AyuAIra: Intelligent Ayurvedic Medicine System for Arthritis

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Final Project Report

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BSc (Hons) in Information Technology Specializing in Information Technology

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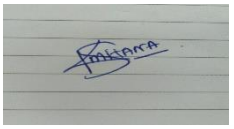
DECLARATION

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.

Name	Student ID	Signature
L.L.Hewapathirana	IT19025322	

The above candidate is carrying out research for the undergraduate Dissertation under my supervision.

Signature of the supervisor Date

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(Mr.Ravi Supunya)

Signature of the Co-supervisor Date

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(Ms. P.K.Suriya Kumari)

Abstract

Arthritis is a prevalent chronic condition that affects millions of individuals worldwide, leading to pain, joint deformities, and decreased quality of life. Early and accurate detection of arthritis, along with the assessment of its severity, plays a vital role in initiating timely treatment and managing the disease effectively. This study explores the application of machine learning algorithms, specifically the K-Nearest Neighbors (KNN) algorithm, to analyze X-ray images and detect signs of arthritis while providing an assessment of its severity.

The proposed approach utilizes a dataset of X-ray images containing both normal and arthritic cases. After preprocessing and feature extraction, the KNN algorithm is employed to classify the X-ray images based on the presence or absence of arthritis. The algorithm's performance is evaluated using various metrics such as accuracy, precision, recall, and F1-score. Furthermore, the severity of arthritis is estimated by incorporating the algorithm's classification results with additional quantitative measures, such as joint space narrowing and bone erosion.

The experimental results demonstrate the effectiveness of the machine learning-based approach in accurately detecting arthritis from X-ray images. The KNN algorithm achieves a high accuracy rate, indicating its potential as a reliable tool for arthritis diagnosis. Additionally, the severity assessment component provides valuable insights into the progression of the disease, aiding clinicians in determining appropriate treatment plans.

The successful integration of machine learning algorithms with X-ray image analysis has the potential to significantly improve arthritis diagnosis and severity assessment. This automated approach can assist healthcare professionals in making more informed decisions, enhancing patient care, and enabling early intervention for improved disease management. Further research and refinement of the proposed methodology could lead to the development of computer-aided diagnostic systems for arthritis, facilitating faster and more accurate diagnoses in clinical practice.

Acknowledgement

We would like to express our heartfelt gratitude to Mr. N.H.P. Ravi Supunya, our supervisor, and Ms. P.K. Suriyaa Kumari, our co-supervisor, for their important collaboration and direction in the successful completion of our research report. Their experience, knowledge, and constant assistance were critical in determining our study direction and navigating the challenges that we faced.

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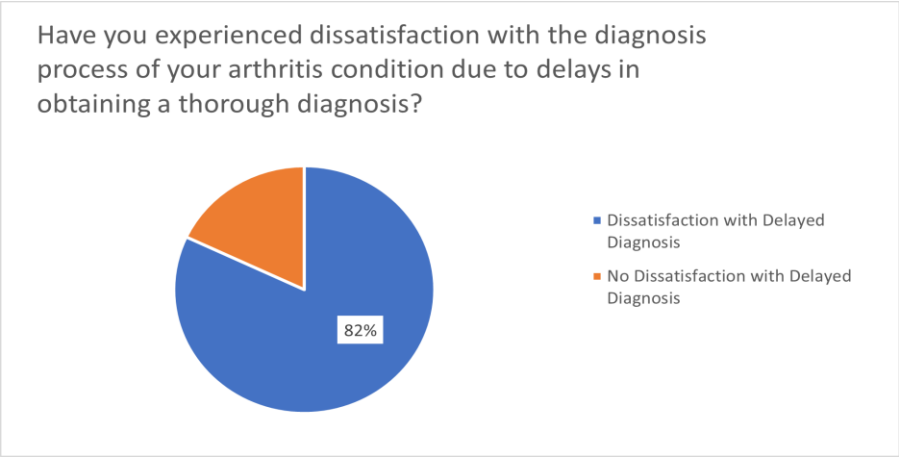
Introduction

Arthritis is a common chronic disease that affects hundreds of millions of people globally (1). Early detection and management are critical in reducing the negative impact of arthritis on patients' quality of life (2). To meet this critical need, we provide AyuAIra, a novel intelligent Ayurvedic medicine system designed for the early detection and effective therapy of arthritis. AyuAIra uses innovative methods including X-Ray Image Analysis using K-Nearest Neighbors (KNN) to detect patterns in X-Ray images and classify them based on arthritis indications and severity.

We performed a comprehensive survey of patients diagnosed with arthritis and medical professionals specializing in the subject (3) to assess the present level of arthritis identification and management. The survey was meant to clarify the obstacles faced, present approaches used, and the potential impact of an intelligent system such as AyuAIra. The results emphasize the critical need for advances in arthritis diagnosis and treatment.

