AyuAira: A Novel Intelligent Ayurvedic Medicine System for Continuous Monitoring and Feedback of Arthritis

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Dissertation submitted in partial fulfilment of the requirement for the Degree of BSc (Hons) in Information Technology Specializing in Information Technology

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DECLARATION

We declare that this is our own work, and this dissertation 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 our 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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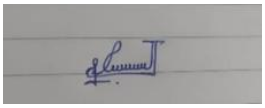
D.H.K.C Jayangika	IT19146270	

The above candidate has carried out research for the bachelor's degree Dissertation under my supervision.

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Signature of the supervisor Date

(Mr Ravi supunya)

…… ……..

Signature of the co-supervisor Date

(Ms. Suriyaa Kumari)

ABSTRACT

The Intelligent Ayurvedic Medicine System for Arthritis is an innovative approach to treating arthritis that combines the ancient knowledge of Ayurveda with the power of modern technology. The system develops personalized treatment plans based on Ayurvedic principles by analyzing patient data, including medical history, symptoms, lifestyle factors, and other relevant data.

Ayurvedic medicine is an ancient Indian system of healing that relies on a holistic approach to promote well-being and treat illnesses. The method is predicated on the idea that the mind, body, and spirit are interrelated, and that good health requires the ideal balance between these three components. Ayurvedic medicine has grown in acceptance as a complementary and alternative form of treatment in recent years. Ayurvedic medicine does, however, have its limitations and possible risks, just like any other medical method. Thus, the safety and efficacy of Ayurvedic treatments can be increased by an intelligent Ayurvedic medicine system that continuously monitors and provides feedback on patients' progress.

The proposed Intelligent Ayurvedic Medicine System for Arthritis Continuous Monitoring and Feedback addresses the limitations of traditional arthritis treatments that often rely on medication and physiotherapy. These treatments are often not personalized and do not take into account the patient's diet, lifestyle, and mental health. The proposed system, on the other hand, provides personalized treatments that consider the patient's unique circumstances. To evaluate the performance of the proposed system, a prototype will be developed and tested using real-world patient data. The prototype will include a mobile or web-based application for collecting and processing patient data, as well as the machine learning algorithms necessary to develop the predictive model. The performance of the system will be evaluated based on metrics such as accuracy, precision, and recall. The potential impact of this research project is significant. By continuously monitoring the patient's symptoms, treatment progress, and overall health, the proposed system has the potential to improve treatment outcomes and reduce the risk of adverse events. Additionally, by providing real-time feedback to the treating doctor, the proposed system has the potential to improve the efficiency of the treatment process and reduce healthcare costs. The system is designed to monitor patients' progress continuously, collecting data on their adherence to the prescribed treatment plan and any changes in their health status. The system uses this information to provide real-time feedback to patients, alerting them to any potential issues and offering suggestions for adjusting their treatment plan if necessary.

Keywords – Machine Learning Algorithms, Predictive Model, Performance Evaluation, Real-time Feedback, Personalized Treatment

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LIST OF ABBREVIATIONS

Abbreviation	Description
ANN	Artificial Neural Network
LSTM	Long Short-Term Memory
ML	Machine Learning
DL	Deep Learning

1 INTRODUCTION

1.1. Introduction & Background Literature

Over 5000 years old, Ayurveda is a thorough, integrative system of medicine. “Ayurveda” is the science of life; Ayus is the Sanskrit word for life and Veda is the Sanskrit word for knowledge [1].It focuses on the concept of achieving overall wellness and health by maintaining a balance between the mind, body, and spirit. The Ayurvedic medical system has grown in popularity in recent years, and the World Health Organization has recognized its effectiveness. Arthritis is a debilitating and chronic disease that affects millions of people worldwide. Early detection and effective management of arthritis are critical to ensure optimal outcomes for patients. Ayurveda, an ancient Indian medical system, offers an alternative treatment option for arthritis, which is gaining popularity among patients worldwide.

With the advent of technology, there is an opportunity to develop an intelligent Ayurvedic medicine system for the early detection and effective management of arthritis. The proposed system consists of four components. X-Ray Image Analysis, Blood Report Monitoring, Ayurvedic Treatment Recommendation, and Continuous Monitoring and Feedback. As shown in Figure 1.1 The system will consist of the four main AyuAIra functions, which are shown in the high-level architecture diagram below. This system will use a mobile-first approach and a web-based application.

