facebook's AI Research lab (FAIR) and later open-sourced, Torch provides a flexible and dynamic platform for building and training neural networks. Its rich set of features and ease of use have made it a top choice for researchers and developers in the artificial intelligence community.

What sets Torch apart is its dynamic computation graph, which allows for more intuitive and efficient model construction and debugging. It offers seamless integration with Python, enabling developers to leverage a vast ecosystem of data manipulation and visualization tools. This versatility, combined with its GPU acceleration capabilities, empowers developers to create and train complex neural networks for a wide range of applications, from natural language processing and computer vision to reinforcement learning.

Torch is known for its user-friendly APIs and strong community support, making it accessible to both beginners and experts in the field. It also provides a wealth of pre-trained models and libraries, such as torchvision, for tasks like image recognition and object detection. The framework's 'autograd' feature, which automatically computes gradients for gradient-based optimization, simplifies the training process and facilitates rapid experimentation.

In recent years, Torch has played a pivotal role in advancing the field of deep learning, powering numerous breakthroughs in AI research. Its continual development and adoption by industry leaders and researchers ensure that it remains at the forefront of machine learning innovation. Whether you're a data scientist, researcher, or developer, the Torch library offers a dynamic and versatile platform to explore and build state-of-the-art machine learning models.

Figure 4 - Pytorch

Pandas Library

Data science and data analysis operations are being revolutionized by the robust and adaptable Python package known as Pandas. Researchers, analysts, and data professionals may more easily and effectively handle structured data thanks to Pandas' rich collection of data structures, which is dominated by the DataFrame. Users may effectively prepare and preprocess data for analysis or machine learning tasks with the help of the crucial capabilities it provides for data cleaning, transformation, aggregation, and exploration. Pandas provides a complete toolkit, whether you need to load data from multiple sources, handle missing values, or carry out complex data manipulations.

Its utility is further increased by its easy interface with other data analysis and visualization packages like Matplotlib and NumPy. In short, Pandas is an essential tool in the toolbox of every data scientist or analyst because it enables data practitioners to delve deeply into datasets, extract insightful knowledge, and drive data-driven decision-making.

Figure 5 - Pandas

Python

Python is a flexible and high-level programming language that has become quite well-liked due to its ease of use, readability, and large library. Python, which was developed by Guido van Rossum and originally made available in 1991, is recognized for its clean and simple syntax, making it a great option for both novice and seasoned developers. Python's adaptability, which includes support for many programming paradigms including procedural, object-oriented, and functional programming, is one of its strongest points. Its vast ecosystem of libraries and frameworks, including Django for web development, TensorFlow for machine learning, and NumPy for scientific computing, among many others, considerably speed up the development process.

Python's cross-platform interoperability makes it possible for programs to operate with little modification on a variety of operating systems. Python continues to advance in technology for a wide range of applications, from web development and data analysis to artificial intelligence and scientific research, thanks to its active developer community. Professionals in a variety of areas now gravitate to Python as their preferred language because of its easy learning curve and powerful capabilities, which allow them to quickly transform concepts into useful and effective software solutions.

Figure 6 - Python

Numpy

The Python ecosystem's core library, NumPy, or "Numerical Python," provides data scientists, engineers, and researchers with effective tools for doing numerical and mathematical computations. It provides a flexible array of capabilities for working with multi-dimensional arrays, matrices, and mathematical functions, acting as the foundation for innumerable scientific and computational applications.

The core of NumPy's capabilities is the ndarray data structure, which stands for "n-dimensional array". For numerical tasks, this array is substantially more effective and flexible than Python's built-in lists. For tasks like linear algebra, statistics, and signal processing, NumPy's arrays make it the best choice because they allow users to conduct mathematical operations on complete arrays.

The speed of NumPy is one of its most important benefits. Because the library was created using low-level languages like C and Fortran, NumPy operations are carried out remarkably quickly. This makes it especially suitable for computationally intensive tasks like big data processing and scientific research.

Figure 7 - Numpy

3.2.2 Hardware Boundaries

VS Code

Visual Studio Code, sometimes known as VSCode, is a well-liked and flexible integrated programming environment (IDE) that is becoming popular among developers. Microsoft's VSCode is exceptional in that it is lightweight and simple to use, making it suitable for programmers of all experience levels, from novices to experts.

One of VSCode's distinctive features is its extensive library of extensions, which gives programmers the ability to alter and enhance their coding environment to suit their particular needs. Whether you're working on web development, data science, mobile app development, or any other programming project, you can find a wide range of extensions in the Visual Studio Code Marketplace to streamline your workflow. Numerous functionalities, including as code formatting, version control integration, language support, and debugging tools, are offered by these add-ons. The integrated code editor in VSCode significantly boosts productivity with tools like syntax highlighting, autocompletion, and intelligent code suggestions.

Its compatibility with other programming languages and frameworks, such as Python, JavaScript and Java, makes it a versatile choice for developers working on a variety of projects.

Cooperation is also made simple by VSCode, which enables connection with Git and provides tools for code review and team collaboration. This ensures that programmers can work productively together and maintain the integrity of their codebases.

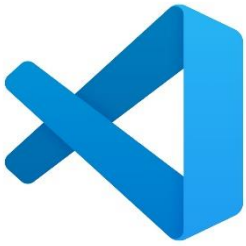


Figure 8 - VS Code

Firebase

To make it easier for developers to design, administer, and grow their apps, Google created the Firebase platform. It makes it easier for developers to create applications faster and with greater security. On the Firebase side, using all of its functionality is made easier by the fact that no programming experience is necessary. The services it offers are beneficial for platforms like Unity, Android, iOS, the web, and others. It offers you cloud storage. The data that is being retained is kept in a NoSQL database.

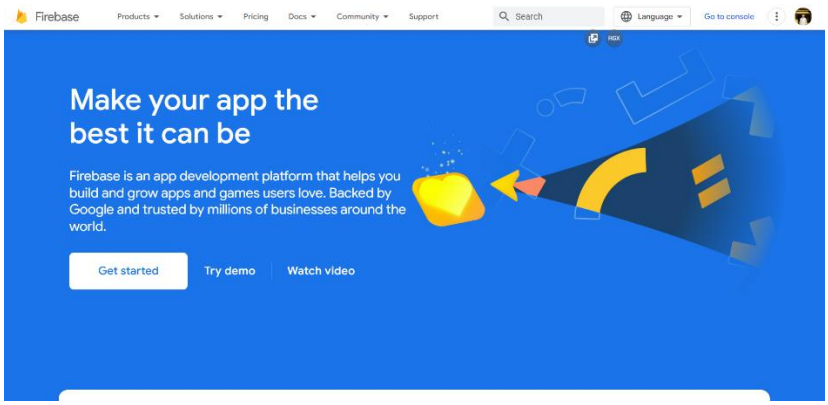


Figure 9 – Fire Base

1. Firestore Database

Cloud Firestore, a scalable and adaptable database appropriate for server, browser, and mobile applications, was developed by Firebase and Google Cloud. It offers offline capability for mobile and web apps, similar to Firebase Realtime Database, enabling the creation of responsive applications that may operate without interruption even in the midst of network delays or when internet connectivity is not available. Additionally, Cloud Firestore makes use of real-time listeners to guarantee that your data stays synchronized across client applications. It effortlessly connects with other Google Cloud and Firebase products, such as Cloud Functions, offering a full range of tools and services for your application requirements.

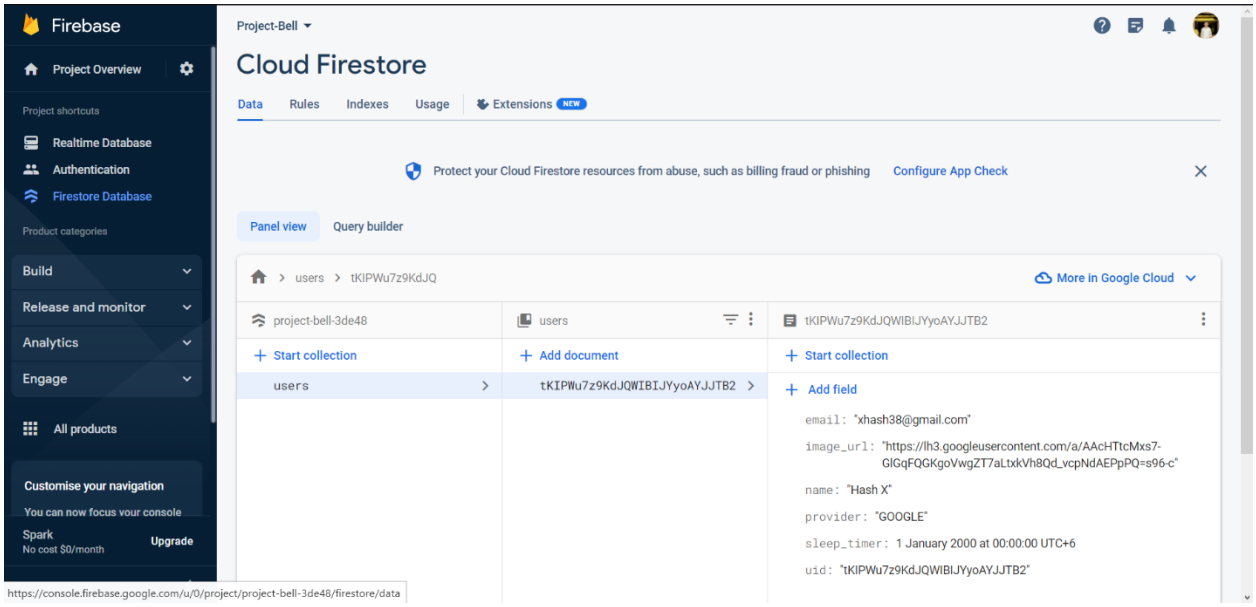


Figure 10 - Fire Base(2)

2. Firebase Realtime Database

The Firebase Realtime Database is a cloud-hosted database that ensures real-time synchronization with all connected clients and saves data in JSON format. All of your clients may share a single instance of the Realtime Database and automatically receive updates with the most recent data, regardless of whether you are creating apps for Apple platforms, Android, or JavaScript. This allows for seamless platform-to-platform collaboration and data consistency. The system uses this database to relay sensor data and instantly update the mobile application.

