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Infrared Thermography for Orthopaedic Disorders by Image Processing

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Abstract - *The orthopaedic or musculoskeletal problems have been increasingfrom last 2 or 3 decades. The technology that exist right now have less number of accuracy and the severity of the matter can go unnoticed because of some human error. So, the Infrared Thermography is one of the new budding technologies for Medical Applications. The main perspective of the report is to shed light on the concept of using Algorithms (Python based), which can improve the accuracy of the systems detecting musculoskeletal disorders. The process or the Algorithms are feasible for all the systems such as X-ray, CT scan, Thermal Imaging, etc. However, the brief also make us known with the advantages of using Digital Thermography and also give us a brief on the detailed report provided by Thermal Imaging and how it can help in the early detection of some severe diseases and injuries. It also provide us with Deep-Learning Algorithms which can be beneficial in any other ortho problem detecting System.*

Key Words:*Thermal Imaging, Musculoskeletal, Orthopaedic Disorder, Infrared Thermography, Digital Infrared Thermal Imaging (DITI), RNN, CNN, ANN.*

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I. INTRODUCTION

Orthopaedic problems have been a major area of concern since ancient times in the human body. The new technologies that are there in the market are good enough to detect the fractures, inflammation, tears etc. But, the accuracy of these systems varies with the system features. The devices used are the instruments and the output is not processed but are only used to see the affected area. In some cases where the X-rays are sufficient enough but the inconsequential details are not picked due to the lack in its visibility which can also be termed as human error. In this case we need a system where the system can read the images from scale to scale and can give the precise output. Image Processing can help in this kind of situations. The Image Processing when processed through the algorithms can predict the right disorder happened in the affected zone.On the other hand, the project also give the details of the DITI and how it can minimize error when used with the algorithms and give a detailed thermal image of the body.

1.1 Digital Infrared Thermal Imaging

DITI is nothing but a thermal imager which can read the heat patterns. The human body emits heat which is not visible with the normal cameras. The heat patterns helps us to detect the underlying diseases by showing us unusual heat pattern at the affected area. DITI is also one of the safe way to detect the problems as it does not emit any radiation and hence can be used frequently to detect some diseases in their early stages. Most importantly it can detect Cancer, Diabetes, Stress Fractures, etc, even before any other device. IRT is solution for all the musculoskeletal related problems.

1.2 DL Algorithms

In this project, DITI will be used to for taking the appropriate images of the body and the DL Algorithm will provide us with the accurate output and will detect the disorder happening to the patients. The DL Algorithms are the Python based codes that are specifically generated to compare the input image with the given reference data and give the output accurately according to the given Reference data. The DL algorithm will use the methods such as CNN, RNN, ANN to give use the accurate output. First we collect sufficient data of images with different disorders and then combine them to make a saturation of a big data set and treat it as the reference data. Then, through the methods (CNN, RNN, ANN) we compare the patients image with the

reference data and get the accurate disorder as our output. However, the same DL methods can be used in any other detecting system such as X-ray, CT scan, etc. The only difference is that the Reference data will contains image of the respective system which is being used. For example if we use DL algorithm to detect disorder through X-ray, then we need to make a reference data using different X-ray images

II. LITERATURE SURVEY

After referring many available research papers, some of the related paper that we were referred are given below

[1] Swati Shinde[1], Uday Kulkarni[2], Deepak Mane[3]

There is a wide spectrum of different deep learning (DL) architectures available for medical image analysis. Among this convolution networks (CNN) found to be more efficient for variety of medical imaging task including segmentation, object detection, disease classification, severity grading, etc. In medical image analysis, accuracy of prediction is of utmost importance.In machine learning or deep learning, quantity and quality of medical image dataset plays a important role for ensuring the accuracy of future prediction. Otherwise because of less number of poor quality images, machine or deep learning models fail to predict accurately. This limitation of less quantity and less quality medical image dataset is almost removed to major extent by the transfer learning concept of deep learning.