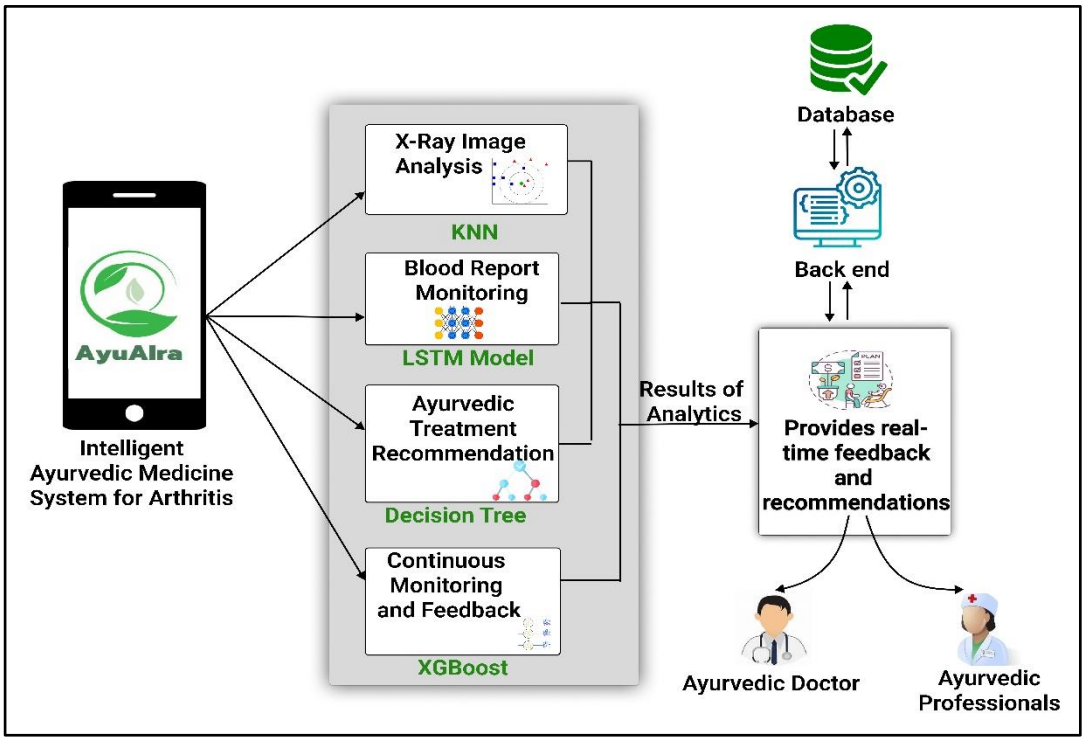


Figure 1.1- High-Level Architecture Diagram

Here, we mainly consider highlighted components in a high-level architecture diagram. The diagram emphasizes the mobile-first approach and web-based application, indicating the system's accessibility and user-friendly interface. Many arthritis patients are unaware of the severity of their condition. Due to a variety of difficulties, they are not interested in getting medical care. For those reasons, when a patient's illness worsens, doctors must also treat it. An Intelligent Ayurvedic Medicine System with Continuous Monitoring and Feedback is suggested as a solution to these problems. This system's goal is to continually monitor the patient's symptoms, medical progress, and overall health in order to give the doctor who treats them feedback [1].

The treatment of arthritis by conventional medicine has had a long history. However, the unknown target and pharmacological mechanism of a single Chinese medicine or preparation hinder the development of traditional medicine [2]. But nowadays, traditional medicine has taken the lead when compared to Western medicine because it provides the best treatments and performance. [3]

The continual monitoring and feedback required to achieve the best possible treatment outcomes, however, cannot be provided by the Ayurvedic treatment methods currently in use. The Intelligent Ayurvedic Medicine System with Continuous Monitoring and Feedback will expand on these ideas by incorporating modern technology in order to improve the accuracy and efficacy of diagnosis and treatment. The system continually monitors the patient's symptoms, the effectiveness of the treatment, and their overall health to give the treating doctor feedback in real time. This will enable a more rapid and personalized method of treatment.

Today, technology is used to solve a wide range of issues. It is evident that, in order to improve the precision and effectiveness of diagnosis and treatment, a successful application that enables a doctor to continuously monitor a patient's symptoms, treatment progress, and general health has yet to be developed. There are no special applications prepared for diseases like arthritis using traditional medicine. As a result, doctors are also agreeing with mobile app-based solutions.

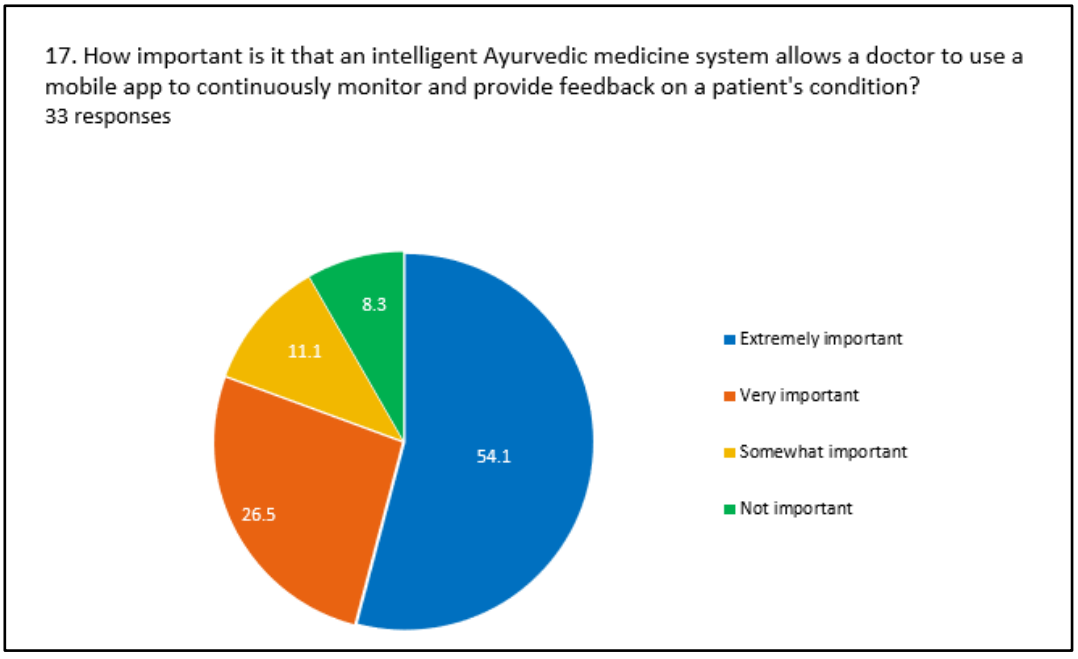


Figure 1.2 Summary of responses for uses mobile application

According to the doctors who take part in the survey, it is difficult to understand the patients' disease conditions precisely because people are not aware of diseases like arthritis and because doctors have time management issues. This study advises giving the treating physician real-time feedback by continuously monitoring patient symptoms, treatment progress, and overall health. For these reasons, many doctors agree to embrace a mobile-first approach with a web-based solution.

In an intelligent Ayurvedic medicine system, it is crucial for a doctor to be able to use a mobile app to continuously monitor and provide feedback on a patient's status. Doctors may keep track of any changes in a patient's condition and take quick action with real-time monitoring via a mobile app. It improves interaction and cooperation between the doctor and patient, allowing for quick response and addressing issues. Personalized treatment recommendations are made possible by the mobile app based on patient data, ensuring individualized care. Utilizing a mobile app has additional advantages such as effective data management, remote patient monitoring, and continuity of treatment. All things considered, integrating a mobile app into an intelligent Ayurvedic medicine system helps practitioners to provide prompt, patient-centered care, improving health outcomes.

1.2 Research Gap & Existing Solutions

A research gap indicated concerns that no prior studies have addressed within the scope of the proposed research. During the literature review, I found several methods for continuously monitoring and providing feedback on arthritis, as well as analyzing systems. The relevant research on existing arthritic disease continuous monitoring and feedback systems is considered and compared in this section.

Table 1.1 Comparison of Existing solution

Features	Research A	Research B	Research C	Research D	AyuAIra
Analyze the x-ray report ,blood report and treatment progress	No	No	No	No	Yes
Using Machine Learning Model (XG Boost Algorithm)	No	Yes	No	No	Yes
Monitor the arthritis patient's symptoms, treatment progress, and overall health	No	No	Yes	No	Yes
long-term continuous real time monitoring	No	Yes	No	No	Yes
Real Time Feedback	No	No	No	Yes	Yes

Research A - Patients' Satisfaction with the Ayurvedic Treatment:

Research B- Long-Term Effects of Ayurvedic Treatment in Rheumatoid Arthritis

Research C - Effectiveness of Ayurvedic Interventions in the Management of Knee Osteoarthritis

Research D - Role of Telemedicine and Ayurveda in the Management of Rheumatoid Arthritis

According to Table 1.1, four research papers indicated several aspects of continuous monitoring and feedback. It was able to understand how different technological methods of disease monitoring had been used.

