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Application Of Deep Learning Techniques For Effective Assessment And Prediction Of Arthritis In Aged People

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Abstarct: ***Arthritis is an autoimmune disorder characterized by chronic synovial inflammation mainly leading to the destruction of joints and bone erosions. In aged people, arthritis is more common than any other disease, and it causes pain in the musculoskeletal system that lowers the quality of life of patients. The use of deep learning in medicine is increasing and has provided new avenues for research into a number of diseases. In this paper, we are using deep learning for detection of arthritis in finger joints from X-ray images of hand based on convolutional neural networks. For training 70 X-ray pictures are taken and for testing 10 X-ray pictures are taken. This system achieved more accuracy for test data sets. The proposed method will aid clinical researchers to learn more on arthritis.***

Keywords : Arthritis, Deep Learning, Convolution neural network, Python, TensorFlow.

I. INTRODUCTION

Arthritis is inflammation of one or more joints. An area where two bones meet is called joints. Arthritis creates pain, rigidity, swelling and loss of functions in our joints. Healthy joints move effortlessly because of smooth and slippery tissue called articular cartilage. Our joints have flexible connective tissue called cartilage. It protects our joints by absorbing the pressure and shock generated by moving and putting stress on them. Reductions in this cartilage tissue's ordinary quality cause arthritis. The X-ray picture of mild arthritis is represented by figure 2 and the X-ray picture of serious arthritis by figure 3. The main reason for arthritis is the reduction of cartilage tissue in joints. This is the only reason which causes arthritis. The main symptoms of arthritis are a joint pain, swelling in hands, redness and causes stiffness in motion.

Two main types of arthritis:

1. Osteoarthritis.
2. Rheumatoid arthritis.

Osteoarthritis: The joint cartilage and underlying bone degeneration cause osteoarthritis. This form of arthritis is more seen in middle age peoples. It creates joints pain and rigidity.Rheumatoid arthritis: Rheumatoid arthritis is a inflammatory disease that will influence more on joints.

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The Rheumatoid arthritis mainly caused in old age people. We have collected all X-ray images from patients who are suffering from Rheumatoid arthritis. The normal image of patient who has Rheumatoid arthritis is shown in figure1.

Fig:1 Image of Rheumatoid arthritis patient.

We propose a CNN based finger joint detection algorithm and TensorFlow. A Convolution neural network is one of the categories of deep neural network. A convolutional neural network in deep learning is a class of neural networks and most frequently used for visual imaging. CNN have been used to understand natural language processing. TensorFlow is a python friendly and open source library for numerical computation. TensorFlow is a large scale machine for gaining knowledge. TensorFlow bundles a slew of machine learning, deep learning models and algorithms together and making them useful through popular metaphor. It utilizes the python language to provide an easy front end API for application constructions. TensorFlow enables the developer to produce dataflow graphs that describes the movement of information through the graph.Deep learning is a subfield of machine learning which is influenced by the brain's structure and function called artificial neural network. The methods of deep learning like (CNN) convolution neural network and deep neural network has been applied in the areas including audio and speech recognition, medical image analysis, computer vision and more. Deep learning techniques have developed the successful outcomes than human specialists. Python is a high level programming model and it is object oriented. Python is used for creating GUI application and also used to create websites and web applications. The GUI library of python is Tkinter. In combination with Tkinter, python makes the creation of GUI easier. Tkinter offers the TK GUI toolkit with a strong object oriented interface. The Tkinter is mostly installed on unix and windows platform.

Fig: 2 Mild arthritis X-ray[5]

Fig: 3 Severe arthritis X-ray[5]

The rest of the sections are splitted as follows: In section two we describe related work, the methodology is explained in section three, section four refers to result and conclusion is described in section five.