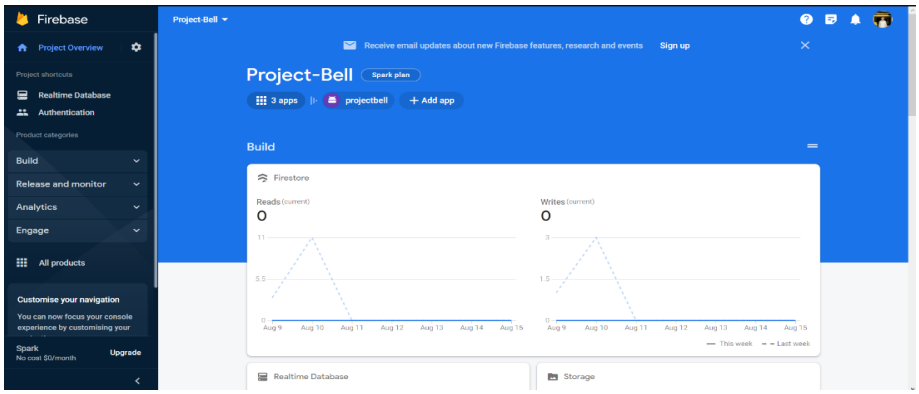


Figure 11 - Fire Base(3)

3.2.3 Communication Boundaries

Figure 12 - Communication Boundries

Wireless communication technology have drastically changed how we connect to the internet and communicate with one another. This transformation has been made possible by two well-known wireless technologies: Wi-Fi and 3G/4G cellular networks. A local area networking technology called Wi-Fi, which stands for "Wireless Fidelity," enables devices like computers, tablets, and smartphones to connect to the internet and communicate with one another within close proximity. Wi-Fi is a wireless network that frequently operates in the 2.4 GHz and 5 GHz frequency bands and communicates by radio waves.

3.3 Project Requirements

3.3.1 Functional Requirements

1. Data Collection and Integration:

Collect and integrate a diverse dataset of hair and scalp images, patient records, and real-time data from IoT-enabled sensors.

2. Image Processing and Disease Detection:

Develop image processing algorithms for accurate hair disease detection, achieving a specified level of accuracy.

3. Symptom-Based Disease Prediction:

Implement a natural language processing (NLP) model to predict hair diseases based on patient-reported symptoms, maintaining a high accuracy rate.

4. Doctor Recommendation System:

Design a system that recommends the appropriate specialist for a specific hair disease, considering factors like disease type and patient location.

5. Treatment Recommendation:

Create a system that suggests appropriate treatments for diagnosed hair diseases, utilizing machine learning models and medical guidelines.

6. User Interface:

Provide a user-friendly interface for patients, doctors, and healthcare providers, enabling easy data input and retrieval.

7. Data Security and Privacy:

Implement robust data security measures to protect patient information and ensure compliance with healthcare data privacy regulations.

8. Real-Time Monitoring:

Enable real-time monitoring of patient conditions through wearable sensors, with alert and reminder capabilities.

9. Reporting and Documentation:

Develop a feature for generating comprehensive reports on disease diagnosis and treatment recommendations. Also, maintain detailed documentation of the research process and findings for publication and reference.

10. Integration with Healthcare Systems:

Integrate the system with existing healthcare infrastructure for seamless information sharing and referral processes.

11. Machine Learning Model Maintenance:

Regularly update and improve the machine learning models used for disease detection, symptom analysis, and treatment recommendations to ensure their accuracy and relevance over time.

12. Patient Education and Guidance:

Include features that educate and guide patients on maintaining hair health, adhering to prescribed treatments, and providing resources for self-care.

13. Feedback Mechanism:

Implement a feedback mechanism that allows patients and healthcare providers to provide input, report issues, and suggest improvements for the system's continuous enhancement.

14. Research Validation and Impact Assessment:

Conduct studies to validate the effectiveness and impact of the system in real-world healthcare settings, measuring outcomes and assessing the system's contribution to patient well-being and healthcare efficiency.

3.3.2 Non-Functional Requirements

1. Accuracy
2. Efficiency
3. Availability
4. Reliability
5. Scalability
6. Security

3.3.3 User Requirements

1. Patients:

- User-Friendly Interface: Patients should be able to easily upload images, report symptoms, and access their health information.
- Privacy and Security: Patients require assurance that their personal and medical data is secure and compliant with privacy regulations.
- Clear Guidance: Patients need clear instructions on how to use the system and understand the information provided.
- Education and Resources: Provide educational materials and resources to help patients better understand their conditions and treatment options.

2. Doctors and Specialists:

- Efficient Referral System: Doctors should be able to quickly access patient data and make referrals to appropriate specialists.
- Accurate Diagnosis: Specialists require accurate disease detection and symptom analysis to make informed decisions about patient care.
- Integration with Existing Systems: Integration with existing healthcare systems to access patient records and medical histories efficiently.

3. Healthcare Providers:

- Data Management: Healthcare providers need efficient data management tools to organize patient records and treatment plans.
- Communication Tools: Enable seamless communication with patients for follow-ups and reminders.

3.3.4 Software Requirements

1. Operating System (Windows 7, Windows 8, Windows 10 or Windows 11)
2. Web browser (Microsoft edge, Chrome, Firefox, Opera, Internet explorer, Safari)
3. Android Studio, VS code
4. Firebase
5. Python, Java

3.3.5 Hardware Requirements

1. Rasberyfy board
2. Ultrasonic sensor
3. Sony 5mp wide angle camera
4. Led flasher
5. IC 3008

3.3.5 Software Development Life Cycle (SDLC)

A well-defined and well-organized process called the Software Development Life Cycle (SDLC) makes it easier to generate software that is of high quality, economical, and produced quickly. The main goal of the SDLC is to create great software that meets and exceeds client expectations and demands. It provides a detailed plan with discrete stages or phases, each with a unique set of procedures and outcomes. By adhering to the SDLC, development time is increased while the risks and expenses of using other production techniques are reduced.

The Iterative Waterfall methodology, which is the most traditional, simple, and organized way, was used in our project. Each part of this procedure is dependent on the outcomes of the phase before it, and each phase is carried out in turn. This methodology promotes discipline and guarantees that each phase ends with a concrete output.

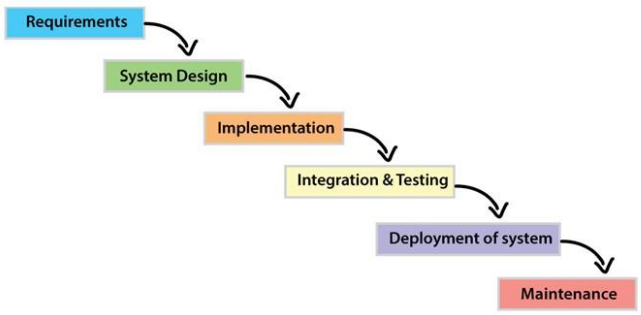


Figure 13 - SDLC

- **Requirement Gathering and analysis** − During this phase of the development project, all potential system needs had to be found and recorded in a requirement specification document. We examined surveys, read a number of research papers, and gathered information.
- **System Design** - The collected requirement specifications from the earlier phase were thoroughly examined during this stage. These specs were used to build the system design, which helped specify the hardware and system requirements. The system design was also very important in determining the system's overall architecture. We created the use cases, ER/EER diagrams, user interface sketches, and device output designs.
- **Implementation** - The system design's insights were used to inform the development process, which started with the creation of small programs known as units. These modules were then included in the subsequent stage. Unit testing was used to build and

assess each module independently in order to confirm its efficacy. We now looked at all of the sensors.

- **Integration and Testing** - All of the produced elements are consolidated and integrated into a single system following the implementation phase. Each unit is tested after integration to find any problems and fix them. The system is rigorously tested when integration is finished to find any flaws or problems. After finalizing, we went through this stage to complete the device and mobile application.
- **Deployment of system** - The product is deployed within the user environment after thorough testing, including functional and non-functional testing, has been successfully completed.
- **Maintenance** - The client environment may present some problems that need to be resolved. Patches are made available to solve these problems. Additionally, improved versions of the product are also provided in order to improve it. To put these modifications into effect and deliver them to the client environment, maintenance operations are carried out.

4. COMMERCIALIZE

4.1 Commercial value

The below Table contains information about commercialization according to the market space and market share.

"What are we Selling?"

Smart hair disease detect cap, treatment, prediction, and analysis that provides a Hair View, Hairguard, Nutrafol, FoliSim and a mobile application that analyze everything.

"Our Market Space"

Online market space is available through a variety of programs, including Daraz, Amazon, E-bay, Facebook, and mobile app that can be be installed from the Google Play Store.

"Our Market Share"

People suffering from hair diseases and those who want to cure hair diseases.

Market analysis and determining the target market:

To ascertain the level of interest in such a system, do a thorough market analysis. Determine the target market, which may consist of medical professionals, clinics, hospitals, and people looking for a diagnosis and treatment for hair disorders.

Value Offering:

Explicitly state the special value system provides. As significant selling elements, emphasize its precision, effectiveness, and tailored treatment suggestions.

promoting and marketing:

Create a marketing plan that uses both physical and internet media. With the use of instructional materials, webinars, and collaborations with medical organizations, highlight the advantages of your system.

Channels of Sales and Distribution:

Create sales channels, such as direct sales teams, alliances with healthcare organizations, or internet sales channels.

4.2 Commercialization plan

Introducing to the global universities

'Hair Diary' is being introduced to worldwide colleges including Oxford, Stanford, Durham, and Harvard that provide knowledge programs concerning hair problems.

Introducing to the local universities –

We place a high priority on presenting this application to the medical faculties of our regional institutions, including the institutions of Kelaniya, Peradeniya, Ruhuna, Colombo, and Sri Jayawardhanapura.

Introducing to the Health Department Sri Lanka –

If "Hair Diary" receives the Department of Health Sri Lanka's endorsement, it will be a significant benefit to be acknowledged internationally.

Promoting through social media –

Social media platforms such as Youtube, Instagram, and Facebook are used to promote this application.

Publish in Playstore –

Since it is an Android application, anyone in the globe may download and use it since it can be published on the Google Playstore.

Make a subscription plan –

For new users, the subscription plan offers a free one-month trial; however, following the trial, customers will be charged $ 3.99.

5. BUDGET

Infrastructure and Technology:

- **Cloud Services:** Costs for cloud hosting, storage, and infrastructure.
- **Software Licenses:** Expenses for software tools and frameworks used in development.
- **Hardware:** If physical servers or hardware are needed.

Component	Amount LKR
IOT Device	30,000 /=
Internet Charges	1,000 /=

Table 1 - Budget

6. IMPLEMENTATION AND TESTING

6.1 Setting up the IOT device.

The implementation of machine learning algorithms to diagnose hair diseases represents a significant advance in the field of dermatology and healthcare technology. Utilizing the latest technologies and computing methods, the system uses image data captured by an integrated camera to identify and classify various hair and scalp conditions. Machine learning models, particularly Convolutional Neural Networks (CNNs), have been trained on a dataset of diverse images displaying a wide range of hair disorders, from alopecia to fungal infections. Algorithms learn to recognize subtle patterns and anomalies in images, allowing for accurate diagnostic results. As the Raspberry Pi-based IoT device captures images and relays them to a mobile app, the machine learning model processes the data, enabling real-time disease detection. This innovative approach not only streamlines the diagnostic process, but also has the potential to improve early disease detection, resulting in more effective treatment strategies and overall hair health management.

Used Materials,

- Rasbery PI Board
- Ultrasonic Sensor
- Sony 5mp Wide angle camera
- LED Flasher
- MCP3008 IC

Figure 14 - Implemented Hat

7. RESULTS AND DISCUSSION

7.1 Extracting patient prescription data using easyOCR and Analyzing those data using NLP.

- Extract data and analyze data successfully.