The comprehensive features proposed in the Intelligent Ayurvedic Medicine System with Continuous Monitoring and Feedback have not been fully addressed in the research papers and systems now used in the field of Ayurvedic medicine. The analysis of X-ray reports, blood reports, and treatment progress has not been thoroughly

explored in the existing literature. None of the research papers discuss the integration of these analyses into the Ayurvedic treatment process, while the proposed system, Ayu Aira, incorporates this feature. This highlights a research gap in understanding the potential benefits of incorporating medical report analysis into Ayurvedic treatments.
Additionally, there hasn't been much focus in the research papers on the monitoring of arthritis patients' symptoms, treatment outcomes, and general health. None of the other study papers directly address this issue in relation to Ayurvedic treatment for patients with arthritis, whereas Research C focuses on monitoring symptoms and treatment progress in patients with knee osteoarthritis. The proposed system, Ayu Aira, includes this feature, suggesting a research gap in exploring the integration of comprehensive symptom monitoring in Ayurvedic treatments.

Research studies have not sufficiently explored the use of a machine learning model, particularly the XG Boost algorithm, as a prediction tool in Ayurvedic medicine. Research has been conducted in other research papers using various algorithms [4]. None of the research papers mention using the XG Boost algorithm for continuous monitoring and feedback, with the exception of the current system Ayu Aira. This knowledge gap emphasizes the need for more research into the possible advantages and constraints of integrating machine learning algorithms like XG Boost into the continuous monitoring and feedback system.

Moreover, long-term continuous real-time monitoring, a crucial feature for assessing treatment efficacy and patient progress, is lacking in the existing research papers. Although Research B discusses long-term monitoring in the context of Ayurvedic treatment for rheumatoid arthritis, other research papers and systems do not address this feature. This indicates a research gap in understanding the potential benefits and challenges of incorporating long-term continuous real-time monitoring in Ayurvedic medicines.

Insufficient research has been done in the existing literature regarding the provision of real-time feedback, which can improve patient care and treatment outcomes. The other research papers do not concentrate on this topic, but Research Paper A and Research Paper D look over real-time feedback in the context of Ayurvedic treatment. The proposed system, Ayu Aira, incorporates real-time feedback, indicating the potential advantages of this feature.

The proposed system continuously monitors the patient's symptoms, treatment progress, and overall health and provides feedback to the treating doctor. The system's goal is to give the treating doctor feedback-based web-based application access intended first and foremost for mobile devices. Through this proposed system, doctors will be able to monitor the development of personalized diseases of the patients and when the disease increases or decreases, will be able to provide the necessary treatment correctly [5]

2 RESEARCH PROBLEM

Computer science and information technology are essential to advancements in healthcare. By using computers and information technology, people are attempting to study the various issues in the health sector in depth and come up with numerous solutions. In general, medical research is in its golden age nowadays. People are constantly interested in doing different types of research and developing innovative ideas to improve human lives. The use of various procedures for various disorders is fairly prevalent. As a result, numerous research projects have been carried out for conditions like arthritis. However, employing conventional Ayurvedic medical treatments does not involve any technical tests. These factors reduce people's use of traditional Ayurveda treatments. Ayurvedic medicine is gaining popularity as an alternative to modern medicine, especially for chronic diseases such as arthritis, diabetes, and hypertension. However, Ayurvedic medicine has not been widely accepted as a viable treatment option due to the lack of scientific evidence to support its effectiveness. [6]

This problem can be solved by giving the treating doctor real-time feedback through the establishment of an intelligent Ayurvedic medicine system with continuous monitoring and feedback. The device would send feedback to the treating doctor and continuously monitor the patient's symptoms, treatment progress, and overall health.

Specific symptoms can be found in different types of arthritis. Similar symptoms occur in various types of arthritis. Joint pain and swelling, stiffness, fatigue, fever, insomnia, and weight loss are all signs of rheumatoid arthritis. [6] Bone fractures, stiffness, pain, tenderness, and a loss of flexibility are all osteoarthritis symptoms. These symptoms have some similarities. The symptoms of the patients can be used to determine the type of arthritis, and the disease progresses at various rates depending on the other illnesses the people are dealing with. The patient's symptoms and overall health must be closely monitored due to this issue. [7]

A key problem with research studies is that doctors face a range of challenges when analyzing changes in disease levels in patients with arthritis. One major issue is that many people forget about their medical history. Since many people suffer from chronic arthritis, treating them repeatedly faces doctors with a number of difficulties. Patients receive a variety of reports and prescriptions but often do not bring them with them when they visit the doctor. These factors make it difficult to treat doctors correctly.

The data received from the first survey is presented in the following figure 2.1. If you look closely, you will see that access to a patient's medical history, especially in the context of arthritis patients, is very important to many doctors. It was 82% of survey respondents when expressed as a percentage. It is very difficult to assess patients over and again given the time constraints faced by many doctors. Therefore, it is very important for a doctor to have access to a patient's complete medical history, including previous treatments, medications, and diagnostic records.

