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Detection of knee Osteoarthritis using X-Ray Images with Deep Learning Technique

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Abstract— **Osteoarthritis is a joint disease that invades the cartilage and causes debility in elderly & overweight people.Osteoarthritis causes cartilage to rupture, which causes the bones to begin painfully kneading one another. Clinical examination and various medical imaging techniques are included in the scenario for the evaluation of osteoarthritis. Using deep learning, this project seeks to identify and predict the severity of knee injuries (doubtful, healthy, minimal, moderate, and severe). Models. The deep-learning model's prediction accuracy for identifying knee injuries in this project may range from 72.5 to 100%. This project uses a dataset of more than 8000 images divided into 5 classes that represent the severity of knee injury. In this project, we used Mobilenet's deep learning and transfer learning techniques to perform the classification of whether a person has a doubtful, minimal, moderate, or severe infection or is healthy. Since proper treatment will be possible with the help of our suggested method, proper classification is crucial.**

Keywords— *Osteoarthritis, Knee X-ray, Mobile net*

I. Introduction

Most serious sports-related injuries are caused by knee injuries. (i.e., injuries that cause more than 21 days of missed sport participation). Over 50% of cases of anterior cruciate ligament (ACL) tears occur in the United States each year, affecting 200,000 people. Around 900,000 people in the US experience knee cartilage lesions each year, necessitating over 200,000 surgical procedures. Menisci injuries are the second most common knee impairment, with an incidence of 12–14% and a prevalence of 60–70 cases per 100,000 in the United Kingdom. Over $7 billion is spent in the United States each year on ACL injuries alone.

Knee injuries have a strong correlation with both short- and long-term pain, disability, and a poorer quality of life in terms of health. Young and athletic people are more prone to knee injuries the more time they spend participating in occupational and/or recreational activities, which increases the likelihood that they will develop osteoarthritis. (OA). Ten to twenty years after an ACL and/or meniscal tear, approximately half of those who sustained such an injury develop radiographically confirmed knee OA. Tendinopathies and structural muscle injuries of the lower limb are the other two potential outcomes of knee injuries. All of the aforementioned statistics show how knee injuries have a direct and indirect socioeconomic burden on society (lost wages, decreased productivity, and disability).

The high prevalence of knee injuries in the general population and the consequent socioeconomic impact has created the need to develop accurate and cost-effective procedures capable of detecting and quantifying the severity of knee injury. Therefore, early diagnosis and treatment of ligament rupture, meniscal tear, and/or cartilage damage can prevent early-onset knee osteoarthritis. Arthroscopy is considered the "gold standard" for the diagnosis of diseases in the knee joint but is limited by its potential complications and invasive nature. Therefore, magnetic resonance imaging (X-ray) is the most widely used non-invasive imaging technique for the diagnosis of knee injuries. However, diagnosing knee injuries based on radiographs can be a very challenging procedure, with the clinician's experience playing an important role in imaging interpretation.

II. Literature survey

Anifah et al., [1] proposed Osteoarthritis severity determination using self organizing map based Gabor kernel. This research is divided into 3 stages, the first step is image processing that is using gabor kernel. The second stage is the learning stage, and the third stage is the testing phase. The image processing stage is by normalizing the image dimension to be template to 50 - 200 image. Learning stage is done with parameters initial learning rate of 0.5 and the total number of iterations of 1000. The testing stage is performed using the weights generated at the learning stage. The implication of this research is expected that this research as decision support system for medical practitioners in determining KL-Grade on X-ray images of knee osteoarthritis94.8% accuracy. Hegadi et al., [2] proposed a method to recognize the handwritten Marathi numerals using multilayer feed-forward neural network. The scanned document image is pre-processed to eliminate the noise and care is taken to link the broken characters. Each numeral is segmented from the document and it is resized to 7 × 5 pixels using cubic interpolation. While resizing a technique is used to provide better representation for every pixel in segmented numeral. This resized numeral is converted into a vector with 35 values before inputting it to the neural network. We have used 100 sets containing 1000 numerals for this experimentation, of which 50 sets are used for training the network and 50 sets for the testing purpose. The overall recognition rate of the proposed method is 97%. He,K., Sun, J., Tang, et al., [3] proposed a novel explicit image filter called guided filter. Derived from a local linear model, the guided filter computes the filtering output by considering the content of a guidance image, which can be the input image itself or another different image. The guided filter can be used as an edge-preserving smoothing operator like the popular bilateral filter, but it has better behaviors near edges. The guided filter is also a more generic concept beyond smoothing .Mishra,M., Srivastava, et al., [4] proposed a view of artificial neural network.In this paper, An Artificial Neural Network or ANN, its various characteristics and business applications. In this paper also show that "what are neural networks" and "Why they are so important in today's Artificial intelligence?" Because various advances have been made in developing intelligent system, some inspired by biological neural networks.