[2] PiotrBargiel[1], Norbert Czapla[2], Jan Petriczko[3]

This paper is a systematic review on the use thermography as a diagnostic tool in musculoskeletal disorders. Thermal imaging cameras record skin surface temperature. As many musculoskeletal disorders impair cutaneous circulation, with thermography we can observe circulatory abnormalities in inflammation, ischemia or sympathetic system dysfunction. Based on literature data a number of uses for thermography in musculoskeletal medicine can be found. In orthopaedics in the diagnosis and evaluation of joint disorders, vertebral column pathologies or to monitor the effects of physical rehabilitation. In rheumatology, to diagnose soft tissue inflammatory disorders. In surgery, and neurology, to assess nerve damage. In sports medicine, to select appropriate training intensity or as a diagnostic tool to detect injuries. Available literature shows that thermography, although unspecific, is a very sensitive method and can be a valuable complementary diagnostic or screening test.

[3] S. Sruthi[1], M. Sasikala[2]

This paper presents a low cost thermal imaging system for medical diagnostic applications. Available systems are expensive and are mostly meant for industrial applications. The implementation begins with a basic thermal array which detects the infrared radiations from the human body part and then converts them to electronic signal. Scene captured by the sensor is represented as a matrix. Each element of matrix represents a temperature value. Temperature is calculated and a pseudo colour image is developed with the help of a microcontroller. This system can be used in wide applications in the field of medicine such as detection of breast cancer, fever screening, thyroid disease detection, early detection of risk for diabetic peripheral neuropathy, Reynaud's phenomenon, orthopaedics etc.

[4]Sanchis-Sánchez[1], Jose MaríaBlasco[2]

The study of the diagnostic accuracy of Infrared Thermal Imaging in the diagnosis of orthopaedic injuries in childhood has been motivated by the high incidence of these injuries throughout the world, being one of the most common reasons for urgent medical consultation. Diagnosis of musculoskeletal injuries usually involves radiography, but this exposes children without fractures to unnecessary ionizing radiation. This chapter assesses whether infrared Thermography could provide a viable alternative in cases of trauma. To evaluate the accuracy of this technique new thermo graphic variables have been added to those commonly analyzed, such as the extent of the injury and the difference in the size of the area that is at an equal temperature or higher than the maximum temperature of the healthy area. Nonlinear cataloguing methods (decision tree models) have also been applied. With the protocol presented, infrared thermal imaging had a sensitivity of 0.91, a specificity of 0.88 and a negative predictive value of 0.95 for diagnosing musculoskeletal injuries.

III. PROPOSED SYSTEM

To detect the body heat patterns first of all we need the Thermal Imager. Importantly we need to adjust the temperature of the room and hence Air-Conditioned room is must. Computer or laptop is used to operate the Thermal Imager. The suitable room temperature and the temperature to be set on the AC are shown by the PC. All the necessary adjustments which are to be done in thermal imager are controlled by the PC. PC is also use to

apply the DL algorithm and to do the image processing part of the process. The python based DL algorithm will we processed on the PC itself. Shortly, Thermal Imager to take the image of the affected body part of the patients. The PC is use to control the Imager and to get the accurate temperature to operate he image stably. Then, the Images are stored in the PC and given as an input to the software. Once the processing is done, then the output is given with the detected disorder details and the detailed Thermal Image with the accurate heat patterns.

IV. THERMAL IMAGER

The thermal imager is basically a camera, which detects the body temperature and generate specific body heatpatterns**.** We use a DITI i.e. Digital Infrared Thermal Imaging camera with a resolution of 640 × 480 High End Resolution. The DITI also has the temperature data for all pixels. Also it has the hot/cold spot tracker for better accuracy. DITI helps to measure skin surface temperature changes of the underlining muscles in the cervical, right arm triceps, and lumbar areas. By using an infrared camera, we obtain an image in which every colour represents a different temperature. Thus, considering that skin temperatures are symmetrically distributed in a healthy person, a thermal asymmetry in different areas can help detect or even prevent some type of injury.