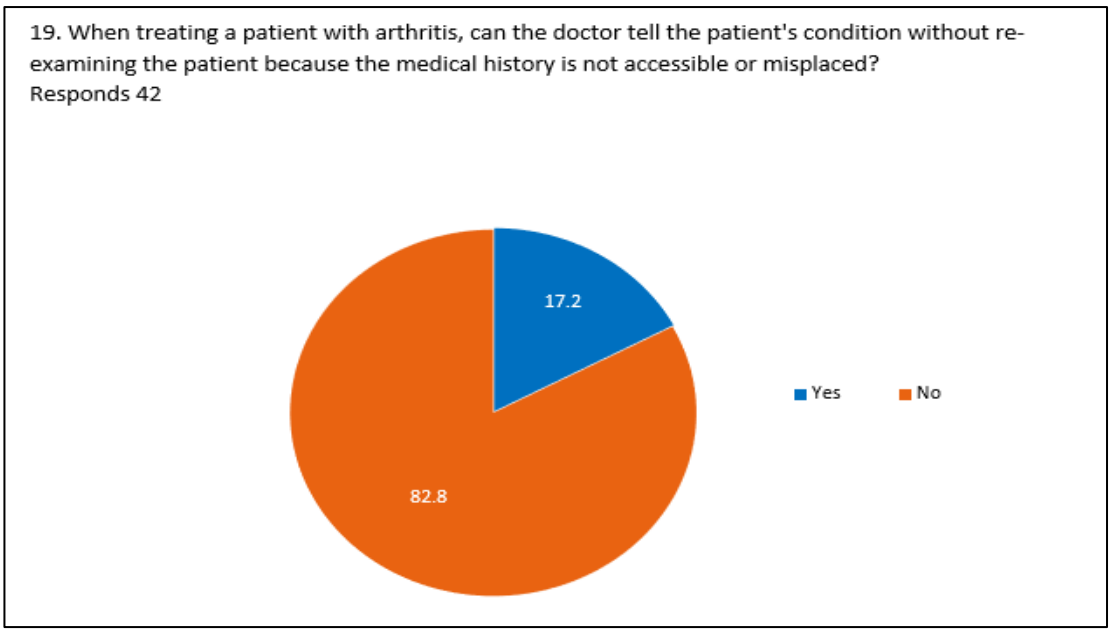


Figure 2.1 Summary of responses regarding arthritis patient medical history

Continued monitoring of patients' disease conditions is crucial for effective treatment. However, due to various factors such as limited access to medical history or misplaced records, doctors often face challenges in accurately assessing the patient's present condition and determining appropriate treatment plans. As shown in Figure 2.3, more than 88% of survey respondents disagree with the treatment of the patient's previous and present disease conditions without continued monitoring. This research problem aims to investigate the impact of the absence of continuous monitoring on treatment decisions and patient outcomes.

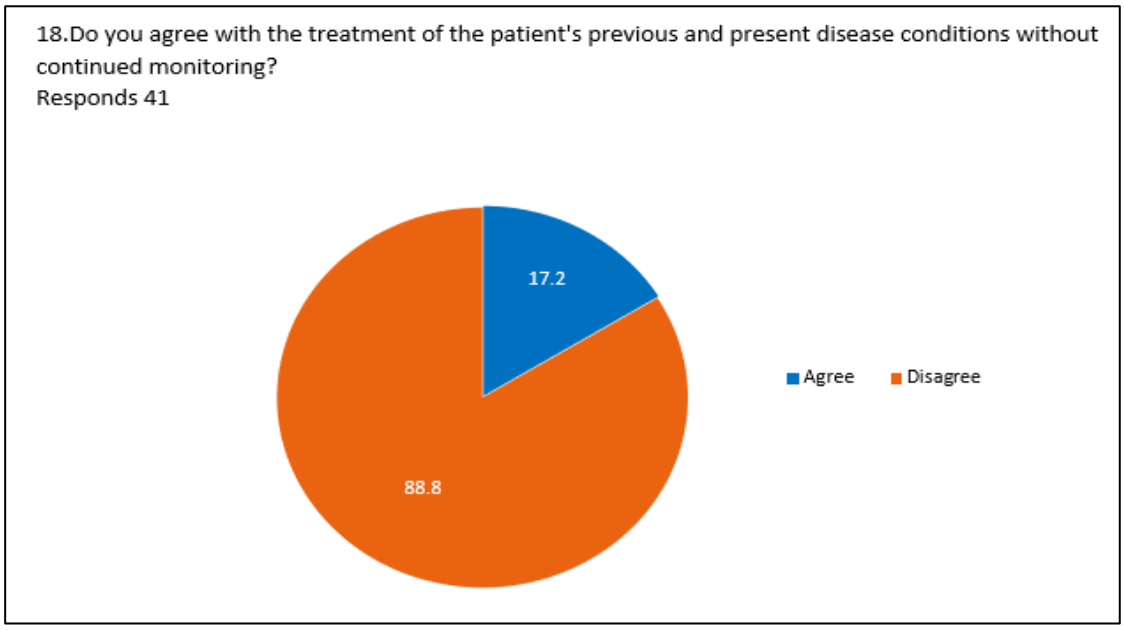


Figure 2.2 Summary of responses regarding continues monitoring.

One of the other problems faced by doctors is the limited understanding of their patient's treatment progress over time. As shown in Figure 2.3, more than 50% are unaware of treatment progress. This can happen for a number of reasons, including patients forgetting or not fully reporting their symptoms or experiences, the difficulty of continuously monitoring patients, and the lack of face-to-face encounters. The effectiveness of the current treatment plan, making necessary changes, or recognizing prospective problems that need immediate care may be difficult for doctors to appropriately assess without a thorough grasp of the therapy progression.

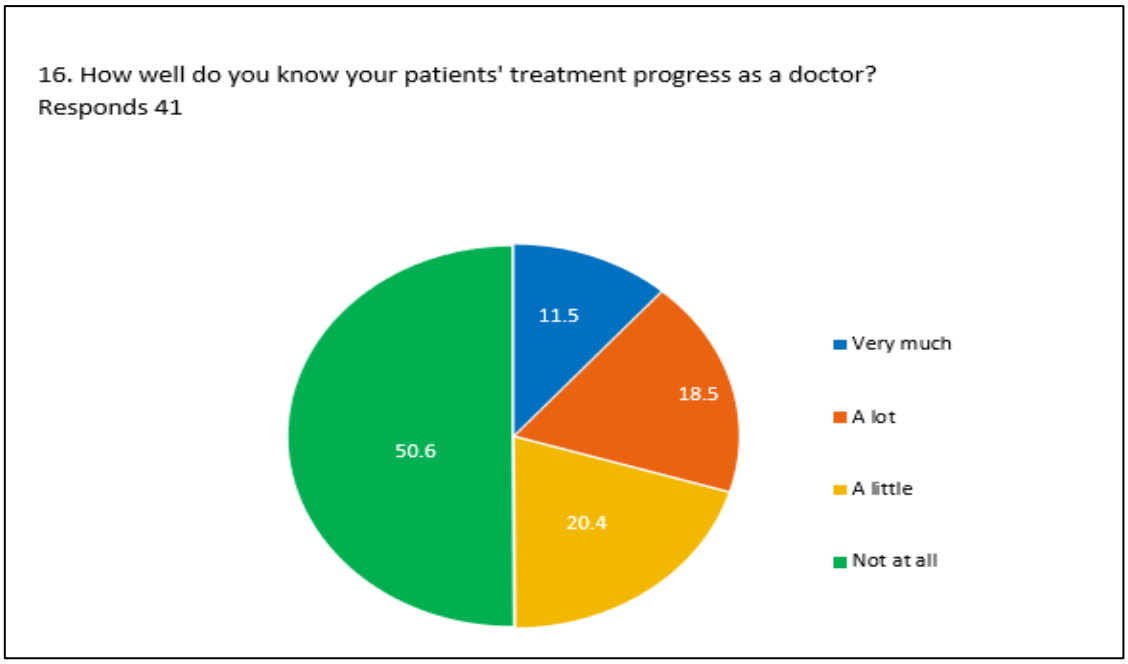


Figure 2.3 Summary of responses regarding treatment progress

The goal of this study is to contribute to the creation of an intelligent Ayurvedic medicine system that improves patient care and treatment outcomes through continuous monitoring and feedback. The results will help doctors, researchers, and innovators in the field of Ayurvedic medicine make important discoveries that will, in turn, lead to better healthcare outcomes and individualized treatment plans.

