AyuAira : Intelligent Ayurvedic Medicine System for Arthritis

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Group report

B.Sc. (Honors) Degree in Information Technology Specializing in Computer Systems and Network Engineering

Department of Computer Systems Engineering

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Declaration of the Candidate

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Name	Student ID	Signature	Date
Hewapathirana L.L	IT19025322		
Mallawaarachchi T.S	IT9955582		
Samaranayaka S.W	IT19955414		
Jayangika D.H.K.C	IT19146270		

Declaration of supervisors

The above candidates are carrying out research for the undergraduate Dissertation under my supervision.

Name of supervisor: Mr Ravi Supunya

Name of co-supervisor: Ms Suriyaa Kumari

Signature of supervisor: Date:

Signature of co-supervisor: Date:

Abstract

The aim of this research is 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. The X-Ray Image Analysis component uses a Convolutional Neural Network (CNN) to identify patterns in X-Ray images and classify them as indicative of arthritis and its severity. The Blood Report Monitoring component employs a Recurrent Neural Network (RNN) to analyze time-series data of blood test results and predict the progression of arthritis. The Ayurvedic Treatment Recommendation component generates personalized treatment recommendations based on the principles of Ayurvedic medicine and the patient's age, sex, symptoms, and overall health. The Continuous Monitoring and Feedback component uses a predictive model to continuously monitor the patient's symptoms, treatment progress, and overall health, and provides real-time feedback to the treating doctor. The proposed system integrates advanced technology with traditional knowledge of Ayurvedic medicine to provide a comprehensive solution for the early detection and effective management of arthritis.

Dedication

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Abbreviation	Description

1. Introduction

The ancient medicinal system Ayurveda uses herbal plants with medicinal values to cure many, whether it be a small cut or a chronic disease. There are several reasons for many people to opt for Ayurveda medicine over modern medicine. One is due the fact that Ayurveda medicine is made up of natural herbs, leaves, flowers, barks, and mineral, thus reducing the use of any harmful man-made chemical from entering the body, another reason is due to the relatively lower price point of Ayurveda medicine in comparison to modern medicine.

This is proved by the fact that 75% of the Sri Lankan population is said to depend on Ayurveda medicine because of its naturalness and the use of valuable plants Moving on, arthritis is another disease that is affecting the lifestyles and well-being of mainly the older citizens The word ‘Arthritis’ comes from the Greek word referring to a disease in the joints, causing immense pain, inflammation, and damage to the bones in the affected area. According to Arthritis has a long history dating back to the ancient Egyptians, but it was not until Dr. John K. Spencer identified ‘osteoarthritis’ in 1886, the disease was given a proper identification.

In the current world, over 100 different types of arthritis have been identified with osteoarthritis been the most common form. Although arthritis and the type of it depends on several factors such as age, gender, weight, height, type of job and more, arthritis can also be seen in patients that has other autoimmune diseases . For the analysis of this report, three types of arthritis have been chosen: osteoarthritis, rheumatoid arthritis and psoriatic arthritis. Osteoarthritic is the joint pains mainly experienced by females in their knees, rheumatoid arthritis is ‘an autoimmune systemic inflammatory disorder’ resulting improper functioning of the immune system due to both genetics and environmental factors and psoriatic arthritis is the severe inflammation of the skin and synovial tissue

The current diagnosis and treatment process for an arthritis patient starts by the patient having to take an X-ray, several blood works done and then the final diagnosis from the doctor. Who then will recommend a treatment plan which will then have to be followed by the patient. However, there is a gap in this modern medicine system. Inability for early detection and not having a proper tracking system to monitor the treatment process of the patients are the gaps. Through the model developed in this article, Ayurveda doctors can early detect the type of arthritis through the X-ray of the patient and create a comprehensive solution using both the advanced technology and Ayurveda medicine for effective management of arthritis, while also reducing the trouble patients must face when trying to visit the doctor. This proposed system will make the entire process of diagnosing, treatment plan and monitoring easier for the Ayurveda doctors.