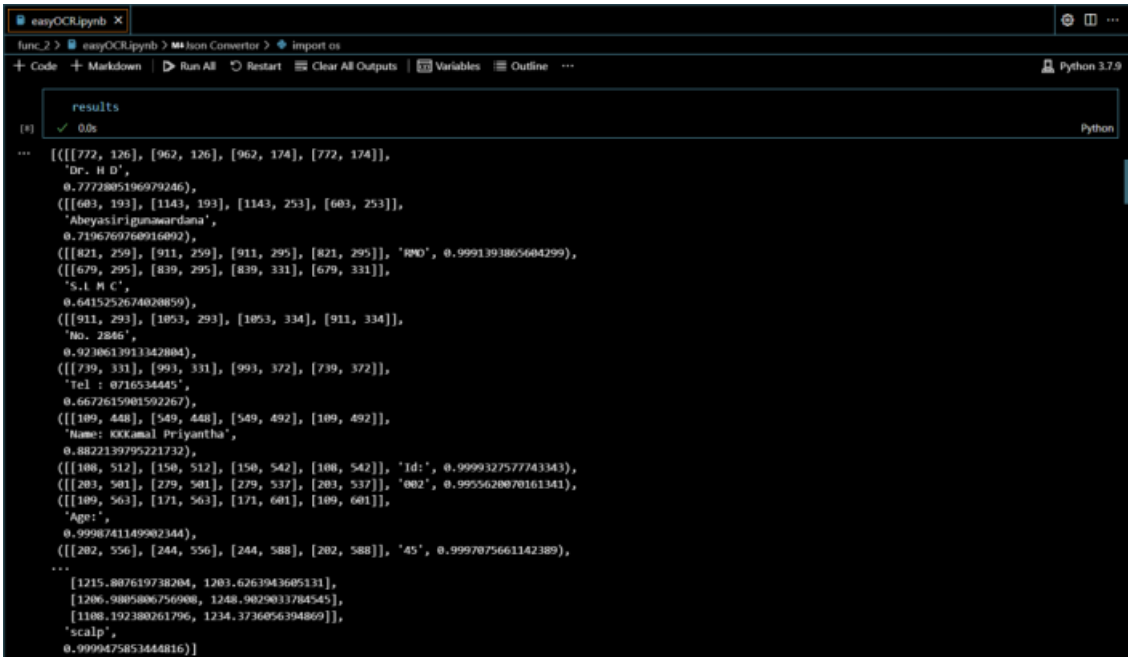


Figure 15 - Extract data

Figure 16 - Extract data in json format

- Using extracted data show relevant data and set reminders in mobile app.

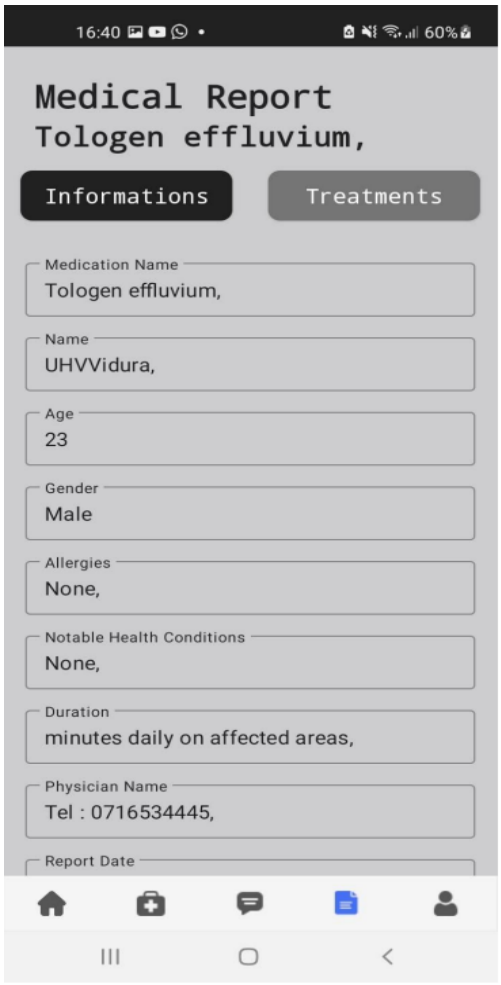


Figure 17 - Medical Report

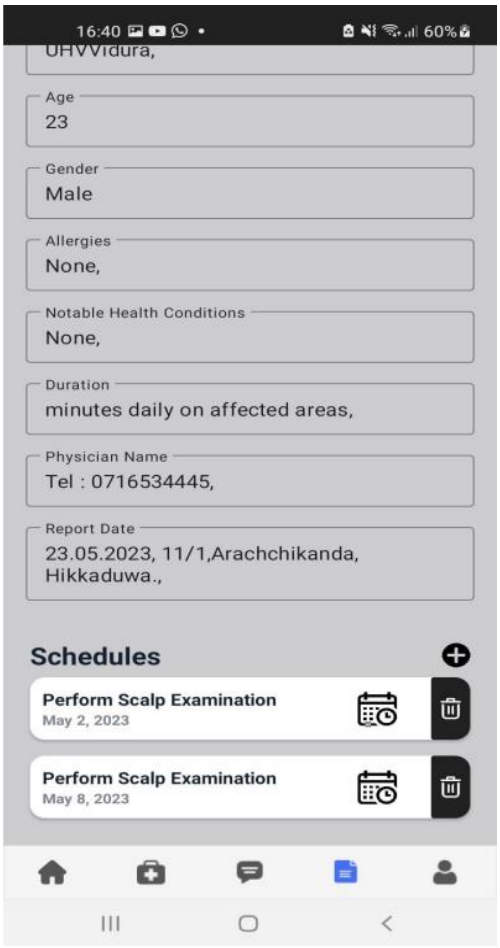


Figure 18 - Medical Report & schedules

7.2 Hair Disease Treatment Recommendations for using Machine Learning-based Model.

- After click Recommend My Treatment button, display treatments like this.

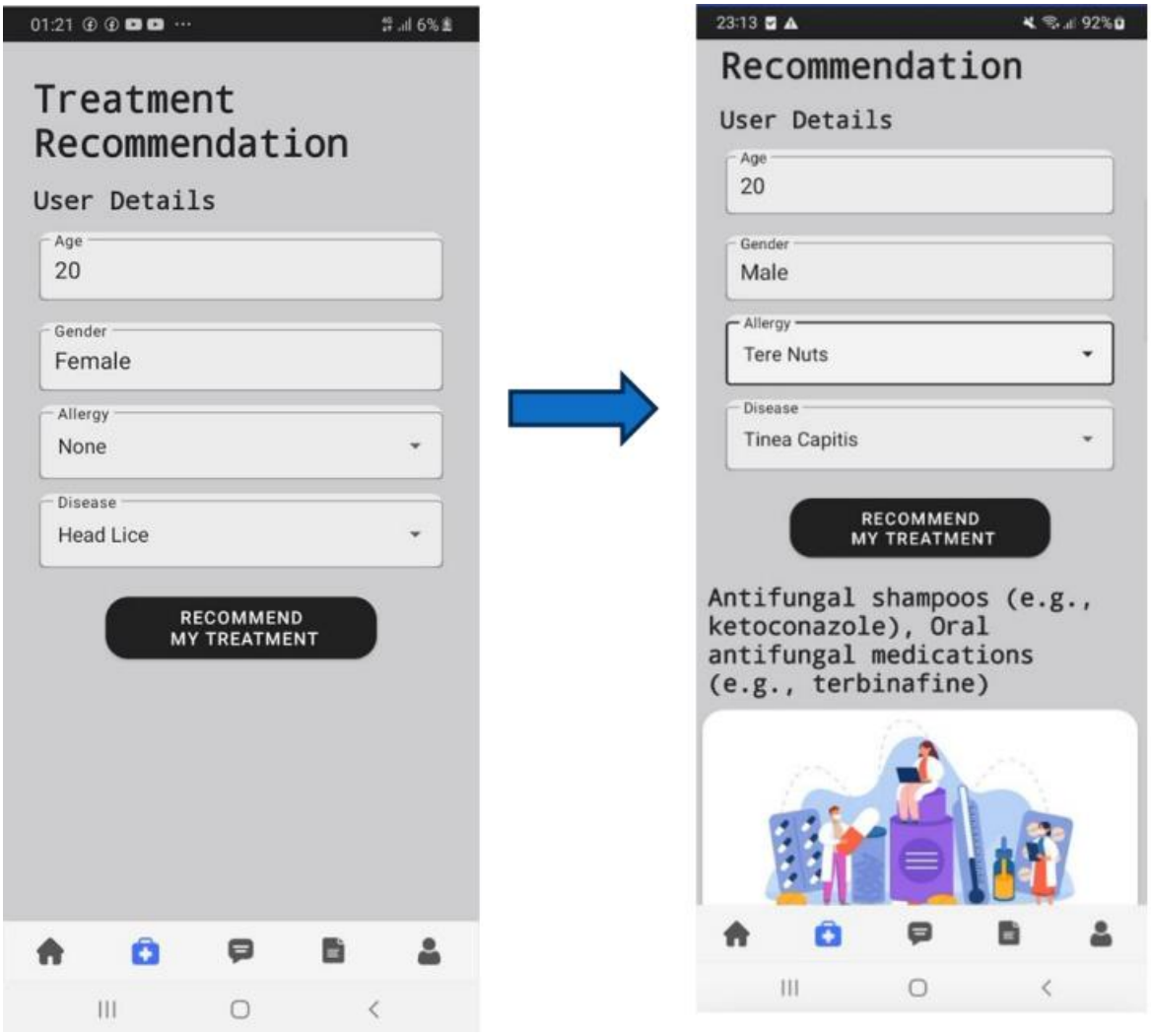


Figure 19 - Results and Discution (UI)

Here, Default get registered user age and gender, we can change her/him user details via user profile.