3. Research Objectives

3.1 Main Objectives

The major goal of the component is to bring a mobile-first, technology-based approach to creating an intelligent Ayurvedic system for continuous feedback and monitoring. The system aims to use modern technologies, such as machine learning and predictive modeling, to continuously monitor the patient's symptoms, treatment progress, and overall health. By integrating and analyzing this data in real time, the system will generate valuable insights and provide timely feedback to the treating doctor. The ultimate objective is to increase the effectiveness and efficiency of Ayurvedic medical care, resulting in better patient results and a more individualized and adaptive approach to healthcare. In order to enhance and integrate traditional medicine with contemporary practices, this research also intends to investigate the possibility of technologically assisted Ayurvedic treatments.

3.2 Specific Objectives

The research project can achieve the following specific goals to receive continuous monitoring and feedback.

- Develop a comprehensive data collection framework:

Designing and putting into practice a solid data-collecting method that captures a wide range of patient data relevant to Ayurvedic treatment is the aim. This framework should make it possible to gather data on symptoms, medical conditions, lifestyle choices, and overall health indicators. It should ensure data integrity, privacy, and security while supporting real-time data acquisition from various sources, such as patient interviews, and electronic health records.

- **Data Preprocessing**

Once the dataset has been collected, we must pre-process it. Most real-world data when viewed on a computer is incorrectly formatted and contains several faults. In machine learning and deep learning, data preparation is a separate segment. Missing values and unsuitable formats exist in real-world data. However, before we can do anything with the data, such as create a machine-learning model, we must first clean and train them. Data preparation entails evaluating the suitability of these processes. Both the test and the training datasets must be pre-processed independently in order to train both models

- **Implement a predictive model using the XGBoost algorithm:**

The XGBoost technique will be used to create a predictive model. This model should take into consideration a number of elements, including patient symptoms, medical history, lifestyle factors, and other relevant health indicators. The model needs to be properly trained to predict treatment results and determine the patient's overall level of health.

- **Real-time monitoring system implementation:**

The goal is to develop a real-time monitoring system that continuously gathers and evaluates patient data over the course of treatment. This system should integrate with various sensors, wearables, and devices to collect data on physiological parameters, daily routines, and lifestyle habits. It should provide timely alerts and notifications to the treating doctor based on predefined thresholds or deviations from expected patterns, enabling proactive interventions.

- **Create a feedback mechanism:**

The goal is to create a feedback system that gives the doctor who treats you insightful and useful information. This mechanism should analyze the collected data, identify patterns, and generate personalized recommendations or suggestions for treatment. To enable the doctor to make informed decisions, the feedback should be personalized for each patient, taking into consideration their particular constitutional characteristics, treatment history, and progress.

- **Evaluate the system's performance and accuracy.**

Evaluation of the Intelligent Ayurvedic Medicine System's performance and accuracy is the aim. This includes assessing the predictive model's performance using appropriate evaluation metrics, such as precision, recall, accuracy, and F1 score. Furthermore, user reviews and evaluations by experts of the system's general performance, usability, and reliability should be considered.

4. METHODOLOGY

The continuous monitoring and feedback component of the Intelligent Ayurvedic Medicine System for Arthritis aims to develop a predictive model that takes into account the patient's symptoms, treatment progress, and overall health, and provides real-time feedback to the treating doctor. This component is crucial for the proper treatment of arthritis since it allows for the early detection of changes in the patient's health, which may help with the avoidance of disease progression and the improvement of treatment plans. We provide an innovative approach in this methodology that uses a combination of deep learning algorithms to integrate data from numerous sources, including physiological signals and self-reported data. Several machine learning models were experimented to make this monitoring, including Artificial Neural Network (ANN), Decision Tree, Random Forest, XG boost and Long Short-Term Memory (LSTM). Based on the results of these algorithms, the XG Boost model was chosen as the most appropriate model for further implementations. Extreme Gradient Boosting, or XG Boost, is a popular machine learning algorithm that is utilized for both regression and classification tasks. It is a performance and speed focused implementation of gradient boosting.

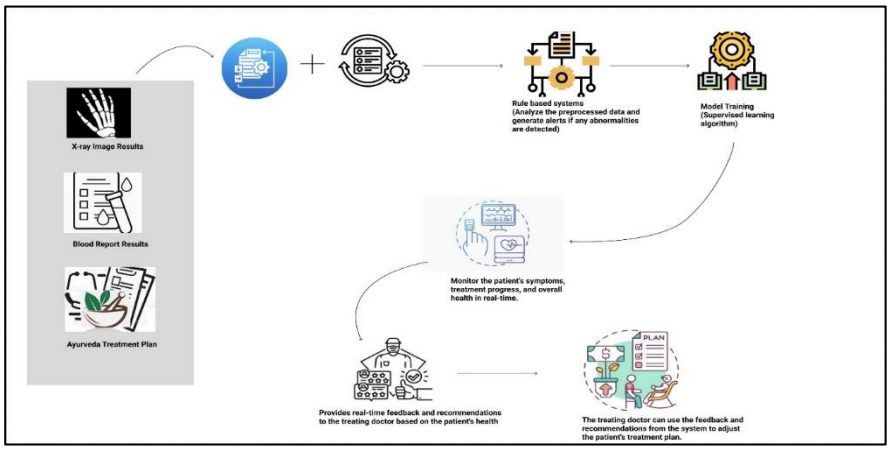
The XG boost algorithm may be used to predict the patient's symptoms, treatment progress, and overall health based on numerous inputs such as physiological signals, self-reported data, and treatment information in the case of continuous monitoring and feedback. Data collection, data pre-processing and splitting, model development and training, model deployment and prediction, and plotting the results were all performed to implement this XG boost algorithm. To use the XG boost algorithm, we must first train it using a dataset of patient data. Gampaha Wickramarachchi Ayurveda Institute and Rajagiriya Ayurvedic Hospital in Sri Lanka provided data. This dataset should contain data on the patient's symptoms, treatment progress, medications, and overall health over time. The dataset should also include details about the inputs utilized to make these predictions, such as physiological signals and self-reported data. Null values and duplicate values were detected and eliminated throughout the data preparation process.