1.1. Literature Review

Ayurveda originated in India several thousand years ago and still to date this ancient medicinal system is used to treat everything from small cuts and wounds to cure chronic illnesses. The use of all parts of Ayurvedic plants; leaves, flowers, the bark, roots, and other minerals, guarantees the naturalness of the medicinal system and ensures a no to low level of side effects [1] [3] Research conducted by the University of Ruhuna with the aim to identify the level of Ayurveda knowledge people have

concluded that most people are not aware of Ayurveda treatments proved by the fact that only 27.2% from the 235 responses chose to undergo Ayurveda treatments, while 91.1% of respondents liked to have easy access to Ayurveda treatments.[3] On the other hand, according to a 2009 report from the World Health Organization (WHO), approximately 80% of the world's population depends on Ayurveda, giving the reasons of high costs and side effects of the modern medicine [1]. The authors, further states that in the past few millennia, 75% of the Sri Lankan population relies on Ayurveda as a result of its natural and use of valuable herbal plants and oils. Arthritis, in Greek is translated as the "disease of the joints". Sometimes confused with 'Arthralgia' which is pain from a localized joint as opposed to Arthritis which is acute or chronic joint inflammation with both pain and damage to bone structure [2]. More than 100 different types of Arthritis have been identified and in this article two main types will be look at: Osteoarthritis, and Rheumatoid Arthritis. Osteoarthritis is the most common type of arthritis. The severity of the disease is identified by the scans done onto both sides of the knee bones basing on the KellgrenLawrence grading system. This disease is a main reason for the inability of older people to walk or go on about their lives and research have predicted that by 2050 at least 130 million people will be affected. [4] States that Rheumatoid Arthritis is another common type of Arthritis and is present in around 1% of the world's population. This 'chronic autoimmune illnesses initially begin as inflammation of the joints resulting in 'atrophy and bone rare fraction' leading to immense pain mainly affecting the small joints in the hands. [5] Even though, the diagnosis of these types of arthritis is based on experience, several different types of scans and certain medical instruments there is no set or proper method to track, record or monitor the condition of the patient continuously throughout his/her treatment. Therefore, through this research, a method to continuously track and monitor the patient once a doctor diagnoses the type of arthritis the patient has from the X-ray scans and blood work has been carefully curated for Ayurveda doctors.

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1.2. Research Gap

1.3. Research problem

1.4. Objectives

1.4.1. Main objective

1.4.2. Specific objectives

2. Methodology

The application is consisting of four major components, as shown in the system diagram in Fig. 1.They are as follows: XRay image analysis, which uses image processing to identify patterns in X-Ray images and classify them as indicative of arthritis and its severity; blood test results analysis, which uses deep learning to predict the progression of arthritis; personalized Ayurvedic treatment recommendation generation based on Ayurvedic principles; and continuous monitoring, which provides real-time feedback to the doctor. Initially, the application will capture X-Ray images of the arthritis as well as the results of the blood report, analyzing the patient's current condition. Separately implemented algorithms are used to recommend the most appropriate personalized Ayurvedic treatment to the patient based on those inputs. However, based on the X-Ray image pattern and blood report results, this system is given the opportunity to identify the selected types of arthritis—Rheumatoid arthritis and Osteoarthritis. The application's four components are discussed further below.

A. X-Ray Image Analysis

X-ray imaging is a common diagnostic tool for detecting joint inflammation. A neurologist examines the X-rays manually and predicts the diagnosis based on their expertise in the Ayurvedic approach. However, this method is timeconsuming and easy to make mistakes. With the advancement of technology and the development of machine learning algorithms, there has been a massive increase in pursuit of creating automated methods to detect joint inflammation and assess the severity of the condition using X-ray images. A convolutional neural network (CNN) was suggested to be developed to identify the patterns in X-ray images and classify them as indicative of arthritis and its severity. We obtained a dataset of X-ray images from Gampaha Wickramarachchi University of Indigenous Medicine. The collected dataset included the different severity levels of arthritis patients' images between mild to severe. Then the dataset split into training, and testing sets as 80:20 ratio respectively. Before training the CNN model we were preprocessed the X-ray images to improve the quality and the accuracy process. First the images were resized to a standard size of 150x150 pixels to ensure that all images were in the same size. Then the images were normalized to improve the stability of the model during training. In the final output the severity of the arthritis divided in to three nodes such as mild, moderate, and severe.