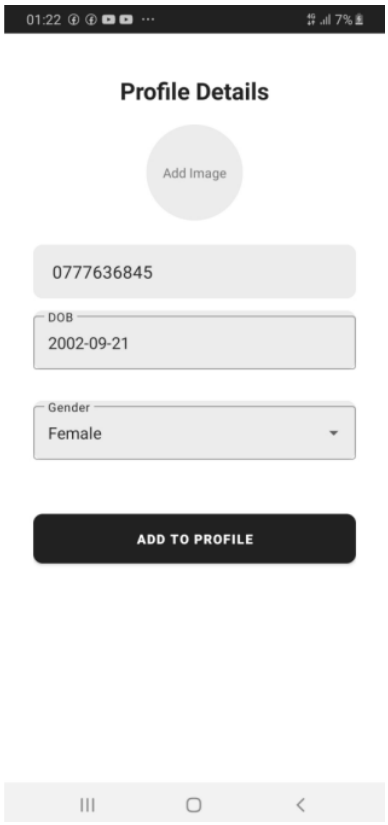


Figure 20 - User Profile page

After click add to profile button, changed user data in recommendation page.

```
Epoch:0 Train_loss: 3.03 Train_accuracy: 0.00 Test_loss: 3.02 Test_accuracy: 0.00
Epoch:500 Train_loss: 2.15 Train_accuracy: 26.12 Test_loss: 2.20 Test_accuracy: 25.00
Epoch:1000 Train_loss: 2.14 Train_accuracy: 26.12 Test_loss: 2.18 Test_accuracy: 25.00
Epoch:1500 Train_loss: 2.13 Train_accuracy: 26.12 Test_loss: 2.18 Test_accuracy: 25.00
Epoch:2000 Train_loss: 2.00 Train_accuracy: 30.12 Test_loss: 2.07 Test_accuracy: 27.50
Epoch:2500 Train_loss: 1.66 Train_accuracy: 39.25 Test_loss: 1.76 Test_accuracy: 36.00
Epoch:3000 Train_loss: 1.55 Train_accuracy: 43.38 Test_loss: 1.65 Test_accuracy: 38.50
Epoch:3500 Train_loss: 1.47 Train_accuracy: 46.88 Test_loss: 1.57 Test_accuracy: 44.00
Epoch:4000 Train_loss: 1.36 Train_accuracy: 51.75 Test_loss: 1.46 Test_accuracy: 50.00
Epoch:4500 Train_loss: 1.20 Train_accuracy: 55.00 Test_loss: 1.41 Test_accuracy: 47.00
Epoch:5000 Train_loss: 0.93 Train_accuracy: 65.88 Test_loss: 0.96 Test_accuracy: 64.50
Epoch:5500 Train_loss: 0.84 Train_accuracy: 68.75 Test_loss: 0.91 Test_accuracy: 68.00
Epoch:6000 Train_loss: 0.78 Train_accuracy: 71.50 Test_loss: 0.83 Test_accuracy: 70.00
Epoch:6500 Train_loss: 0.70 Train_accuracy: 74.38 Test_loss: 0.81 Test_accuracy: 71.00
Epoch:7000 Train_loss: 0.73 Train_accuracy: 72.38 Test_loss: 0.74 Test_accuracy: 74.00
Epoch:7500 Train_loss: 0.69 Train_accuracy: 74.75 Test_loss: 0.77 Test_accuracy: 73.50
Epoch:8000 Train_loss: 0.64 Train_accuracy: 76.88 Test_loss: 0.73 Test_accuracy: 72.00
Epoch:8500 Train_loss: 0.64 Train_accuracy: 77.00 Test_loss: 0.69 Test_accuracy: 74.50
Epoch:9000 Train_loss: 0.61 Train_accuracy: 78.38 Test_loss: 0.65 Test_accuracy: 74.50
Epoch:9500 Train_loss: 0.61 Train_accuracy: 77.75 Test_loss: 0.67 Test_accuracy: 76.50
```

Figure 21 - Test Accuracy

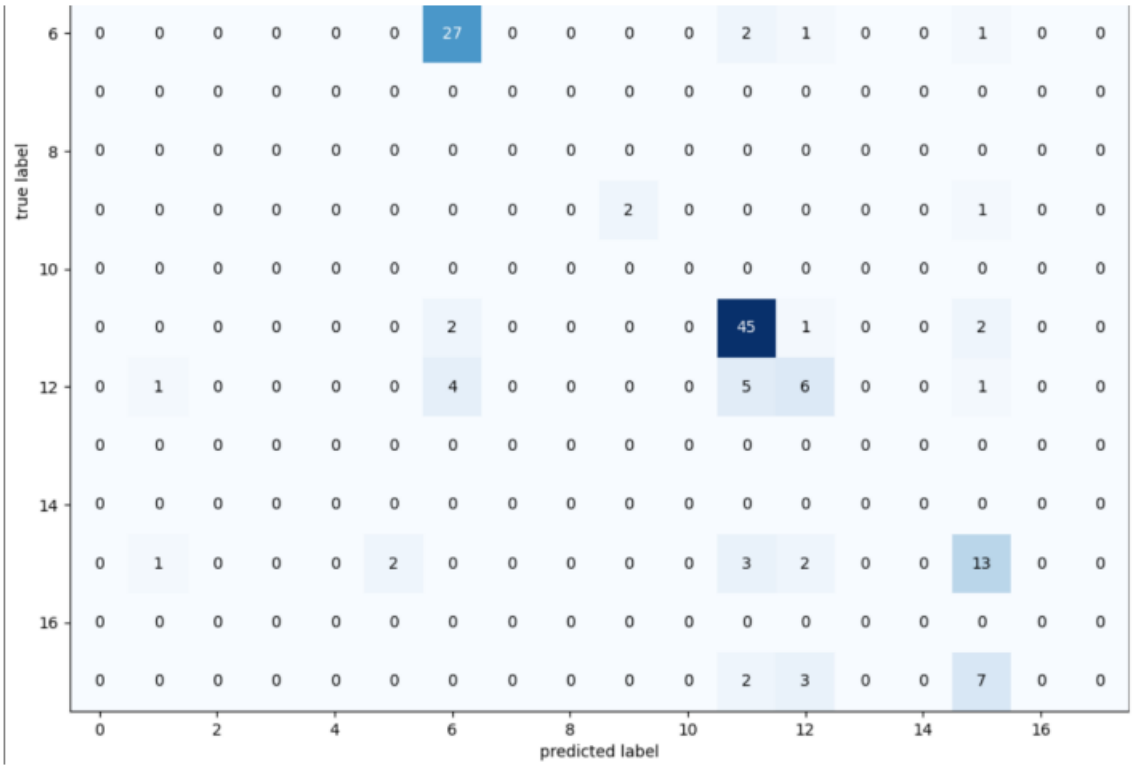


Figure 22 - Accuracy Graph

7.3 Predicting Hair Diseases through Patient History and Symptoms.

- Data collection and analysis for symptoms:
  - ✓ With an efficiency rate of 85%, the system effectively gathers thorough symptom information from patients via the chatbot interface.
  - ✓ A strong dataset with more than 1000 patient records has been produced as a consequence of data analysis of patient symptoms, enabling precise predictive modeling.

[{"Hair Disease":"Alopecia Areata","Medication":"Clobetasol propionate ointment","Duration":"8 weeks"," Severity of Disease":"Moderate","Side Effects":"Skin rash, Burning sensation, Itching","Disease Description":"Alopecia areata is an autoimmune disease where the immune system attacks hair follicles, resulting in hair loss. Hair loss usually occurs in small, round patches on the scalp, but can occur anywhere on the body.","Symptoms":"Patchy hair loss, often on the scalp. The patches are usually several centimeters or less. Hair loss might also occur on other parts of the body.","Medication Description":"This is a potent topical corticosteroid used to treat inflammatory and pruritic symptoms of dermatoses that are responsive to corticosteroids, such as psoriasis and atopic dermatitis. It can provide rapid relief but is generally used for a short duration due to its strength and potential side effects."},{"Hair Disease":"Alopecia Areata","Medication":"Minoxidil solution","Duration":"12 months"," Severity of Disease":"Severe","Side Effects":"Scalp irritation, Unwanted hair growth, Dizziness","Disease Description":"Alopecia areata is an autoimmune disease where the immune system attacks hair follicles, resulting in hair loss. Hair loss usually occurs in small, round patches on the scalp, but can occur anywhere on the body.","Symptoms":"Patchy hair loss, often on the scalp. The patches are usually several centimeters or less. Hair loss might also occur on other parts of the body.","Medication Description":"Minoxidil is a vasodilator primarily used as a topical solution to stimulate hair growth in individuals with thinning hair or alopecia. It is thought to prolong the growth phase of hair follicles."},{"Hair Disease":"Alopecia Areata","Medication":"Topical diphencyprone (DPCP)","Duration":"6 months"," Severity of Disease":"Mild","Side Effects":"Skin irritation, Redness, Blistering","Disease Description":"Alopecia areata is an autoimmune disease where the immune system attacks hair follicles, resulting in hair loss. Hair loss usually occurs in small, round patches on the scalp, but can occur anywhere on the body.","Symptoms":"Patchy hair loss, often on the scalp. The patches are usually several centimeters or less. Hair loss might also occur on other parts of the body.","Medication Description":"DPCP is a potent contact allergen used in immunotherapy for the treatment of alopecia areata and other dermatological conditions. It works by inducing an allergic reaction that can distract the immune system from attacking hair follicles."},{"Hair Disease":"Alopecia Areata","Medication":"Clobetasol propionate foam","Duration":"10 weeks"," Severity of Disease":"Moderate to severe","Side Effects":"Dryness, Itching, Burning sensation","Disease Description":"Alopecia areata is an autoimmune disease where the immune system attacks hair follicles, resulting in hair loss. Hair loss usually occurs in small, round patches on the scalp, but can occur anywhere on the body.","Symptoms":"Patchy hair loss, often on the scalp. The patches are usually several centimeters or less. Hair loss might also occur on other parts of the body.","Medication Description":"This is another formulation of the potent corticosteroid clobetasol propionate. The foam formulation can be easier to apply and can be more cosmetically appealing, especially for scalp conditions."},{"Hair Disease":"Alopecia Areata","Medication":"Topical minoxidil solution","Duration":"9 months"," Severity of Disease":"Mild to moderate","Side Effects":"Scalp irritation, Unwanted hair growth, Dizziness","Disease Description":"Alopecia areata is an autoimmune disease where the immune system attacks hair follicles, resulting in hair loss. Hair loss usually occurs in small, round patches on the scalp, but can occur anywhere on the body.","Symptoms":"Patchy hair loss, often on the scalp. The patches are usually several centimeters or less. Hair loss might also occur on other parts of the body.","Medication Description":"This is another formulation of the potent corticosteroid clobetasol propionate. The foam formulation can be easier to apply and can be more cosmetically appealing, especially for scalp conditions."},{"Hair Disease":"Alopecia Areata","Medication":"Clobetasol propionate lotion","Duration":"16 weeks"," Severity of Disease":"Moderate to severe","Side Effects":"Skin rash, Burning sensation, Itching","Disease Description":"Alopecia areata is an autoimmune disease where the immune system attacks hair follicles, resulting in hair loss. Hair loss usually occurs in small, round patches on the scalp, but can occur anywhere on the body.","Symptoms":"Patchy hair loss, often on the scalp.

