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Osteoarthritis Grade Prediction System

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A B S T R A C T :

Osteoarthritis is a common joint disorder that leads to pain, stiffness, and reduced mobility, especially in older adults. Early and accurate detection is crucial for effective treatment and management. Early and accurate prediction of osteoarthritis grade is essential for timely intervention and treatment planning. The severity of osteoarthritis can be detected through radiographic images that show structural changes in the joint, such as joint space narrowing and bone spur formation. These radiographic patterns can be analyzed using advanced machine learning and deep learning techniques to automate and enhance the diagnostic process. In this work, we propose a system to predict the grade of osteoarthritis using knee joint X-ray images. After training the dataset with these algorithms, their performance is evaluated and compared to determine the most effective model for grade prediction. The system also suggests potential treatment paths based on the predicted grade of osteoarthritis.

Keywords: Osteoarthritis, machine learning, deep learning, CNN, ResNet, SVM, grade prediction, X-ray analysis.

INTRODUCTION

An osteoarthritis grade prediction system is a technology designed to help doctors identify the severity of osteoarthritis in patients. Osteoarthritis is a common joint condition that causes pain, stiffness, and reduced movement, especially in older adults. The prediction system uses medical data, such as X-ray images or patient records, and applies machine learning or image analysis techniques to estimate the disease stage. This helps doctors make quicker and more accurate decisions about treatment. By using this system, healthcare providers can offer better care and monitor the disease's progress over time, leading to improved patient outcomes.

The primary side effects of OA are pain and trouble in joint movement, decreased capacity and interest limitation, Joint stiffness in the first part of the day or after delayed rest. The present assessment of OA depends on clinical assessment, side effects furthermore basic radiographic appraisal strategies (X-ray), MRI (Magnetic Resonance Imaging), CT (Computed Tomography) and so forth. While a few different techniques have been proposed, Kellgren Lawrence (KL) framework is approved technique for characterizing individual joints into 5 grades

The sample of normal & affected Osteoarthritis knee image is shown below in figure 1.1 and 1.2.

Figure 1.1 Normal Knee Image

Figure 1.2 Osteoarthritis Knee Image

METHODOLOGY

2.1. Image Collection & Preprocessing:

Knee X-rays are collected from trusted datasets and cleaned using noise removal, normalization, resizing, and augmentation to prepare them for analysis.

2.2. Feature Extraction

A Convolutional Neural Network (CNN) scans X-rays to detect key indicators like joint space narrowing and bone deformities. Grad-CAM visualizes important features for transparency.

2.3. Model Training & Classification

Deep learning models (like ResNet50, DenseNet121) are trained using labeled data (KL Grades 0–4) with techniques like cross-validation and hyperparameter tuning for high accuracy.

2.4. Explainable Predictions:

AI-generated heatmaps show why a specific OA grade was predicted—boosting clinician trust and understanding.

2.5. User Dashboard & Reporting:

Doctors get instant, auto-generated reports via a web/mobile dashboard, integrated with patient records for monitoring and decision support.

SYSTEM DESIGN

3.1 Architecture Diagram

The architecture diagram of the Osteoarthritis Grade Prediction System presents a comprehensive clinical support framework designed to aid healthcare professionals in diagnosing and managing osteoarthritis. Users, such as radiologists and clinicians, interact with the system through an intuitive application interface. Medical images like X-rays or MRIs are uploaded via the Image Acquisition and Preprocessing Module, where they are enhanced for analysis. These images then pass to the Feature Extraction Module, which identifies critical indicators of osteoarthritis, including joint space narrowing and osteophyte formation. Extracted features are fed into the Grade Prediction Engine, where machine learning models classify the severity of osteoarthritis based on standardized grading systems such as Kellgren-Lawrence grades.
The results are compiled into structured reports by the Report Generation Module, making diagnostic information easily accessible for clinicians. Patient records, imaging histories, and predictions are securely maintained through the Patient Data Management Module within a centralized data storage system. Each module continuously updates this repository, ensuring complete and current clinical information.