Blood Report Monitoring

In this research, blood test results from arthritis patients will be tracked over time using a longitudinal strategy. Patients with arthritis who are under therapy will be chosen for the research, which will be carried out at an Ayurvedic medical clinic. Patients with arthritis who are getting treatment will be chosen for the research. Patients will receive consideration Figure 1: Overall System Diagram if they have had at least two blood tests performed at the medical center, with the first test being performed at the time of diagnosis or before receiving treatment. Data from outpatient ferritin testing performed at Gampaha Wickramaarchchi University over a three-month period in 2022–2023 were used in this investigation. Each patient's blood reports were gathered, and the blood report results were retrieved (ERP, Blood Sugar, CRP).The patient's age, sex, blood report findings, and medical history for predictive tests run on the same

collection were all included in the data set. Point-of-care test outcomes and testing from satellite laboratories were not included; only results from testing completed within the main hospital laboratories were. If a collection lacked at least two predictor tests, it was eliminated. Using a final training set of 300 cases and a test set of 100 cases, the cases were divided into training and test partitions at random in a 7:3 ratio. Pre-processing will be performed on the data to eliminate any missing values or outliers. The blood test results will be converted into a time series format, with each result serving as a data point in the series. Create an LSTM model that can take time-series data as input and produce the predicted score for arthritis progression. The design can include dropout, batch normalization, or recurrent dropout layers for regularization, as well as one or more LSTM layers with various numbers of nodes. ht = LSTM(xt, ht-1) LSTM is a Long Short-Term Memory network that processes the input data and stores relevant information in its internal state. xt is the input at time t, consisting of blood test results (e.g., blood sugar, CRP, ESR, CPC metrics) and Ayurvedic treatment information for that time period. ht-1 is the internal state of the LSTM from the previous time step, which provides context for the current input. The LSTM uses the input xt and the previous internal state ht-1 to compute the new internal state ht, which is then used to make a prediction about the progression of arthritis at the next time step. The output of the LSTM at each time step can be fed into a fully connected layer to generate a final prediction for the progression of arthritis. The model is trained using a suitable loss function (e.g., mean squared error) and an optimization algorithm (e.g., Adam) to minimize the prediction error. Based on the outcomes of their blood tests and previous treatments, use the trained LSTM model to forecast the progression of arthritis in new patients. Analyze the f and offer your thoughts on the causes of arthritis progression and the efficacy of various therapies.

C. Ayurvedic Treatment Recommendation

The primary goal of the Ayurveda treatment recommendation component is to provide patients with arthritis individual treatment recommendation based on Ayurvedic medical principles. This method can take the patient's age, gender identity, symptoms,