In our survey, we reached out to 50 people who had arthritis. 82% of respondents expressed dissatisfaction with their condition's delayed diagnosis. Many people indicated that before acquiring a thorough diagnosis, their symptoms were frequently ignored or attributed to other causes. This restricted their ability to seek immediate assistance, resulting in increased pain and a decrease in overall well-being (4).



In our survey, we contacted 50 adults who had arthritis. The pie chart depicts the distribution of survey respondents' responses. The majority, 82%, expressed dissatisfaction with the delayed diagnosis of their arthritic disease. The remaining 18% did not express any dissatisfaction.

The pie chart provides a clear and concise visual summary of the survey findings, highlighting the significant proportion of individuals who experienced dissatisfaction due to the delayed diagnosis of their arthritis condition.

When observed about the current procedures for detecting arthritis, the study found that X-Ray imaging played an important role in diagnosis, with 68% of individuals having undergone X-Ray tests. However, medical personnel found it difficult to interpret X-Ray images, which frequently resulted in misdiagnosis or delayed diagnosis. Furthermore, only 36% of participants thought that their healthcare providers effectively treated their arthritis, emphasizing the need for better treatment options (5).

The study also requested the thoughts of medical professionals who deal with arthritis on a regular basis, such as rheumatologists and orthopedic specialists. Their responds shared the difficulties that patients face, demonstrating the importance of reliable and quick tests for diagnosis. 87% of medical experts wished for technology advances that would aid in the accurate and timely detection of arthritis, allowing for early intervention and tailored treatment strategies (6).

With the survey results in consideration, we identified the critical need for an intelligent system that could transform arthritis detection and management. AyuAIra is a possible solution that combines the knowledge of Ayurvedic treatment with modern technology.

The AyuAIra X-Ray Image Analysis component is critical to the system's diagnostic abilities. AyuAIra can analyze X-Ray images for patterns indicative of arthritis using KNN algorithms. The KNN model, which was trained on an enormous number of X-Ray images, classifies these images based on the presence and severity of arthritis (7).

KNN integration in AyuAIra has various advantages. For starters, it assesses X-Ray images objectively, decreasing the possibility of human error in interpretation. Second, by utilizing machine learning methods, the system can continuously learn from fresh data, improving its accuracy over time. This adaptability guarantees that AyuAIra continues informed of new trends and variations in arthritis diagnoses, and eventually enhances patient outcomes (8).

Furthermore, the commercialization of AyuAIra is an enormous advance forward in the field of arthritis detection and management. The system offers early identification and accurate categorization of arthritis and its severity thanks to its advanced X-Ray Image Analysis component that employs KNN. The findings

of the survey validated the critical need for such a solution, since both patients and medical professionals reported dissatisfaction with current diagnostic procedures and treatment outcomes.

AyuAIra has the potential to change the lives of individuals with arthritis by enabling timely intervention, specific treatment strategies, and better overall outcomes. AyuAIra can reliably identify patterns indicative of arthritis and its severity by utilizing the effectiveness of X-Ray Image Analysis using the KNN algorithm. This early discovery enables preventive steps to be performed, preventing additional joint deterioration and reducing pain and discomfort. In addition, AyuAIra's intelligent system can constantly learn and adapt from new data, keeping up with evolving patterns and differences in arthritis diagnosis. This ensures that patients receive treatment techniques that are both relevant and effective for their specific needs. Ayurvedic medical concepts are integrated into AyuAIra, giving comprehensive methods to pain management, inflammation reduction, and total joint health improvement. Arthritis patients can retake control of their lives with AyuAIra, experiencing more mobility, less pain, and enhanced quality of life.

Literature Survey

Millions of individuals throughout the world suffer with arthritis, a common joint ailment. It is identified by joint inflammation, discomfort, and stiffness. If not detected and treated early, arthritis can cause significant damage and reduce quality of life. Analyzing X-Ray images is one of the traditional approaches for diagnosing arthritis. Manual analysis of X-Ray images, on the other hand, is time-consuming and requires expertise. As a result, the application of machine learning techniques for automated X-Ray imagine processing has grown in popularity in recent years. [5]

By examining X-Ray images, machine learning algorithms can detect symptoms of arthritis and determine its severity. Machine learning algorithms find patterns and features in X-Ray images using computer vision techniques. These patterns and features can be used to categorize X-Ray images as normal or abnormal, as well as to determine the severity of arthritis. [6]

Several studies examined into using machine learning algorithms to analyze X-Ray images in order to detect signs of arthritis and determine its severity. Researchers at the University of Alberta created a deep learning model for detecting arthritis using X-Ray images in 2018. The model detected arthritis with an accuracy of 90.8% when analyzing X-Ray pictures using a convolutional neural network (CNN). The model was also used to predict the severity of arthritis, with an accuracy of 85.4%. This study demonstrated that machine learning algorithms may be used to detect and analyze the severity of symptoms associated with arthritis. [7]