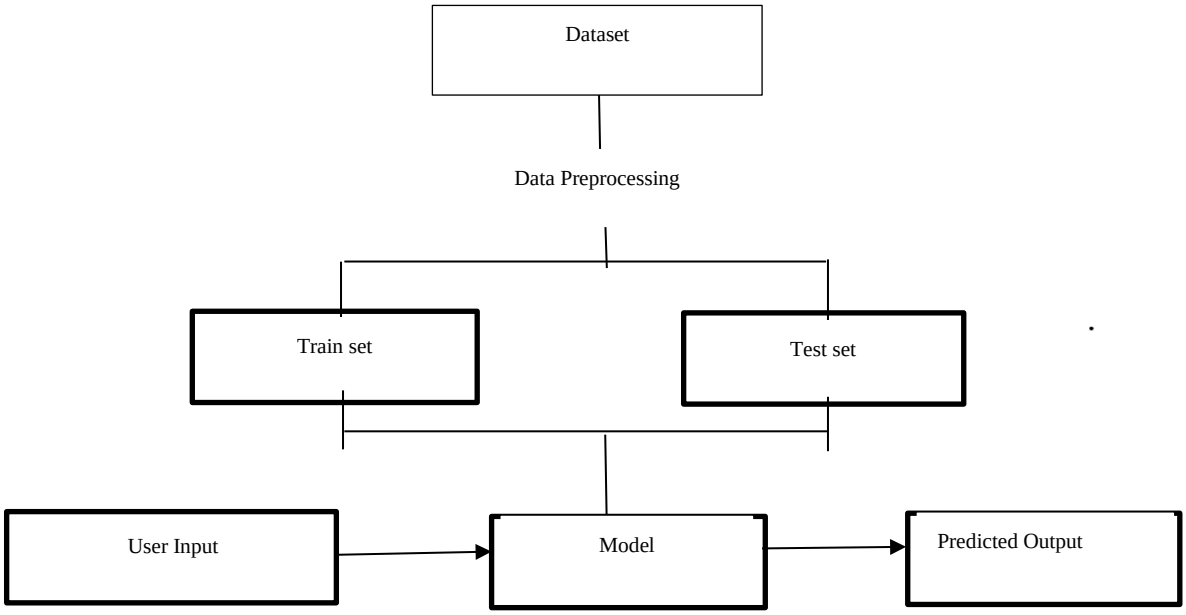
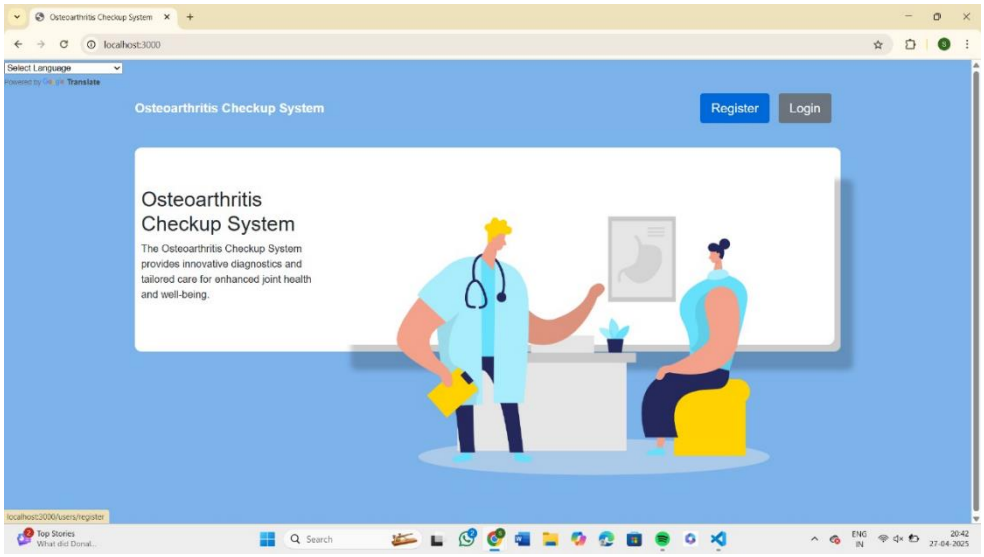