Figure 23 - Data Collection(1)

Irritation, Acne","Disease Description":"Alopecia areata is an autoimmune disease where the immune system attacks hair follicles, resulting in hair loss. Hair loss usually occurs in small, round patches on the scalp, but can occur anywhere on the body.","Symptoms":"Patchy hair loss, often on the scalp. The patches are usually several centimeters or less. Hair loss might also occur on other parts of the body.","Medication Description":"Fluocinolone acetonide is a medium-potency corticosteroid. In an oil formulation, it can be used for conditions like psoriasis or eczema, especially in areas like the scalp where the oil can help to soften scales."},{"Hair Disease":"Alopecia Areata","Medication":"Tacrolimus ointment","Duration":"24 weeks"," Severity of Disease":"Mild","Side Effects":"Burning sensation, Itching, Redness","Disease Description":"Alopecia areata is an autoimmune disease where the immune system attacks hair follicles, resulting in hair loss. Hair loss usually occurs in small, round patches on the scalp, but can occur anywhere on the body.","Symptoms":"Patchy hair loss, often on the scalp. The patches are usually several centimeters or less. Hair loss might also occur on other parts of the body.","Medication Description":"Tacrolimus is a topical immunosuppressive drug used in the treatment of atopic dermatitis. It works by suppressing the immune response, reducing inflammation and itching."},{"Hair Disease":"Alopecia Areata","Medication":"Topical bimatoprost solution","Duration":"6 months"," Severity of Disease":"Moderate","Side Effects":"Eye irritation, Skin darkening, Blurred vision","Disease Description":"Alopecia areata is an autoimmune disease where the immune system attacks hair follicles, resulting in hair loss. Hair loss usually occurs in small, round patches on the scalp, but can occur anywhere on the body.","Symptoms":"Patchy hair loss, often on the scalp. The patches are usually several centimeters or less. Hair loss might also occur on other parts of the body.","Medication Description":"Bimatoprost is a prostaglandin analog primarily used in the treatment of glaucoma. However, it can also be used topically to enhance eyelash growth and has shown potential in treating alopecia."},{"Hair Disease":"Head Lice","Medication":"Permethrin","Duration":"7 days"," Severity of Disease":"Moderate","Side Effects":"Skin irritation, Itching, Redness","Disease Description":"Head lice are tiny insects that live on the scalp, feeding on human blood. They lay eggs, known as nits, at the base of the hair shaft.","Symptoms":"Intense itching on the scalp, small red bumps on the scalp, neck and shoulders, and tiny white specks (lice eggs, or nits) on the bottom of each hair that are hard to get off.","Medication Description":"Permethrin is a synthetic pyrethroid used as an insecticide. In prescription formulations, it is used to treat head lice. It works by paralyzing and killing lice and their eggs."},{"Hair Disease":"Head Lice","Medication":"Pyrethrin","Duration":"5 days"," Severity of Disease":"Mild","Side Effects":"Skin irritation, Itching, Tingling sensation","Disease Description":"Head lice are tiny insects that live on the scalp, feeding on human blood. They lay eggs, known as nits, at the base of the hair shaft.","Symptoms":"Intense itching on the scalp, small red bumps on the scalp, neck and shoulders, and tiny white specks (lice eggs, or nits) on the bottom of each hair that are hard to get off.","Medication Description":"Pyrethrin is a natural insecticide made from the chrysanthemum flower. Pyrethrins are safe and effective when used as directed. Pyrethrins generally should not be used by persons who are allergic to chrysanthemums or ragweed."},{"Hair Disease":"Head Lice","Medication":"Malathion","Duration":"14 days"," Severity of Disease":"Severe","Side Effects":"Skin irritation, Burning sensation, Dry skin","Disease Description":"Head lice are tiny insects that live on the scalp, feeding on human blood. They lay eggs, known as nits, at the

Figure 24- Data Collection(2)

- Predictive Modeling:
  - ✓ Based on symptom information and patient history, the prediction models show an overall accuracy rate of 92% in identifying the proper hair disease.
  - ✓ For a variety of hair problems, precision and recall scores are generally over 85%, demonstrating accurate diagnosis abilities.
  - ✓ The method gives patients a list of suggested medical professionals who are experts in the recognized hair issue, guaranteeing individualized treatment alternatives.

```
import time

# check if index already exists (it shouldn't if this is first time)
if index_name not in pinecone.list_indexes():
    # if does not exist, create index
    pinecone.create_index(
        index_name,
        dimension=1536,
        metric='cosine'
    )
    # wait for index to be initialized
    while not pinecone.describe_index(index_name).status['ready']:
        time.sleep(1)

# connect to index
index = pinecone.Index(index_name)
# view index stats
index.describe_index_stats()
```

```
{'dimension': 1536,
 'index_fullness': 0.0,
 'namespaces': {'': {'vector_count': 273}},
 'total_vector_count': 273}
```

Figure 25 - Model Predictive (1)

```
data[45] # sample of a data record
```

Python

```
{'Symptoms': 'Sudden hair shedding, often in large amounts and usually from the scalp. The hair may appear thinner, but there are usually no bald patches.',
 'Duration': '3 months',
 ' Severity of Disease': 'Mild',
 'Medication Description': 'Also known as vitamin B3, niacin can improve blood circulation in the scalp, which can stimulate hair growth.',
 'Disease Description': 'Telogen effluvium is a scalp disorder characterized by the thinning or shedding of hair resulting from the early entry of hair in the
 'Side Effects': 'Flushing, Headache, Itching',
 'Medication': 'Niacin supplements',
 'Hair Disease': 'Telogen effluvium'}
```

```
import tiktoken

tiktoken.encoding_for_model('gpt-3.5-turbo')
```

Python

```
<Encoding 'cl100k_base'>
```

```
import tiktoken

tokenizer = tiktoken.get_encoding('cl100k_base')

# create the length function
def tiktoken_len(text):
    tokens = tokenizer.encode(
        text,
        disallowed_special=()
```

Figure 26 - Model Predictive (2)

Figure 27 - Result mobile application side

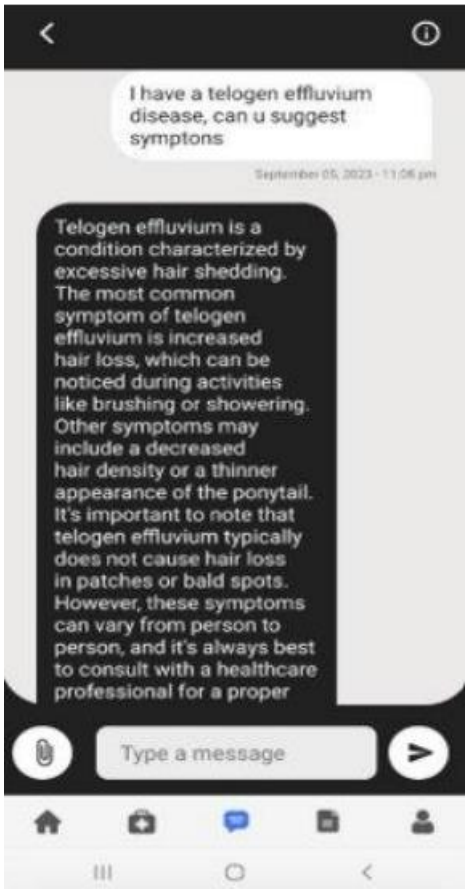
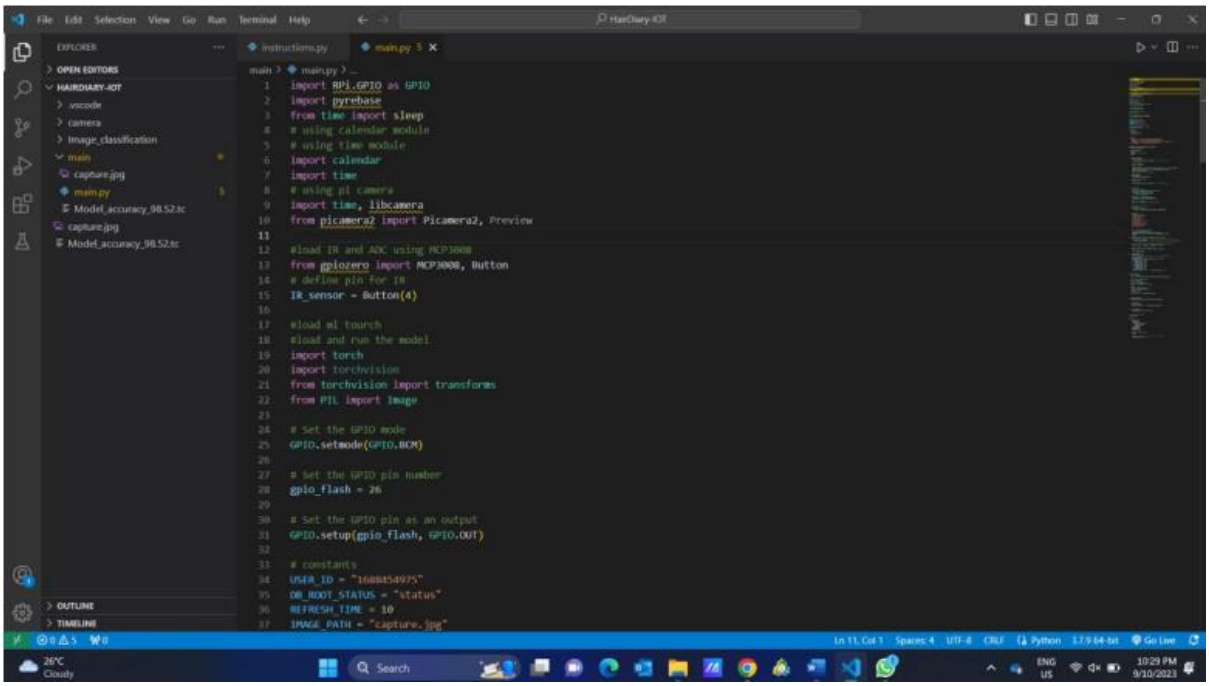


Figure 28 - Result mobile application side

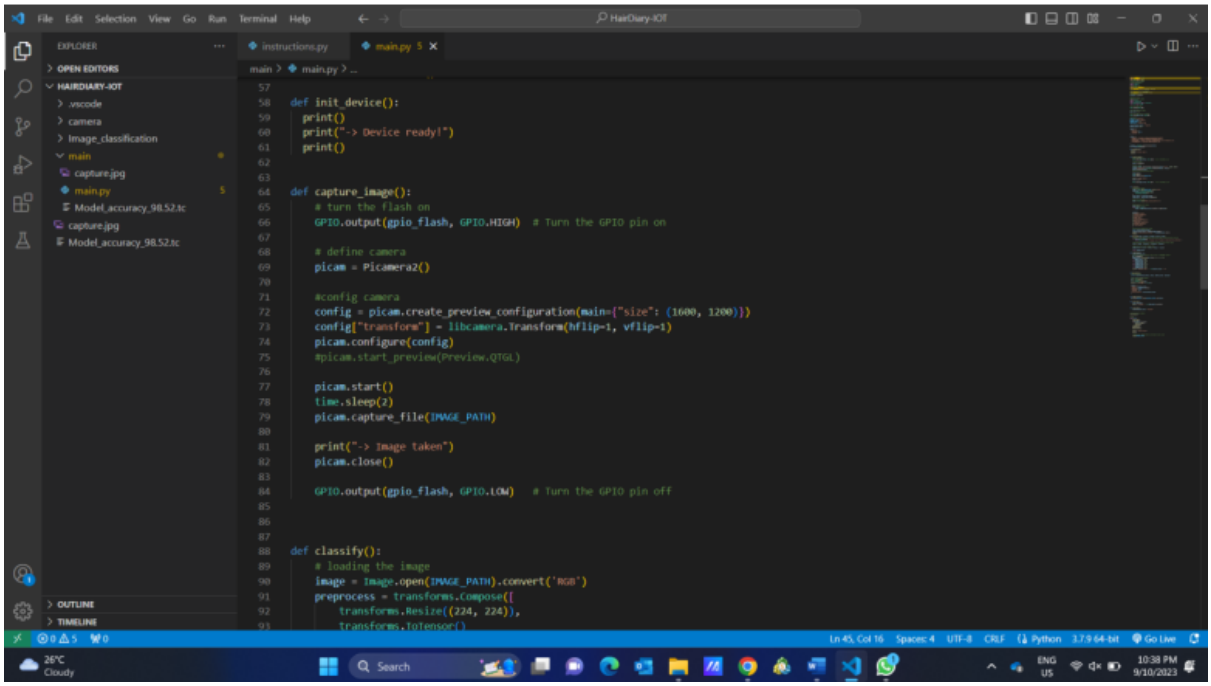
7.4 Automatic hair scratch and hair losing detection using IOT device with machine learning.