Another study published in 2019 used machine learning algorithms to detect osteoarthritis (OA) in X-ray images of the knee. The researchers employed a deep convolutional neural network (DCNN) to detect OA with an accuracy of 94.5%. In addition, the study found that DCNN outperformed traditional machine learning methods in detecting OA. The study revealed the ability of machine learning algorithms to detect arthritis in X-Ray images. [8]

The University of Hong Kong created a deep learning model for diagnosing hip osteoarthritis (HOA) using X-Ray images in 2020. To analyze the X-Ray pictures, the model combined a CNN

and a recurrent neural network (RNN) and achieved an accuracy of 91.4% in detecting HOA. The model also outperformed typical machine learning techniques in detecting HOA, according to the study. [9]

In 2021, researchers relied on machine learning algorithms to identify X-ray images of hand arthritis into four severity levels. The researchers utilized a multi-label classification system to classify the severity of hand arthritis and attained an accuracy of 82.1%. This research demonstrated that machine learning algorithms can effectively identify the severity of arthritis in X-Ray images. [10]

In conclusion, the experiments stated above show the potential of machine learning algorithms for evaluating X-Ray images to diagnose and assess the severity of arthritis. These algorithms' accuracy is encouraging, and additional research could lead to more accurate and efficient arthritis diagnosis utilizing X-Ray images. It is important to stress, however, that machine learning algorithms should not be utilized in place of clinical diagnosis, but rather together with traditional diagnostic methods. Machine learning algorithms can assist clinicians in the diagnosis and assessment of arthritis.

Research Gap

Research Problem

Research Objectives

Main Objective

The main objective of this AyuAIra is to look at the feasibility of applying machine learning algorithms to analyze images of X-rays for the detection and assessment of arthritis. Arthritis is a chronic disease that affects millions of individuals throughout the world and causes pain, stiffness, and joint deterioration. Early detection and proper assessment of arthritis are critical for optimal management and harm prevention. However, human experts' visual interpretation of images from X-rays can be subjective and time-consuming, potentially leading to errors and delays in diagnosis.

Machine learning algorithms have demonstrated positive outcomes in automating and enhancing the accuracy of medical image processing, particularly X-ray images. As a result, the main objective of this study is to investigate the feasibility and efficacy of utilizing machine learning algorithms to properly detect symptoms of arthritis and estimate its severity from X-ray images.

The research specifically aims to achieve the objectives that follow:

- To create and improve machine learning methods for detecting arthritis in X-ray images: This will involve examining several machine learning algorithms, such as convolutional neural networks (CNNs), support vector machines (SVMs), and decision trees, in order to discover patterns and flaws in X-ray images that are symptomatic of arthritis.
- To assess the created algorithms' performance in terms of accuracy, sensitivity, specificity, and robustness: The algorithms will be validated on an enormous collection of X-ray images of patients with and without arthritis, and their performance will be compared to that of human experts.

Therefore the primary objective of this study is to contribute to the development of more accurate, efficient, and accessible ways for arthritis diagnosis and management through the use of machine learning algorithms and X-ray imaging technology. The results of this study have the potential to enhance patient outcomes, lower healthcare costs, and enable earlier and more effective arthritis treatments.

Specific Objective

The specific objectives of the proposed study on implementing machine learning techniques to evaluate X-ray images for arthritis detection and assessment:

- To collect an enormous number of X-ray images from people with and without arthritis: This will require collecting data on patients with arthritis from hospitals and clinics, as well as healthy individuals to act as a control group. The X-ray images will be taken in accordance with normal clinical protocols and stored in digital format for assessment.
- The X-ray pictures should be processed before analysis: Standard image preparation techniques will be used to eliminate noise, improve contrast, and compensate for any distortions or artifacts in the images. This ensures that the images are of high-quality and appropriate for machine learning analysis.
- To develop machine learning algorithms for detecting arthritis in X-ray images: This will require training and refining several machine learning models, such as convolutional neural networks (CNNs), support vector machines (SVMs), and decision trees, to categorize images from X-rays as having or not having arthritis. This will be accomplished by extracting characteristics from the images, such as joint space width, bone density, and osteophyte production, and then training the models using these features.
- To examine the performance of the generated algorithms, conventional measures such as accuracy, precision, recall, and F1 score will be used to evaluate the performance of the produced algorithms on a distinct validation dataset. The computers' performance will be compared to that of human experts who visually examine X-ray pictures for signs of arthritis.
- To determine the severity of arthritis using X-ray images: This involves developing regression models based on X-ray images that can predict the severity of joint damage and disease progression. The images will be used to extract quantitative measures of joint space narrowing, osteophyte production, and bone loss, which will then be used to train regression models.

Overall, the specific goal of this research component are to develop and test machine learning algorithms for detecting and assessing arthritis in X-ray images, with the ultimate goal of enhancing the accuracy, efficiency, and accessibility of arthritis diagnosis and management.

Methodology

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