II. RELATED WORK

Max A Viergever, Maria J H De Hair, Yinghe Huo, Floris P Lafeber and Koen L Vincken said by searching for distinct route sections consecutively we can detect the joint area across the scaphoid bone. Firstly, the boundary could not be affected by X-ray projection and get the correct joint margin it follows the backtrack process for joint margin delineation. The precision of quantified JWS is assessed by comparing with manually acquired ground reality. It is discovered that 90% of the joints had a JWS deviation of less than 20% from the usual JSW of manual signs, with a mean JWS mistake of <10% [2]. Hamidreza Moussavi, Ali Nouri and Rasoul Amirfattahi by using NP windows in bilateral hand pictures, they attempted to assess the structural asymmetry. Firstly, they have removed the background of the images and then the images have to be registered to obtain the values of distribution in the joint. In the next step, the joint histogram has been estimated and for images, they have applied NP windows. Finally, data is calculated by using an joint estimated histogram. Because of certain symmetrical patterns in bilateral hand pictures, this technique shows the MI values which are calculated for healthy patients are greater. From these results, we can distinguish the patient groups with p-value of about 0.0124 at a significance level of 5% [3]. Sujata N Kale and Swati A Bhisikar have developed an algorithm on image processing which gives the solution for two major problems in JSW measurements and joint detection. This algorithm has five steps, In the first step using the Gaussian filter, the image preprocessing is made. In the second step by separating the foreground and background, the hand mask is extracted by using Otsu's binarization technique. In the third step, they apply the morphological thinning to get a thin skeleton of a binarized image. In the fourth step, the joint located in the X-ray is detected by using the Gabor filter. In the fifth step, the joint space width is evaluated and extracted automatically. They have successfully calculated 120 JWS values for finger joints by experimenting 10 digital X-ray images of a hand with the resolution of about 2000 pixels*2000 pixels [4].

Atuski Tashita, Syoji Kobashi, Kento Morita and Manabu nii proposed the joint detection approach in fingers and estimation of mTS score technique for patients who have mild and severe (RA) Rheumatoid Arthritis. The analyzed consequences of the proposed method for 45 RA patients show an accuracy of 81.4 %. The JSN score and erosion were detected with an accuracy of 64.3% and 50.9 % respectively. The values of estimation error and erosion of JSN score is 0.43 ± 0.12 and 0.59 ± 0.24, respectively. They have considered the high estimated error will harms the accurate estimation. These results suggest the patch for the image. The proposed method improves accuracy by increasing the number of subjects [5]. A Maria J H De Hair, Yinghe Huo, Floris P Lafeber, Koen L Vincken, Desiree van der Heijde, and Max A Viergever presents a complete computerized technique for joint place and margin detection in (RA)Rheumatoid Arthritis hand radiographs. The suggested method is suitable for RA qualification of JWS and used in big cohorts. With the quantitative measurements, it could be anticipated that JSN could be detected larger than using ordinal values. Their further study is primarily applied to the automatic technique to huge scale cohorts, thus examining whether the strategy has a multiplied sensitivity relative to the standard SvdH scoring method [14].

III. METHODOLOGY

In deep learning, CNN is a class of deep neural network and CNN is mainly applied to study visual imagery. CNN is a multilayered model. The four layers are: Convolution layer, Pooling layer, ReLu layer and Fully connected layer. The convolution, pooling and ReLU layers are hidden layers. CNN's construction block is the Convolution layer. This layer's parameters consist of filters and specify the size of the kernel and amount of filter.

The Pooling layer is a nonlinear down sampling type. This layer works and resizes each slice of the input.

The ReLU (rectified linear unit) layer that focuses primarily on non-saturating activation functions. It gets rid of all adverse value from the activation map by setting the values to zero. In Fully connected layer the high-level reasoning in the neural network is done. The neurons in this layer are linked to all prior layer activations and classification is done in this layer. Figure 4 represents the four layers and classification of CNN model.

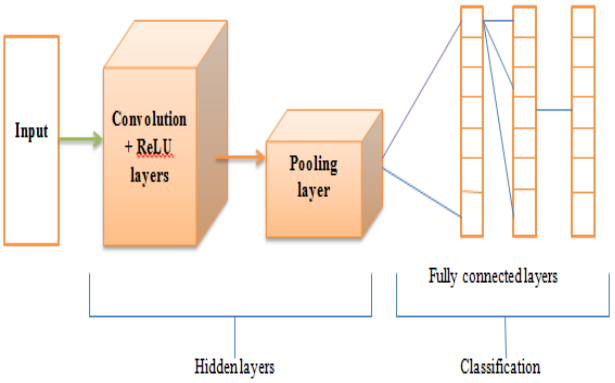

Fig:4 CNN model four layers and classification.