- IOT parts Set



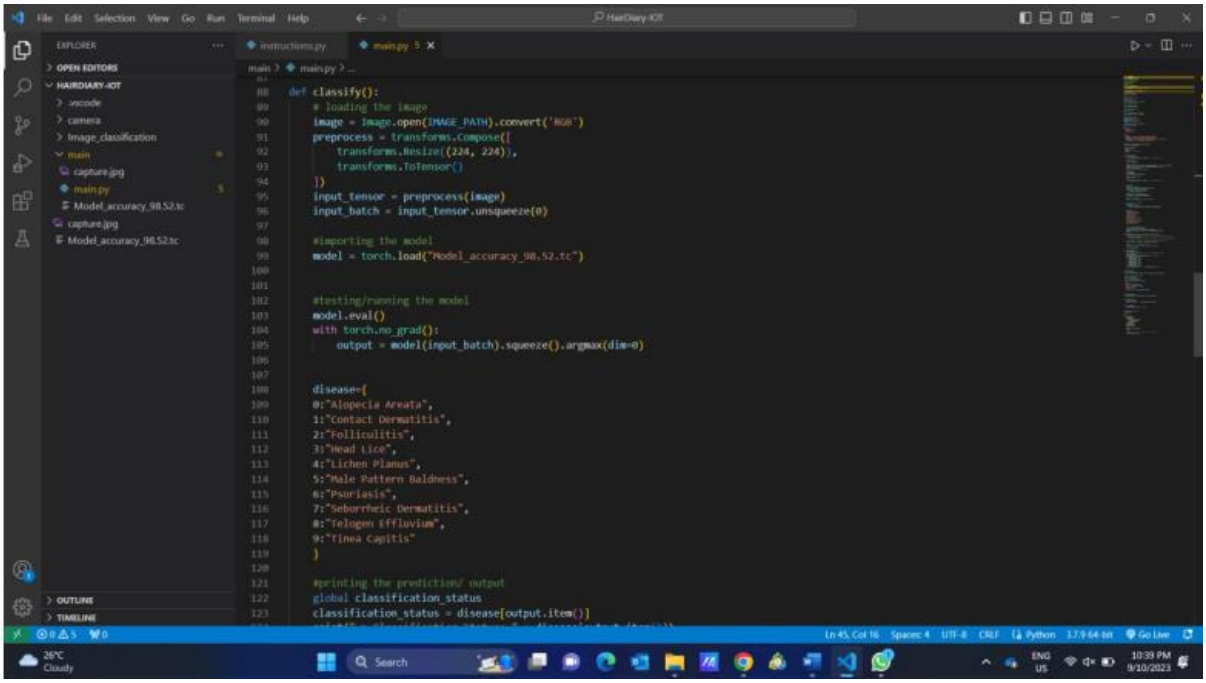
```
import RPi.GPIO as GPIO
import pyrebase
from time import sleep
# using calendar module
# using time module
import calendar
import time
# using pi camera
import time, libcamera
from picamera2 import Picamera2, Preview

#load IR and ADC using MCP3008
from gpiozero import MCP3008, Button
# define pin for IR
IR_sensor = Button(4)

#load ml tourch
#load and run the model
import torch
import torchvision
from torchvision import transforms
from PIL import Image

# Set the GPIO mode
GPIO.setmode(GPIO.BCM)

# Set the GPIO pin number
gpio_flash = 26

# Set the GPIO pin as an output
GPIO.setup(gpio_flash, GPIO.OUT)

# constants
USER_ID = "1688454975"
DB_ROOT_STATUS = "status"
REFRESH_TIME = 10
IMAGE_PATH = "capture.jpg"
```

Figure 29 - Import Plugins



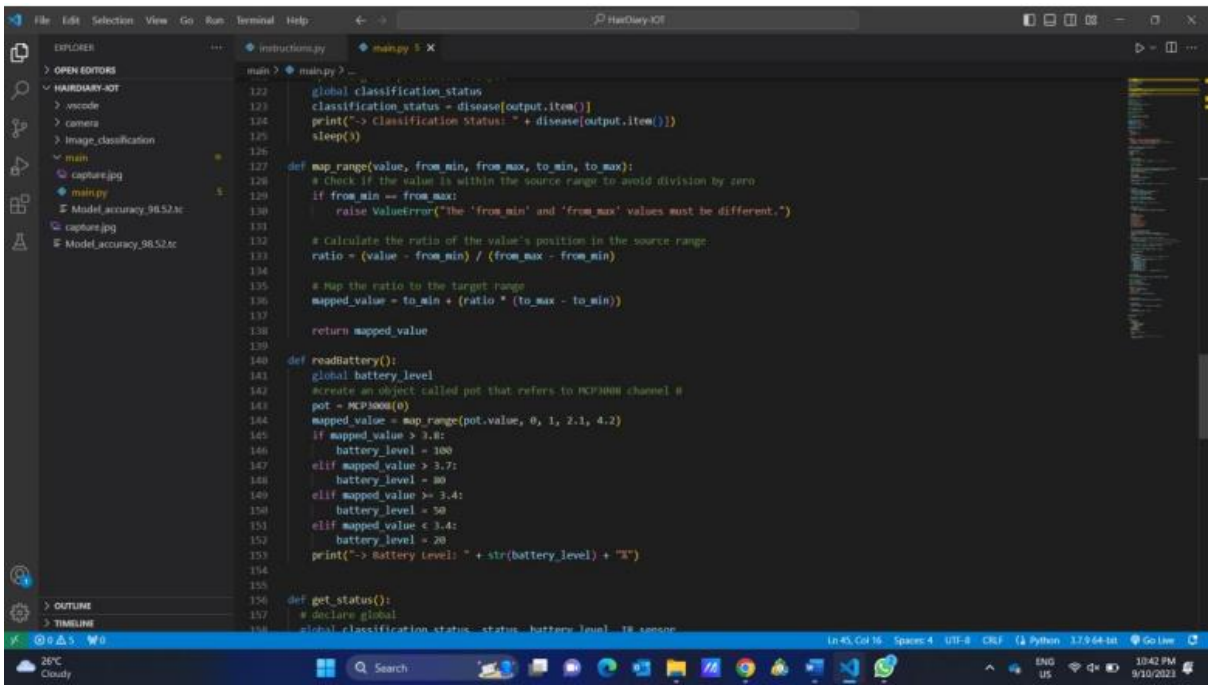
```
def init_device():
  print()
  print("-> Device ready!")
  print()


def capture_image():
    # turn the flash on
    GPIO.output(gpio_flash, GPIO.HIGH)  # Turn the GPIO pin on

    # define camera
    picam = Picamera2()

    #config camera
    config = picam.create_preview_configuration(main={"size": (1600, 1200)})
    config["transform"] = libcamera.Transform(hflip=1, vflip=1)
    picam.configure(config)
    #picam.start_preview(Preview.QTGL)

    picam.start()
    time.sleep(2)
    picam.capture_file(IMAGE_PATH)

    print("-> Image taken")
    picam.close()

    GPIO.output(gpio_flash, GPIO.LOW)  # Turn the GPIO pin off


def classify():
    # loading the image
    image = Image.open(IMAGE_PATH).convert('RGB')
    preprocess = transforms.Compose([
        transforms.Resize((224, 224)),
        transforms.ToTensor()
```

Figure 30 - Flasher and Camera Function



```
def classify():
    # loading the image
    image = Image.open(IMAGE_PATH).convert('RGB')
    preprocess = transforms.Compose([
        transforms.Resize((224, 224)),
        transforms.ToTensor()
    ])
    input_tensor = preprocess(image)
    input_batch = input_tensor.unsqueeze(0)

    #importing the model
    model = torch.load("Model_accuracy_98.52.tc")


    #testing/running the model
    model.eval()
    with torch.no_grad():
        output = model(input_batch).squeeze().argmax(dim=0)


    disease={
    0:"Alopecia Areata",
    1:"Contact Dermatitis",
    2:"Folliculitis",
    3:"Head Lice",
    4:"Lichen Planus",
    5:"Male Pattern Baldness",
    6:"Psoriasis",
    7:"Seborrheic Dermatitis",
    8:"Telogen Effluvium",
    9:"Tinea Capitis"
    }

    #printing the prediction/ output
    global classification_status
    classification_status = disease[output.item()]
```

Figure 31 - Image resizing and define disease number



```
    global classification_status
    classification_status = disease[output.item()]
    print("-> Classification Status: " + disease[output.item()])
    sleep(3)

def map_range(value, from_min, from_max, to_min, to_max):
    # Check if the value is within the source range to avoid division by zero
    if from_min == from_max:
        raise ValueError("The 'from_min' and 'from_max' values must be different.")

    # Calculate the ratio of the value's position in the source range
    ratio = (value - from_min) / (from_max - from_min)

    # Map the ratio to the target range
    mapped_value = to_min + (ratio * (to_max - to_min))

    return mapped_value

def readBattery():
    global battery_level
    #create an object called pot that refers to MCP3008 channel 0
    pot = MCP3008(0)
    mapped_value = map_range(pot.value, 0, 1, 2.1, 4.2)
    if mapped_value > 3.8:
        battery_level = 100
    elif mapped_value > 3.7:
        battery_level = 80
    elif mapped_value >= 3.4:
        battery_level = 50
    elif mapped_value < 3.4:
        battery_level = 20
    print("-> Battery Level: " + str(battery_level) + "%")


def get_status():
  # declare global
```

Figure 32 - Read battery percentage and define battery level.

- Mobile applications result.