and general health into consideration. To do this, the component's development will use a combination of machine learning algorithms and a knowledge-based system to evaluate patient data and generate personalized treatment suggestions based on Ayurvedic principles. For classification and regression tasks, machine learning experts frequently use the decision tree method. In the medical industry, it is frequently utilized for diagnosis and making therapy recommendations. The approach to developing the decision tree algorithm's Ayurvedic treatment suggestions component will make use of the Scikit Learns module, a popular Python machine learning tool. To build the Ayurvedic treatment suggestions component, a phased method would be utilized. The first step will be to gather and analyze knowledge on Ayurveda treatments for arthritis, including herbal remedies, dietary modifications, lifestyle changes, and other Ayurvedic treatments. Both the Ayurvedic General Hospital in Rajagiriya and the Gampaha Wickramarachchi Ayurveda Institute in Sri Lanka will provide information for this research. During the data preparation procedure, null values and duplicate values were discovered and removed. Then Scikit Learns StandardScaler was used to scale the data set for optimal performance. The dataset must still go through preprocessing after eliminating missing values, encoding category categories, and normalizing numerical variables, the dataset must still go through a pre-processing stage. Then the data was split into two sections for training and testing preparations. The decision tree method will then be used to the preprocessed data to build a model that predicts the best treatment recommendation for a new patient based on that patient's features. The algorithms will be trained using patient data, and will then generate personalized treatment suggestions based on Ayurvedic principles. The algorithms will then be evaluated using independent patient data to verify their effectiveness and accuracy. The algorithm that produces the best results will be chosen based on its performance indicators, including accuracy, sensitivity, specificity, and F1 score. The suggested algorithm will then be put into practice and used in a clinical context to offer personalized treatment suggestions to arthritis patients. The goal of the ayurveda treatment suggestions component is to provide patients with personalized treatment suggestions that are specific to their particular requirements and features, improving the treatment's efficacy and reducing the likelihood of side effects. Therefore, the suggestions of Ayurvedic treatments is an essential element of the

suggested intelligent Ayurveda medicine system and has the potential to improve the quality of life for arthritis patients.

D. Continuous Monitoring and Feedbacks

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 use 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, and Long Short-Term Memory (LSTM). Based on the results of these algorithms, the artificial neural network model was chosen as the most appropriate model for further implementations. The ANN model is a machine-learning algorithm that can learn patterns and predict results based on input data. They include mainly composed of interconnected nodes, or neurons, that are arranged into layers and can be trained to detect complicated data patterns. The ANN model 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 ANN model. To use the ANN model, 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 Learnas 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.

2.1. System architecture

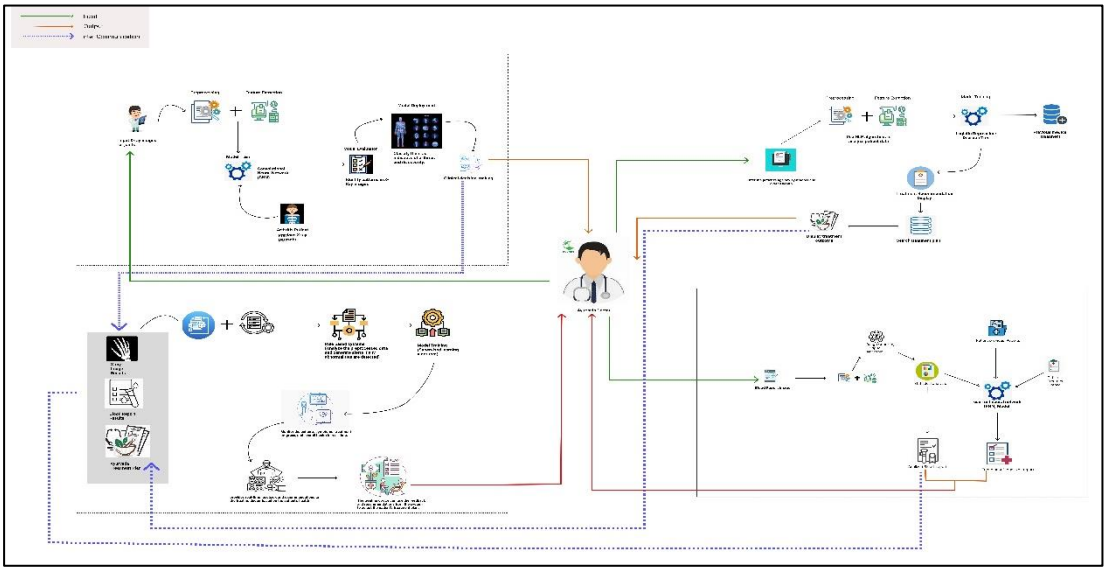

Figure 2.2.1: System architecture