The flow chart in Figure 5 represents the detection of arthritis. For detecting arthritis there are four stages: Data collection, Preprocessing phase, Model building and prediction.

A. Data Collection

Collection of data sets is a major part of the project. The X-ray images are collected from the diagnosis centre and BMC hospital; because it is a government hospital and more patients come to this hospital. The X-ray images are collected from aged people. The images are collected from both healthy and arthritis patients. The images are predicted into healthy and unhealthy.

B. Preprocessing phase

Here we convert the image into a grayscale image. We resize the image by changing the dimensions, height or both. Also, the ratio of the original image will be preserved in the resized image. To resize an image, OpenCV presents cv2.resize() function. Later we convert the images into NumPy array and we append the NumPy resultant array of images and images are send to training datasets.

C. Model building

In deep learning, the models are built using neural networks. The neural network takes the input images and then processed in hidden layers using weights (there are two hidden layers), weights are adjusted during training to find the patterns in order to make good predictions. The neural network learns the patterns on its own by analyzing the image for better prediction.

D. Prediction

In this step, we intake images from test data set. We pass the image for prediction. Finally, the model predicts whether the given X-ray image is healthy or unhealthy (Arthritis).

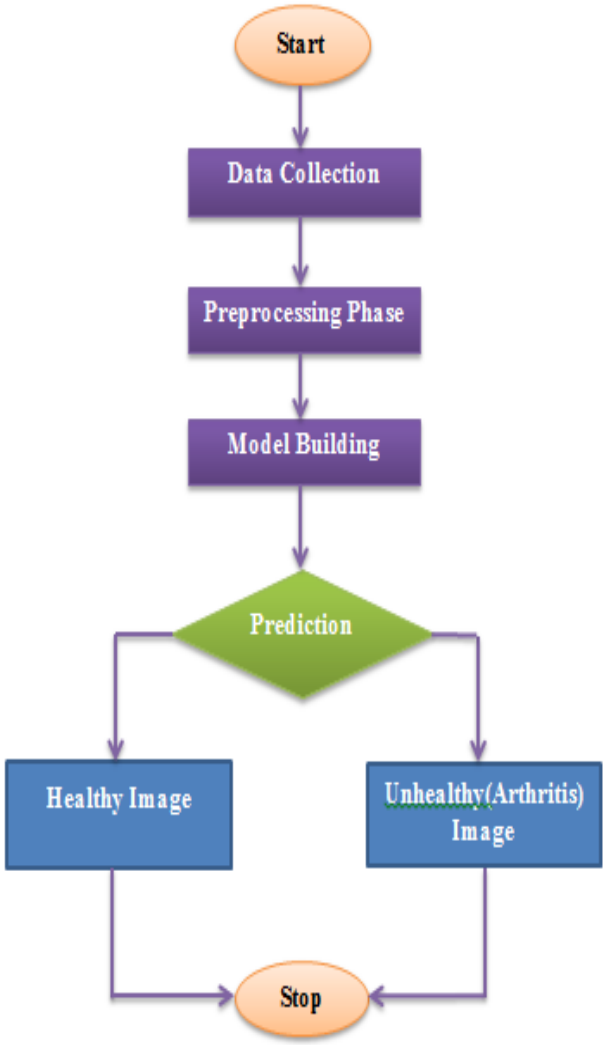

Fig: 5 Flow chart of detection of arthritis

IV. RESULT

In this paper, we assessed the efficiency of CNN-based finger joint detection. For this purpose, 70 fingers X-ray pictures of fingers are taken for training and 10 fingers X-ray pictures of fingers are taken for testing. All 10 images gave accurate results. The X-ray images are predicted into healthy and unhealthy patients. The remedies will be displayed for unhealthy (Arthritis) patients. This will help doctors to see whether their prediction is right.