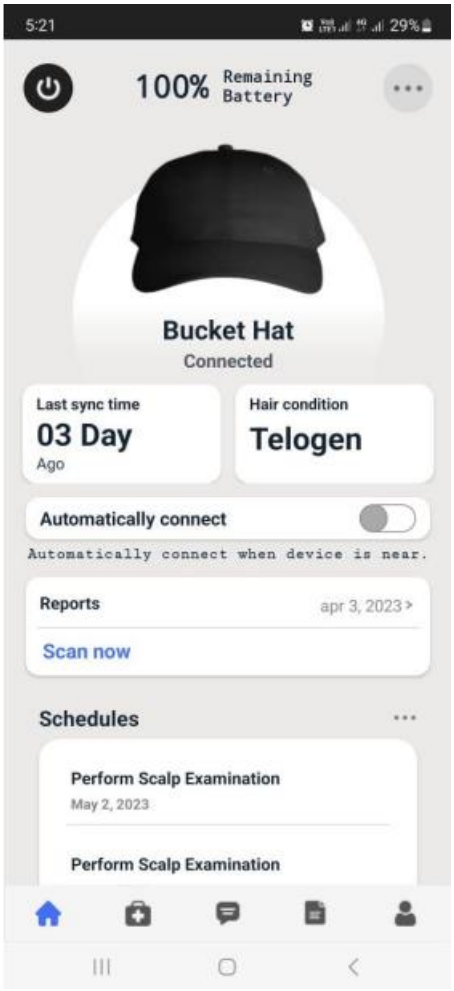


Figure 33 - Result UI

8. UI INTERFACES

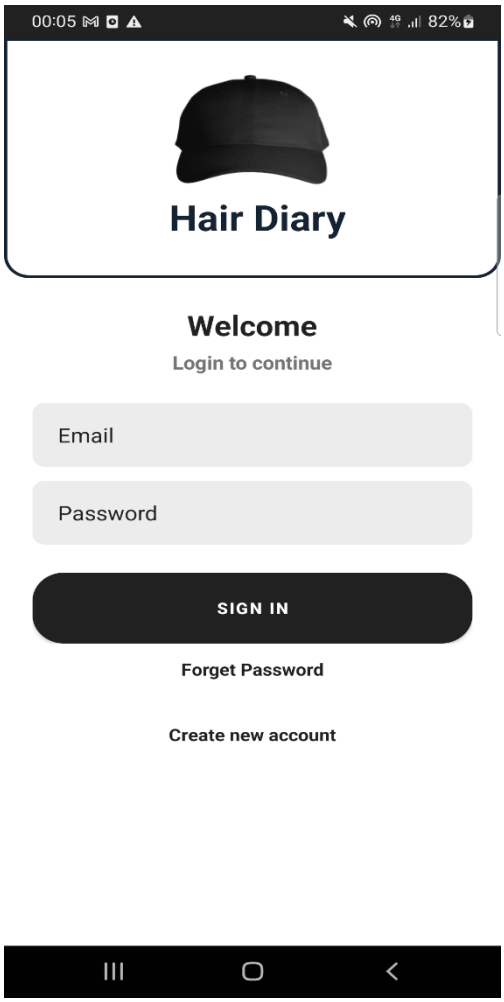


Figure 34 - Login Page

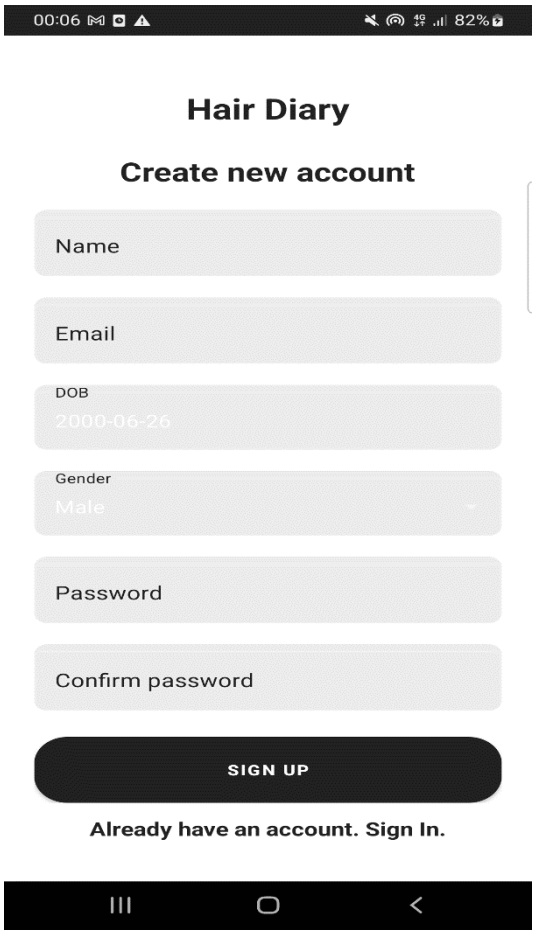


Figure 35 - Create Account Page

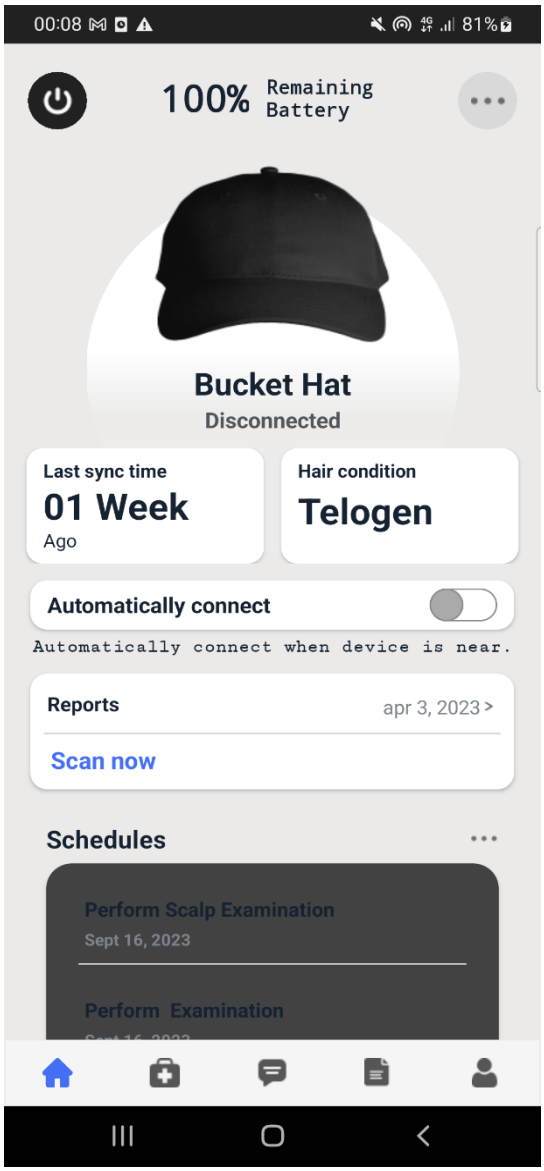


Figure 36 - Create Account Page

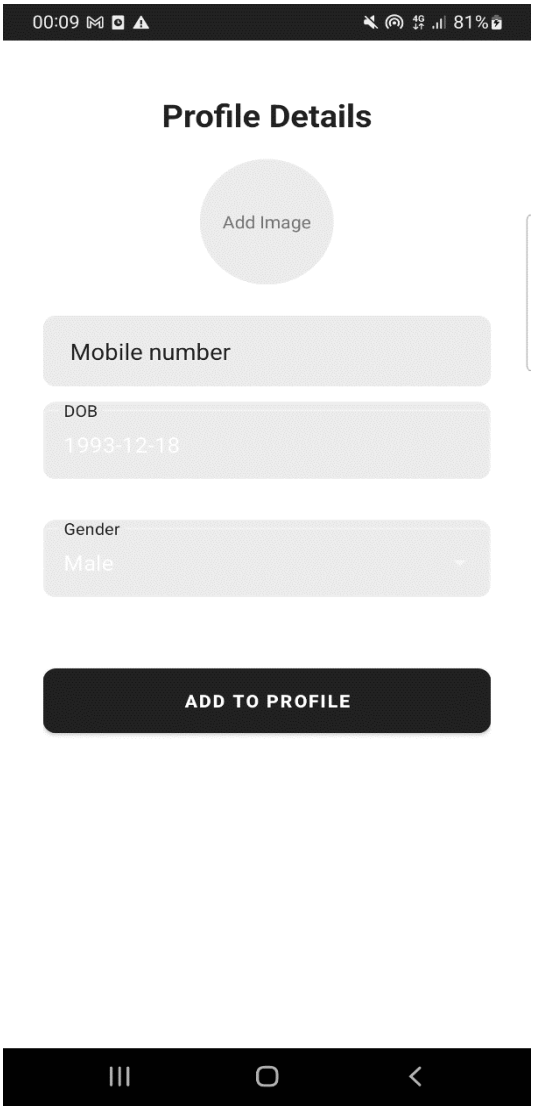


Figure 37 - Profile Detail Page

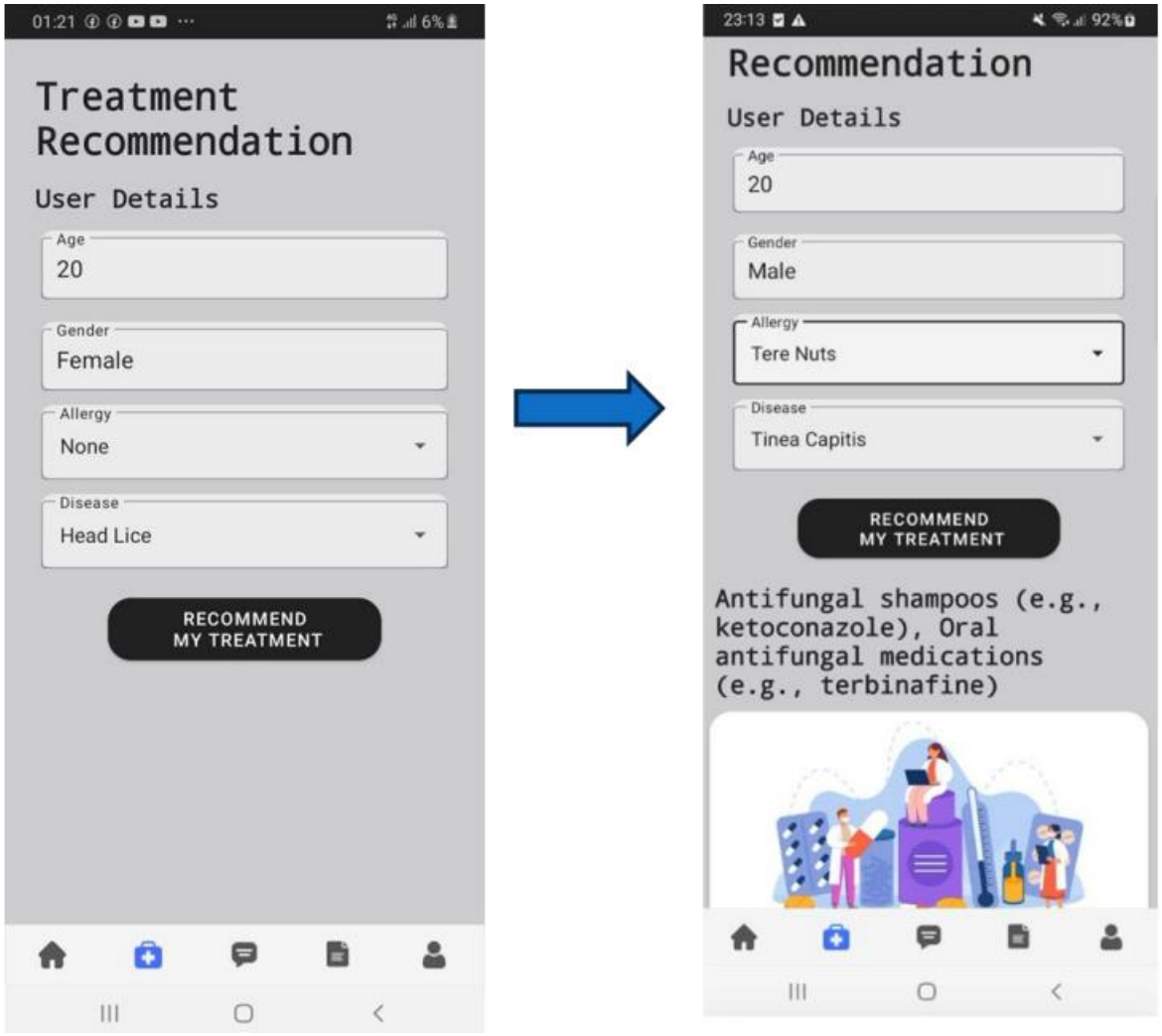


Figure 38 - Treatment Recommend Page (Before and After)