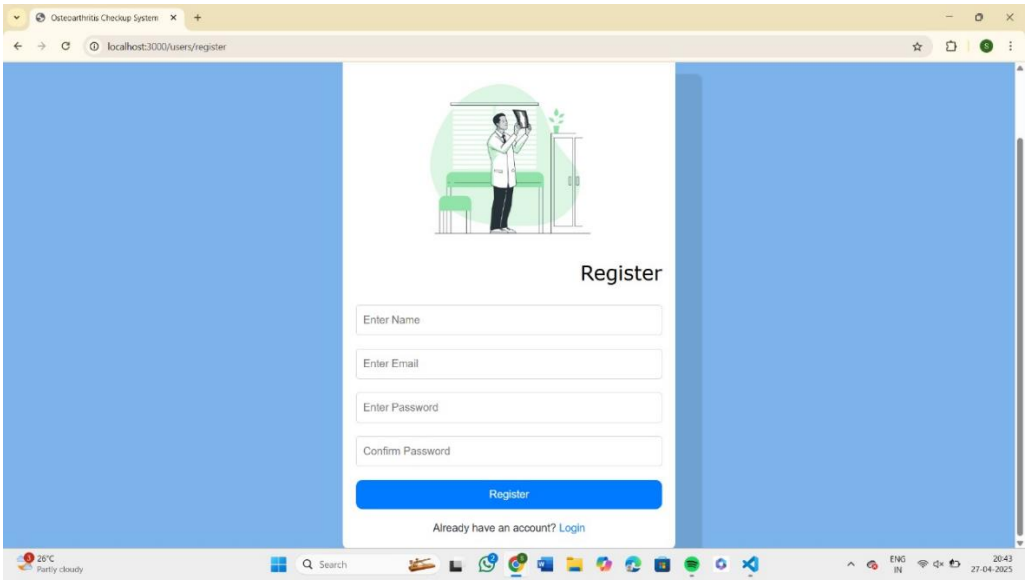
Fig.3.1: Architecture Diagram

IV RESULTS AND DISCUSSION

The Osteoarthritis Grade Prediction System was thoroughly tested, and the results confirmed its ability to accurately predict osteoarthritis severity based on medical images. The system demonstrated high reliability in grading osteoarthritis using machine learning models, providing clinicians with valuable, data-driven insights to enhance diagnosis and treatment planning.



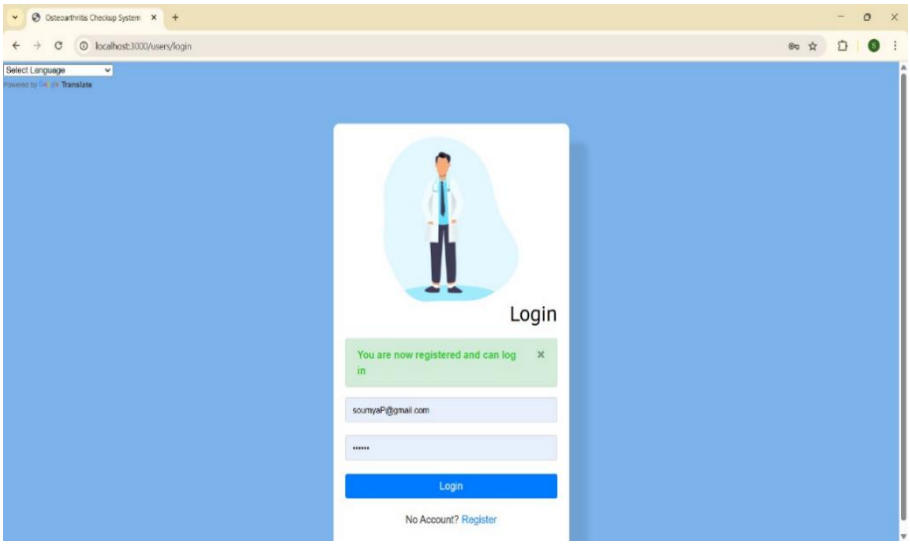
Snapshot.4.1: Home Page



Snapshot.4.2:Registration Page

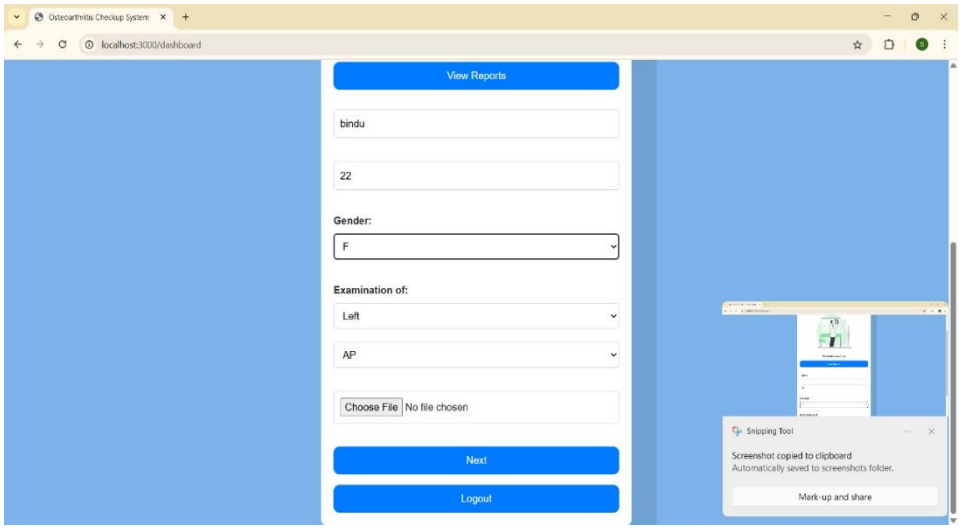
The Osteoarthritis Checkup System home page introduces the platform, highlighting its goal to deliver personalized diagnostics and care for joint health. Users can choose to register or log in to access the system.