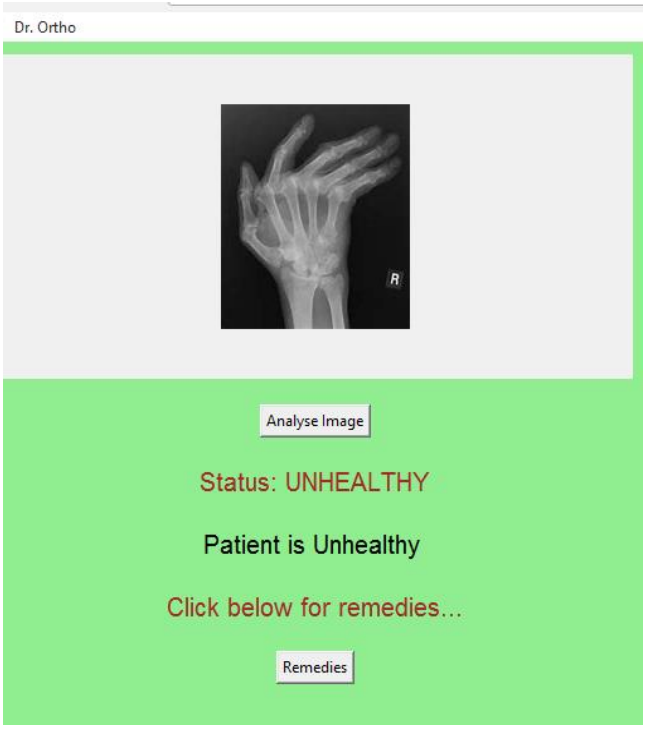

Fig: 6 Output of arthritis patient

After selecting an X-ray image we have to test whether the input image is healthy or unhealthy. The functionality of the input image corresponds to the characteristics of arthritis then the given input image is unhealthy (arthritis patient). Figure 6 represents the output of arthritis (unhealthy) patient.

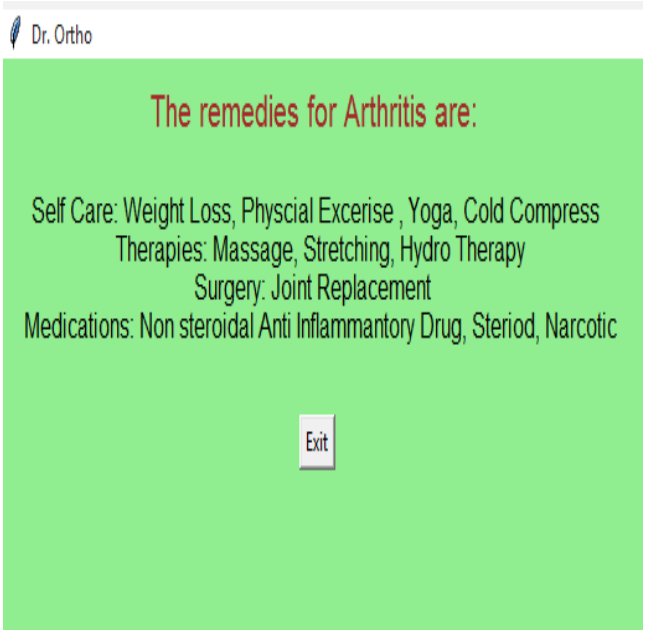

Fig: 7 Remedies for arthritis patient

After testing the X-ray image, if we get the image status as unhealthy then the patient has arthritis. For Arthritis patient the remedies will be displayed which is shown in figure 7. These remedies are helpful for arthritis patients.

Fig: 8 Output of a healthy patient

By selecting an X-ray image for testing if we get the input image status as healthy then the patient is healthy and it is shown in figure 8. The functionality of the input image corresponds to the characteristics of normal person (who does not have arthritis).

V. CONCLUSION

In this paper, we proposed a Deep Learning Model for predicting Arthritis in finger joints using Convolution Neural Network. Using test data sets collected from aged people the X-ray images are predicted. CNN achieves more accuracy using pre-processed data and number of neural layers for Arthritis detection. This is an image analysis tool for hand (finger joint) X-ray and it will be a useful resource for clinical researchers to learn more about the advancement of finger joint in aged people.

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