Next Scikit Learns was used to preprocess the data, select a model, and evaluate it. Then the data was split into two sections for training and testing preparations. Following the collection and preprocessing of data, the next stage is to create a prediction model using machine learning methods. We will create a prediction model that considers the patient's symptoms, treatment progress, and general health, and will send real-time feedback to the doctor. To create the prediction model, we will use deep learning methods such as CNNs and RNNs. After the machine learning model has been developed and evaluated, it may be deployed to provide real-time feedback to the treating doctor.

The model should be integrated into the intelligent Ayurveda medicine system, allowing the doctor to monitor the patient's symptoms, treatment progress, and overall health. The system can be programmed to warn the doctor when the patient's condition changes, indicating the need for a change in treatment. The system's real-time feedback may also be utilized to improve the model's performance. As new data is available, the model may be retrained and updated to represent the most recent information. This iterative model improvement and real-time feedback procedure might result in a more accurate and effective continuous monitoring and feedback system.

4.1 System Overview

- TensorFlow – Images preprocessing and classification
- Google Collab – to gain computation power to train the image recognition model.
- Firebase – Database server
- Python – Backend development language
- Flask – Form validation, or any other components where pre-existing third-party libraries provide common functions.
- XG Boost Algorithm
- React– Development language of the mobile application**.**



4.1.1 Data Gathering and Data Pre-Processing

The Intelligent Ayurvedic Medicine System was developed using information acquired from 200 patients during the project's initial phase. Patients' consent was obtained during the data-gathering procedure while maintaining their privacy and confidentiality. This data includes information about the patient's symptoms, treatment history, overall health parameters, and other relevant factors. Once the data is collected, it undergoes a series of pre-processing steps. Data cleaning to handle missing values and outliers, feature selection to identify the most relevant variables, feature encoding to convert categorical variables into numerical values, data normalization to ensure consistent scales, data splitting into training and testing sets, data balancing if necessary to deal with the class imbalance, and feature scaling as dictated by the XGBoost algorithm are all included in this process. The dataset's quality and applicability for training the predictive model are ensured by these pre-processing processes.

Data collection from various sources and subsequent data pre-processing are part of the methodology for creating the Intelligent Ayurvedic Medicine System. Cleaning the data deals with missing values and outliers, and feature selection aids in the discovery of pertinent variables. Data is normalized and categorical features are encoded to produce scales that are consistent. Then, training and testing sets are created from the dataset. To alleviate the class imbalance, data balancing techniques may be used. To satisfy the demands of the XGBoost algorithm, feature scaling is finally carried out. These procedures verify the data's quality and suitability for use in training the predictive model as well as their readiness to provide the treating doctor with real-time feedback.

4.1.2 Feature Extraction

Feature extraction is essential for identifying and collecting valuable data from the gathered data in your study on continuous monitoring and feedback. This involves preprocessing the data, selecting relevant features based on domain knowledge and exploratory analysis, and utilizing the xgboost algorithm for feature importance analysis. The most crucial elements are then kept, providing information on the patient's symptoms, medical progress, and general state of health. Additional relevant features can be created using feature engineering techniques, and a thorough validation procedure guarantees that the chosen features make a beneficial contribution to the performance of the predictive model. Effective patient care is made possible by this feature extraction technique, which provides real-time monitoring and input to the treating doctor.

4.1.2 Label Encoder

This process is used to convert categorical labels into numerical labels. This process is suited better for the ordinal type of categorical data. There several types of labels encoding methods. Some of them are Mapping, label Encoding and One Hot Encoding. Label encoding method is converting each column value into a number. It is a straightforward method. Mapping is a method that manually assigns numeric values to each and every label in the data set. One hot Encoding method is One-Hot Encoding, a well-known alternative strategy, addresses this ordering issue. Each category value in this strategy is moved into a new column and given a 1 or 0 (indicating true or false) value.

```
# Preprocess the data.encode the categorical variable into numerical labels
le = LabelEncoder()
data["Arthritis Type"] = le.fit_transform(data["Arthritis Type"])
X = data.drop(["Arthritis Type"], axis=1)
y = data["Arthritis Type"]
X = pd.get_dummies(X)
```

Figure 4.1 Label encoder

4.1.3 Splitting the dataset into training and test dataset.

The dataset is split into a training and test dataset after applying the methods described above, ensuring a fair distribution of data points and retaining the accuracy of the data regarding the patient's symptoms, progress with treatment, and overall health. The predictive model is trained using the xg boost algorithm utilizing the training dataset, which makes up about 70–80% of the data. This algorithm is renowned for its ability to manage complex data and produce precise predictions. The remaining 20–30% of the data is set aside for the test dataset, which will be utilized to assess the model's effectiveness and determine its capacity to give a treating doctor real-time feedback. Following this process will help us create a reliable predictive model that takes into consideration a variety of variables and allows for continual monitoring and input to improve patient treatment.

```
17
18  # Split the data into training and testing sets
19  X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)
20
```

4.1.4 Model Development

The underlying model, the XGBoost algorithm, was chosen because of its suitability for continuous monitoring and feedback tasks and its capacity to handle complicated and high-dimensional data. Preprocessed data was used to create the predictive model, which took into account the patient's symptoms, progress with treatment, and other health indicators.

To ensure a suitable balance for the model's training and evaluation, the dataset was separated into training and validation sets during the training process. To enhance the model's performance, hyperparameter adjustment was done. To get the best results, parameters including learning rate, maximum depth, and the number of estimators were iteratively changed.

4.1.5 Real-Time Monitoring and Feedback System

Implementing a system that can continuously gather new patient data in real-time is part of this phase. The system may gather patient data from a variety of sources, including mobile applications, wearable technology, and IoT sensors. These sources can keep track of physiological data (such as heart rate and blood pressure), symptoms, medication adherence, and other relevant health-related information. The trained XGBoost model receives the real-time data collection and uses it to generate predictions based on the patient's current data. The model's output gives the treating doctor information about the patient's state and the course of their treatment. A user interface is created so that the treating physician can access and analyze the model's feedback. The user interface should offer pertinent summaries, data visualizations, or alerts based on the model's predictions and be simple to use and visually appealing.