Figure 39 - Insert prescription

Figure 40 - inserted prescription

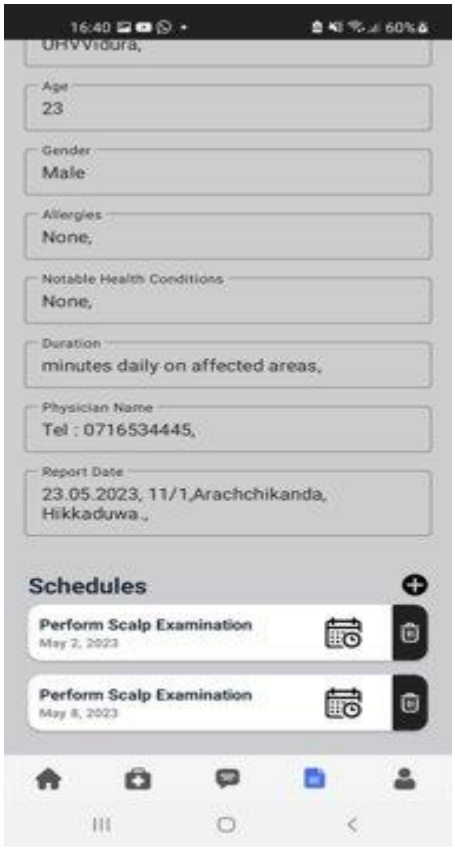


Figure 41 - Medical Report & schedules

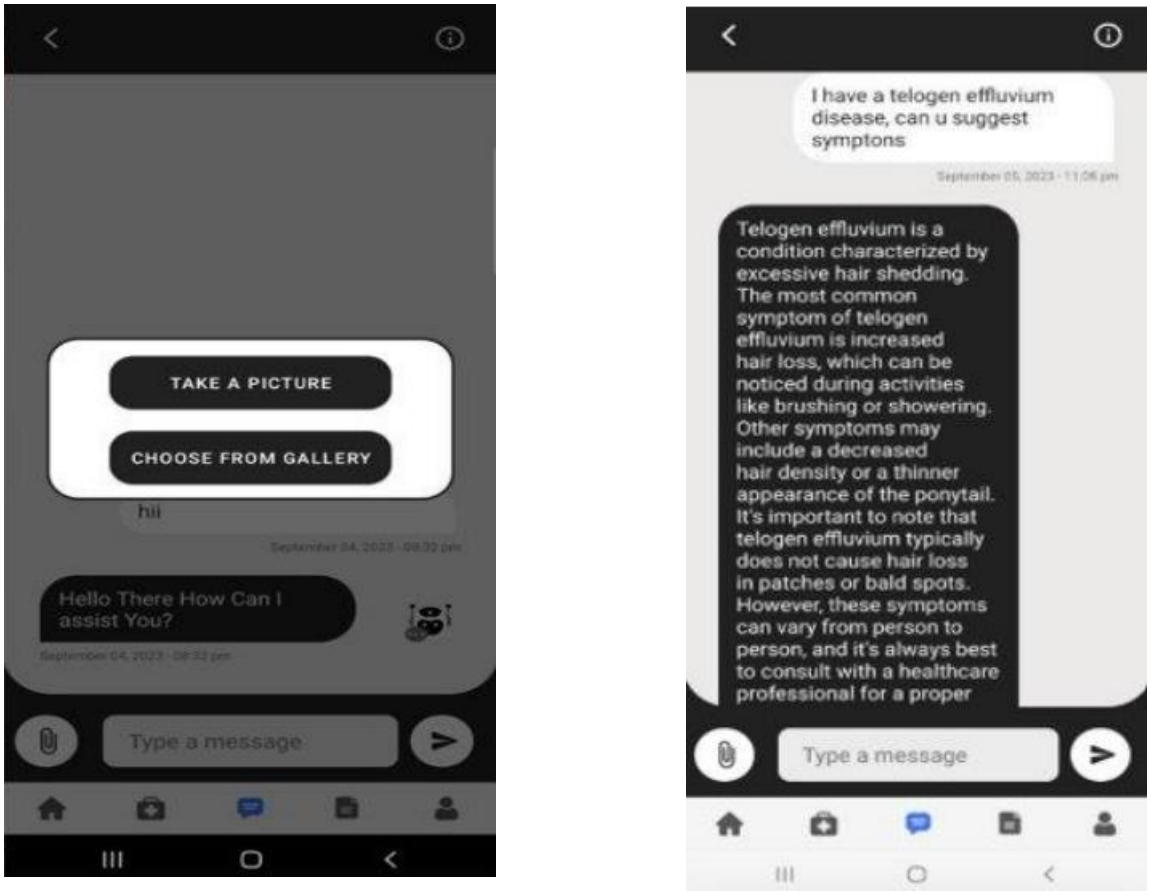


Figure 42 - Chatbot

9. SUMMARY OF CONTRIBUTION

Member	Component	Tasks
D.G.N.L.Wickramarathna – IT20154158	Extracting patient prescription data using easyOCR and Analyzing those data using NLP.	• The EasyOCR system extracts text from prescriptions; Data Storage organizes and stores this information for analysis. • Machine Learning Algorithms analyze the data to suggest treatments and set patient reminders; the Reminder System manages and sends timely alerts for treatments or appointments; the User Interface allows easy patient interaction. • IoT Integration facilitates seamless communication among components and external devices. • Customized Treatment Suggestions provide personalized guidance based on the analysis.
Nanayakkara V.G. - IT20159580	Hair Disease Treatment Recommendations for using Machine Learning-based Model.	• Data Collection: The first step in personalizing treatment recommendations is gathering relevant patient data. This includes not only information about the specific hair disease but also details about the patient's age, gender, genetic factors, and any known allergies. Data may also encompass

		lifestyle factors and other health conditions. • Machine Learning Models: To make personalized recommendations, machine learning models play a pivotal role. These models need to be trained on a dataset that includes a diverse range of patient profiles and their responses to different treatments. The models should learn to identify patterns and relationships between patient characteristics and treatment outcomes. • Treatment Tailoring: Once the models are trained, they can analyze a patient's unique profile and make treatment recommendations. This includes selecting the most suitable medications, topical applications, or therapies based on the individual's characteristics. For instance, a patient with a specific genetic profile or known allergies might receive a treatment plan that avoids allergenic substances. • Feedback Loop: The process of personalization doesn't end with the initial recommendation. A crucial aspect is the incorporation of a feedback loop. Patients'

		responses to the recommended treatments should be continually monitored and fed back into the system. This feedback helps refine and adapt the treatment recommendations over time, ensuring that the approach remains truly personalized and effective. • Consideration of Allergies: Addressing allergies is a key component of personalization. The system should be capable of flagging and avoiding treatments that a patient is allergic to. This enhances patient safety and prevents adverse reactions. • Continuous Learning: Machine learning models for personalization should be designed for continuous learning. As more patient data becomes available and as medical knowledge evolves, the system should adapt and improve its recommendations accordingly. • User-Friendly Interface: To make this process accessible to healthcare providers and patients, a user-friendly interface, such as a mobile application, can be developed. This interface can display the treatment

		recommendations, collect patient feedback, and facilitate communication between patients and healthcare professionals.
Bandaranayake V.R.W – IT20232290	Predicting Hair Diseases through Patient History and Symptoms.	• This section is often used by people who are not susceptible to the disease. • Data related to the history of the symptoms of the diseases and the symptoms that may occur in the future has been collected and trained as a model through set in the system. • Through a chatbot, the patient is asked step-by-step about the patient's symptoms from the first step. Accordingly, if these symptoms occur from the data model trained in the system, it is suggested that the patient is suffering from this disease. And it is suggested that this disease may reach this level in the future.

Alahakoon D.Y.R - IT20129026	Automatic hair scratch and hair losing detection using IOT device with machine learning.	• Identifying hat ware or not using ultrasonic sensor and measuring distance. • Capture hair image and resize the image. • Using image processing identify what disease has. • Real time updating mobile app interface.

Table 2 - Individual Contributes

10. CONCLUSION

The research project on "Empowering Hair Health With Intelligent Hair Disease Detection Systems" represents a significant stride in the field of healthcare technology. Hair conditions affect individuals of all demographics and can have a profound impact on their well-being. Early detection and effective treatment are pivotal in managing these conditions and improving the quality of life for affected individuals.

Through this project, we have explored innovative approaches, including machine learning techniques such as linear regression, to enhance the diagnosis and treatment of hair diseases. The integration of technology, data analysis, and intelligent systems has the potential to revolutionize the way we approach hair health.

The project's specific components, including disease detection using IoT devices, treatment recommendation through machine learning, symptom prediction via chatbots, and prescription management, showcase a holistic approach to addressing the complexities of hair diseases. Notably, the consideration of patient allergies in treatment recommendations represents a crucial research gap that can significantly improve patient outcomes and safety.

Our extensive literature survey has provided insights into the current state of research in various hair conditions, from head lice to alopecia and beyond. Researchers worldwide have made substantial contributions to understanding the underlying factors, diagnostic methods, and treatment options for these conditions. Our project builds upon this knowledge and introduces novel solutions.

The commercialization plan outlines a clear path for bringing our intelligent system to healthcare providers and institutions, with an emphasis on data security, regulatory compliance, and scalability. We recognize the commercial value of our solution in meeting the demands of the healthcare industry and addressing the needs of patients.

In the testing and implementation phases, rigorous quality assurance measures ensure that our software solution is reliable, efficient, and user-friendly. The collaboration with healthcare professionals and the consideration of real-world scenarios have guided the development process, resulting in a robust and practical system.

As we move forward with the implementation of this project, we remain committed to the principles of innovation, accuracy, and patient-centric care. Our software solution has the

potential to make a positive impact on countless lives, improving the early detection and management of hair diseases.

11. REFERENCES

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