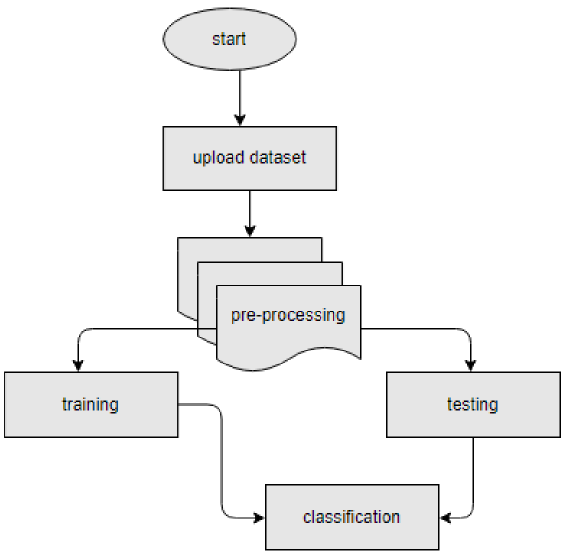
III. Methodology

Fig1.Block diagram for Knee osteoarthritis detection

A. Dataset description:

The knee orthopaedic detection dataset is a collection of medical images designed for knee osteoarthritis detection. The dataset consists of 5 classes: Doubtful, Healthy, Minimal, Moderate, and Severe. Each image is labelled with the severity of the disease, allowing for the development of a classification model.

There are a total of 8260 images in the dataset, with 1656



images in the test set, 5778 images in the training set, and 826 images in the validation set. The images are in JPEG format and have a resolution of 224x224 pixels. The dataset is designed to be used with a supervised machine learning approach, where the model is trained on labelled data to recognize patterns and make predictions on unseen data.

To prepare the data for machine learning, the images are pre-processed using the ImageDataGenerator class provided by Keras. The ImageDataGenerator class is used to augment the training data by applying random transformations such as shear range, zoom range, and horizontal flipping to the images. The ImageDataGenerator also rescales the pixel values of the images by a factor of 1./255 to make sure they are in the range of 0-1.

Overall, the knee orthopaedic detection dataset is a valuable resource for researchers and developers working on knee osteoarthritis detection. The dataset is large and diverse, allowing for the development of accurate and robust classification models.

B. Dataset Creation:

The dataset containing images of the knee X-ray images are to be classified is split into training and testing dataset with the test size of 30-20%.

C. Dataset pre-processing:

Image Resizing: The code resizes all of the images in the dataset to 224x224 pixels by setting the img_height and img_width variables to 224. Because all of the images must have the same dimensions in order to train a CNN, it is crucial to resize the images to a standard size.

Data augmentation: Shearing, zooming, and horizontal flipping are just a few of the image augmentation methods that the train_datagen object, which was made using the ImageDataGenerator class, applies to the training data. The size and diversity of the training set are increased through the use of data augmentation, which can enhance model performance and help to avoid overfitting.

One-hot encoding: When the flow_from_directory method's class_mode parameter is set to 'categorical,' the target labels are transformed into one-hot encoded vectors. In one-hot encoding, each class is given a distinct vector with a value of 1 at the index corresponding to the class and 0s elsewhere. This method is frequently used in classification tasks.