4.1.6 Evaluation and Validation

In this stage, extensive tests are used to evaluate the effectiveness of the real-time monitoring and feedback system. When detecting and predicting changes in patient symptoms, treatment response, and overall health, you evaluate the system's accuracy, timeliness, and efficacy. To do this, it is possible to compare the model's predictions with actual labels or professional opinions. Assure that the predictions and feedback are provided in a period that allows for clinically useful action by evaluating the system's capacity to deliver timely feedback. Surveys and interviews are used to obtain feedback from patients and doctors in order to evaluate the system's usability and user satisfaction. To show the system's superiority in terms of accuracy, efficiency, or other important metrics, its performance can also, if appropriate, be contrasted with that of benchmarks or existing approaches.

4.2 Use case diagram of the system.

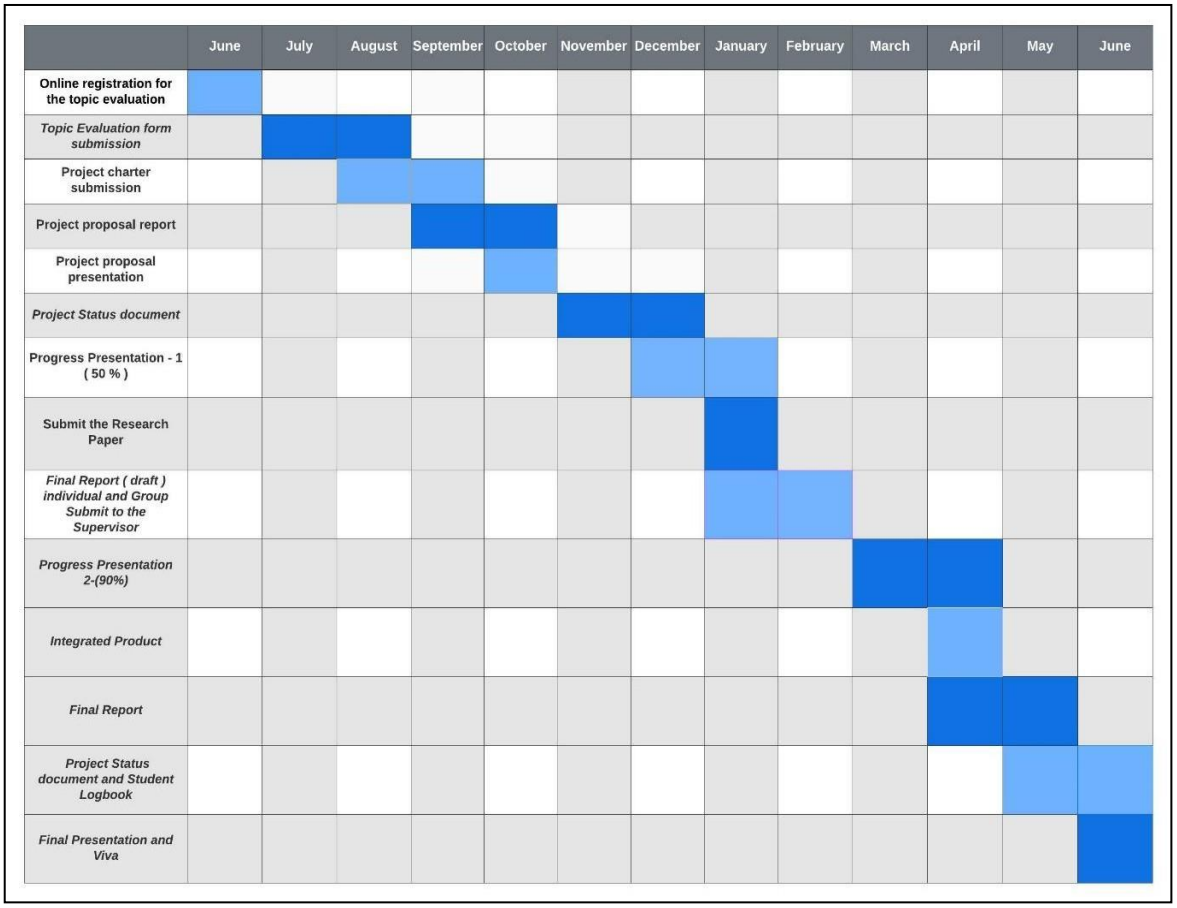
4.3 System Development Process

In this section of the proposed study, the authors describe their approach to designing and integrating a specific section within the research and development project. They have chosen to adopt the Agile methodology, particularly the Scrum framework, due to its ability to facilitate continuous iteration and adaptability. The author's solution focuses on the system developed based on the literature survey and implemented survey, allowing for continual improvements. The Agile approach enables testing and adapting to evolving requirements throughout the project lifecycle. Integration is a vital aspect, ensuring seamless integration of the new section with existing components and effective communication between project sections.

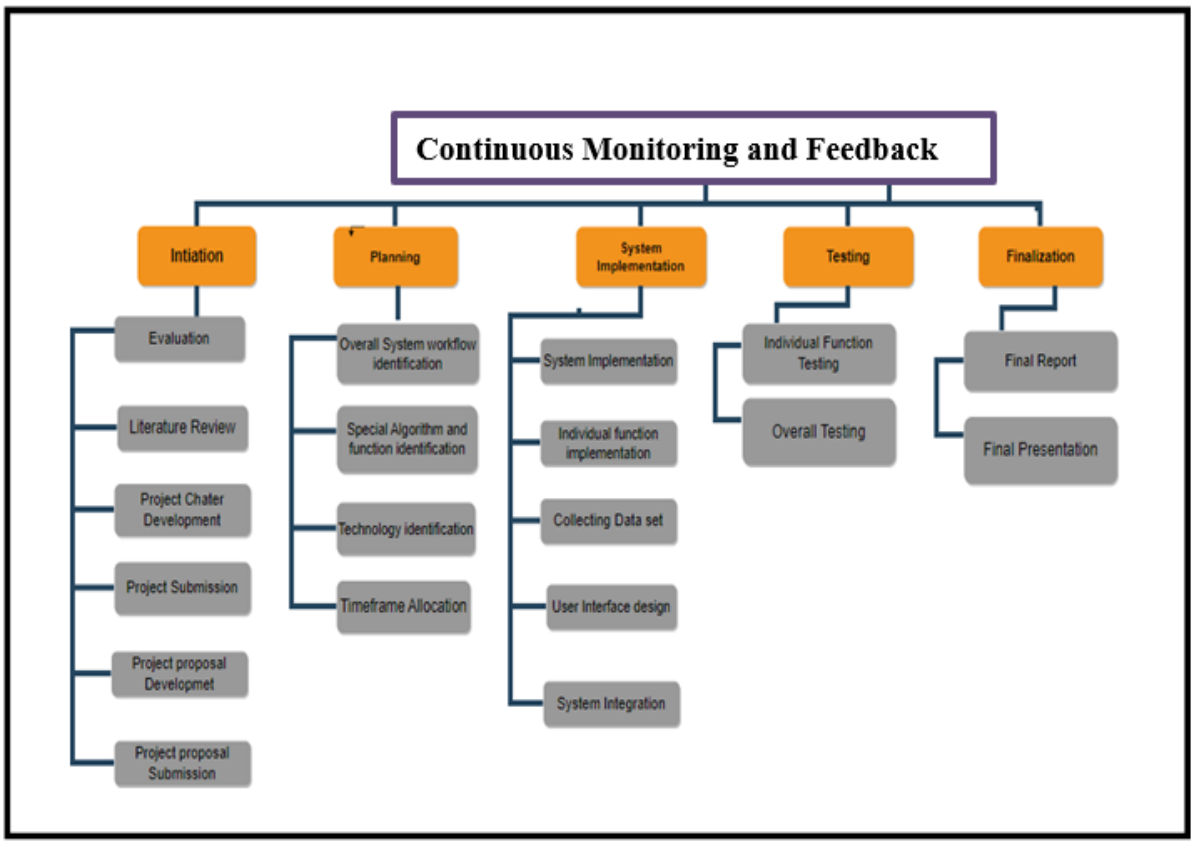
The Agile development process involves working in short iterations called sprints, delivering incremental improvements to the system. Regular collaboration and communication among team members, including daily stand-ups and sprint reviews, facilitate knowledge sharing and issue resolution. Transparency and stakeholder involvement are emphasized, ensuring timely feedback and addressing evolving requirements. By leveraging the Agile methodology, the authors aim to create an iterative and adaptable approach, resulting in a robust and effective solution that aligns with the changing needs identified in the study