The Register page allows new users to create an account by entering their personal and medical details



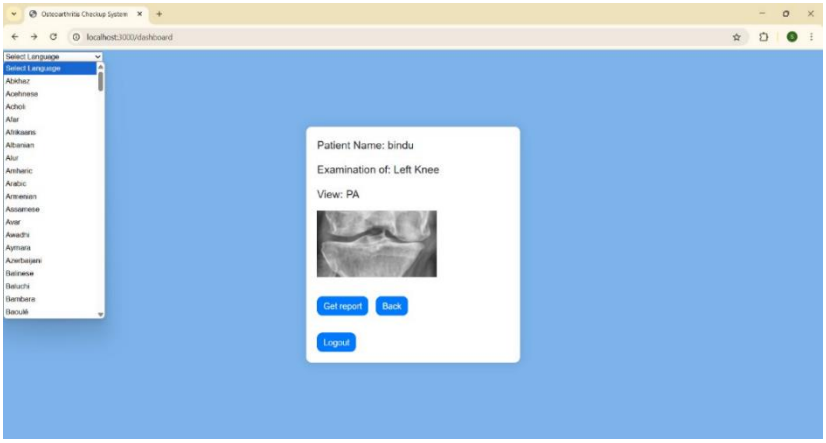
Snapshot.4.3: Login Page

The Login page allows existing users to securely access the Osteoarthritis Checkup System by entering their credentials. It ensures personalized access to diagnostic results and health management features.



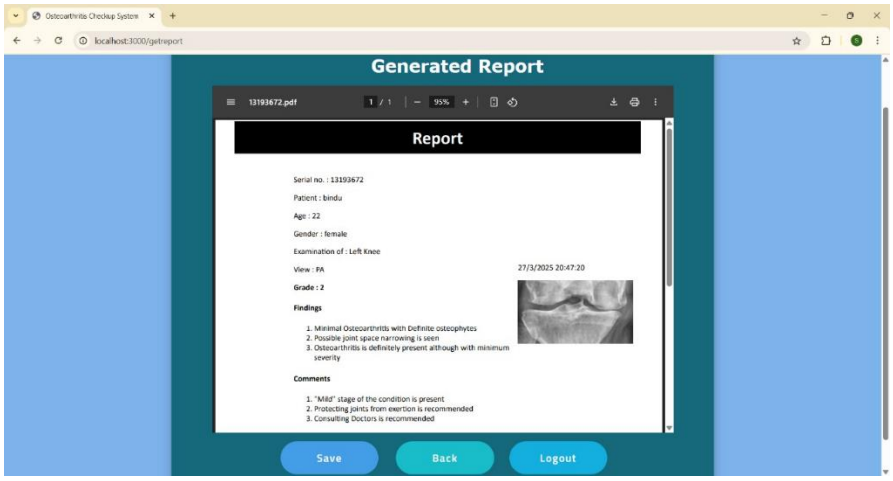
Snapshot.4.4: Patient Report Uploading

Doctors use this dashboard to input patient details, select the area and type of examination, and upload diagnostic files such as X-rays. This ensures accurate record-keeping and enables the system to assist in osteoarthritis assessment



Snapshot.4.5: Report Upload& change Language

This page displays a preview of the uploaded X-ray along with the patient's name, examination area, and view type. Doctors can review the image and click “Get report” to generate a diagnostic analysis or go back to make changes.



Snapshot.4.6: Generated Report

This page displays the auto-generated osteoarthritis diagnostic report, including patient details, examination findings, and medical recommendations. Doctors can save, go back, or log out from this screen.

IV. CONCLUSION

The Osteoarthritis Grade Prediction System was successfully developed and rigorously tested to ensure its performance, reliability, and user-friendliness. Through comprehensive unit, integration, regression, performance, supervised, usability, and security testing, the system demonstrated its capability to accurately predict osteoarthritis grades from medical images and assist healthcare professionals in clinical decision-making. Testing results confirmed that the system meets key objectives, including high prediction accuracy, efficient processing of medical imaging data, seamless integration with healthcare workflows, and robust data security in compliance with industry standards. Usability evaluations showed that the system is intuitive and accessible even for users with minimal technical expertise, supporting its adoption in clinical settings. Overall, the Osteoarthritis Grade Prediction System has proven to be an effective, scalable, and secure solution for enhancing diagnostic support, contributing to better patient outcomes, and advancing the role of AI technologies in modern healthcare. Future work will focus on continuous model improvement, expanding to other joints affected by osteoarthritis, and integrating advanced imaging modalities to further enhance diagnostic capabilities.

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