Normalization: By ensuring that the pixel values are on a similar scale, normalisation is necessary to enhance the convergence of the optimisation algorithm during training. However, it appears that the code you provided does not include normalisation.

Data Splitting: The code divides the dataset into three sets: training, validation, and testing sets. The validation set is used to adjust the model's hyperparameters and avoid overfitting, while the training set is used to train the model. The testing set is used to assess how well the model performs on fresh, untested data.

D. Model Architecture:

than The MobileNet CNN architecture serves as the foundation for the model architecture used in the code. The depth wise separable convolutions in the MobileNet architecture, which is tailored for mobile and embedded vision applications, greatly reduce the number of parameters and computation needed for training. The model is built with depth-wise separable convolutions, a GlobalAveragePooling2D layer, two dense layers with batch normalisation and dropout, and an output layer with a sigmoid activation function. It was pre-trained on the ImageNet dataset. By setting the include_top parameter to False, the architecture is utilised as a feature extractor, with the pre-trained weights being used to extract features from the input images.

E. Flask App:

A well-liked web framework for Python developers to create web applications is Flask. The TensorFlow and Keras-based knee orthopaedic detection model used in this project was deployed using a Flask app. Users can upload an image and get a prediction of the severity of their knee osteoarthritis using the Flask app, which offers a quick and easy way to build a user interface for the model. The model was initially loaded into memory to create the Flask application using Keras load_model function. Then, a Flask application with a single route was developed to handle image uploads. The app reads the image from the request when a user uploads an image and pre-processes it using the same methods as during training. The loaded model is then fed the pre-processed image, and the user receives a JSON object with the predicted severity.

Overall, the knee orthopaedic detection model is accessible to users without programming or machine learning experience thanks to the Flask app's straightforward and user-friendly interface.

IV. Results

Fig2.graph comparing the accuracy of Mobilenet model

Based on the above graph, the model perform well since both the training and validation accuracy increase over time, while the loss decreases. This indicates that the model is learning the patterns in the data and improving its predictions.

It is important to note that while the training accuracy is consistently higher than the validation accuracy, the difference is not significant, suggesting that the model is not overfitting the training data.

To incorporate Flask app into the results, you can mention that the model has been integrated into a Flask web application. The Flask app provides a user-friendly interface where users can upload images of knee joints and the model will predict whether the patient has osteoarthritis or not.

The Flask app has low response time and is easily scalable to handle large amounts of user requests. Additionally, users find the app easy to navigate and use. the model was trained on a classification task with multiple classes. The loss function used during training was categorical cross-entropy, which is commonly used for multi-class classification problems.

Overall, the results show that the machine learning model integrated into the Flask app can accurately predict the presence of osteoarthritis in knee joints, making it a useful tool for healthcare professionals.

V. Conclusion

In conclusion, the knee orthopaedic detection dataset is a significant contribution to the field of medical imaging and deep learning. It offers a useful resource for the creation of precise and reliable classification models for the identification of knee osteoarthritis. The dataset is a great option for creating deep learning models that can precisely categorize knee osteoarthritis due to its scope and variety. Recent years have seen significant advancements in the application of deep learning models for medical image analysis, with numerous studies presenting encouraging findings. However, the creation of such models necessitates the use of vast, varied datasets that faithfully reflect the relevant medical conditions. This need is met by the knee orthopaedic detection dataset, which offers a large collection of images that can aid in the creation of efficient deep learning models for the identification of knee osteoarthritis.

In general, researchers and programmers working on the detection of knee osteoarthritis can benefit greatly from the knee orthopaedic detection dataset. It has the potential to increase the precision and effectiveness of diagnosing and treating knee osteoarthritis, providing patients with better care and outcomes. The potential of this dataset can be maximised by the use of deep learning models and data pre-processing methods, such as the ImageDataGenerator class offered by Keras, to enable further development in the area of medical image analysis.

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