4.4 Gantt Chart

Figure 4.4 shows the Gantt chart of the development process made in accordance with the possible dates.



4.5 Work Breakdown Chart



4.6 Commercialization Aspect

4.6.1. Targeted Audience

The target audience for the system is the Ayurvedic Doctors. Ayurvedic doctors specialize in providing personalized treatments and therapies based on the principles of Ayurveda.

4.6.2 Benefits to the end-users

- **Improved Health Management:** The real-time monitoring and feedback system empowers patients to actively participate in their own healthcare. By continuously monitoring their symptoms, treatment progress, and overall health, patients gain valuable insights into their condition. This promotes self-awareness and enables them to make informed decisions regarding their lifestyle, treatment adherence, and necessary adjustments under the guidance of their Ayurvedic doctors.

- **Personalized Treatment Plans**: The system takes into account individual patient characteristics, such as symptoms and overall health, to generate personalized treatment plans. This ensures that patients receive tailored care that aligns with their specific needs and conditions. By following these personalized treatment plans, patients can experience optimized therapeutic benefits and improved health outcomes.

- **Timely Intervention and Support**: The real-time feedback feature of the system allows patients to receive timely intervention and support from their Ayurvedic doctors. In critical situations or when changes in symptoms are detected, the system can alert both the patient and the doctor, facilitating prompt action. This timely support can prevent complications, reduce the risk of exacerbations, and improve the effectiveness of treatment interventions.

- **Enhanced Communication and Collaboration**: The system acts as a communication platform between patients and their Ayurvedic doctors. Patients can provide real-time updates on their symptoms and treatment progress, while doctors can provide guidance and adjust treatment plans accordingly. This promotes a collaborative and interactive healthcare approach, fostering a stronger doctor-patient relationship and leading to better patient engagement and satisfaction.

4.6.3 Advertising and Communication

- Social Media Campaigns: Promote the system through engaging content on platforms like Facebook, Twitter, LinkedIn, and Instagram.
- Industry Conferences and Events: Showcase the system at Ayurveda conferences and healthcare exhibitions, conducting live demos and presentations.
- Collaborations with Key Influencers: Partner with influential figures in the Ayurvedic community to endorse and promote the system.
- Professional Associations and Publications: Publish articles and case studies in Ayurvedic journals and newsletters, and participate in webinars and speaking engagements.
- Online Platforms and Directories: List the system on relevant healthcare technology databases and platforms catering to Ayurvedic doctors.
- Website and Blog: Develop a comprehensive website with informative blog posts and share them on social media and through email newsletters.

5. IMPLEMENTATION & TESTING, RESULTS & DISCUSSION

5.1 Testing Phase

- **Unit Testing**

Individual programs, subroutines, procedures, and, in general, all system units are subjected to unit testing. It is a method of coordinating all of the testing components. Each module's unit test should be distinct. This achieves two goals: It reduces the cost of repairing failures and improves unit performance without causing it to fail. This is beneficial because the testing is done independently, which means that if a problem is discovered, it can be addressed appropriately. It simplifies the debugging process. The system began as a series of smaller programs that were eventually combined into the final phase.

- **Integration Testing**

Integration testing After being combined, each component is tested as a whole in Integration Testing. Integration testing is the process of looking for flaws and issues in individual parts or units of a software project to ensure they work together as intended. Integration testing ensures that when two or more components are evaluated, the end result meets the functional requirement. This is completed both before and after validation testing. Module testing in this environment always began at the top of the programming hierarchy and worked its way down. Because testing begins early in the implementation process, problems can be identified sooner rather than later in the development cycle. It is easy to integrate because it is simple to test in a development environment. Integration testing is more effective than end-to-end testing. Isolating failures is straightforward and dependable. Integration testing necessitates both developer and tester attitudes.

- **System Testing**

System testing is a series of tests designed to test and evaluate how an integrated software computer system performs in accordance with requirements. This contrasts the current system or program with its original goals. The failure of a system to meet its objectives is the goal of system testing. It validates the users' requirements as well as the system's architecture and development. The results of integration testing were used as inputs for system testing. It can detect faults in integrated components and the system as a whole. The final result of this testing strategy is the monitoring of the system's behavior. System quality is typically ensured by a testing team that is independent of the implementation team and performs system testing. There are functional and nob functional tests included

- **Acceptance Testing**

The process of comparing the initial specifications of a system to the current requirements required by end users is known as acceptance testing. Typically, this is the responsibility of the end user or client. Before giving the system to the user, the developer will test it with the users.

- **Regression Testing**

As part of the process, developers must replace or modify functionality; These alterations may cause unanticipated actions that can have a significant impact. Most of the time, regression testing is used to make sure that a change or addition hasn't changed any of the functions that are already in place. It also aims to find errors and flaws that may have been unintentionally incorporated into the current solution and to make sure that problems that were previously removed are still active. Regression testers can continue their work with the assistance of a variety of functional testing technologies.

5.2 Results & Research Findings

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