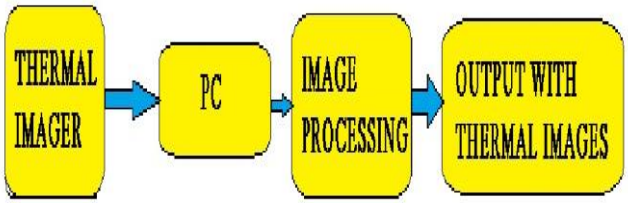

Fig -1: Image Processing Block Diagram

V. IMAGE PROCESSING

The images taken from the Thermal imager has to be pre-processed before given to the software. The images are pre-processed with the help of python codes where we use suitable approach to the problem. Most commonly SVM and Random Forest are used to do the pre-processing. After the pre-processing the input data i.e. the image is given fed to the code by converting it into appropriate binary form. We already have the Reference data in the code. The reference data is nothing but the collection of images of different disorders, while selecting the images for the reference images we have to be careful about the accuracy of the images. Then, the input image i.e. the patients image is given in the code. The codes are mainly based on the DL algorithm such as ANN, CNN, RNN. Mostly in many cases CNN algorithms are used to get better result. Then the image is processed with the algorithm to give the accurate output. The output has to be accurate and hence we apply appropriate EDA or Pre-processor to complete the image processing. The accuracy depends on DL algorithm too and for that we have to choose the appropriate algorithm.

5.1 CNN

CNN is Convolutional Neural Network which is fairly specific network for processing the data, most specifically the images as the images has shape like a 2D matrix. This method is specialized for image detection and classification. The images have 2D matrix pixels and the CNN understands this 2D matrix to detect or classify the images.

VI. SYSTEM REQUIREMENT

Table -1: Software Requirements

Sr.no.	Software
1	XAMPP
2	Flask
3	Anaconda
4	Python
5	MySQL

Table -2: Hardware Requirements

Sr.no.	Hardware
1	CX-640 IR camera
2	Laptop
3	Data and power cables
4	12v power adapter
5	Printer

VII. RESULT AND DISSCUSSION

7.1 XAMPP

XAMPP is a free and open source cross-platform web server solution stack package developed by apache friend, consisting mainly of the apache HHTP server and interpreters for scripts written in the PHP and Perl programming language. XAMPP provides a control panel for efficient management of the software in the XAMPP package. We can use the control panel to determine whether Apache and MySQL are currently running and to start or stop them. Before we can use our development environment, Apache and MySQL must be running.

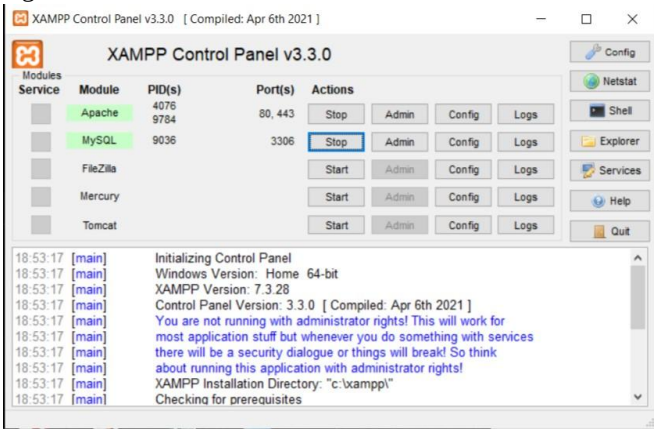

Fig -2: XAMPP Control Panel

7.2 Anaconda Command Prompt

Flask is a micro web framework written in python. It is classified as a micro framework because it does not required particular tools or libraries. Flask is our web server and our code will run in flask at backend for that we have to create virtual environment for flask using anaconda.

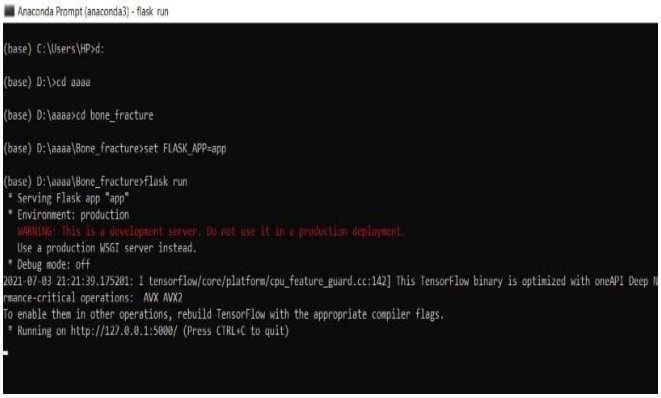

Fig -3: Anaconda Prompt

7.3 Front Page

This is our web page that we have written in the HTML language. This web page is simple document displayable by a browser.

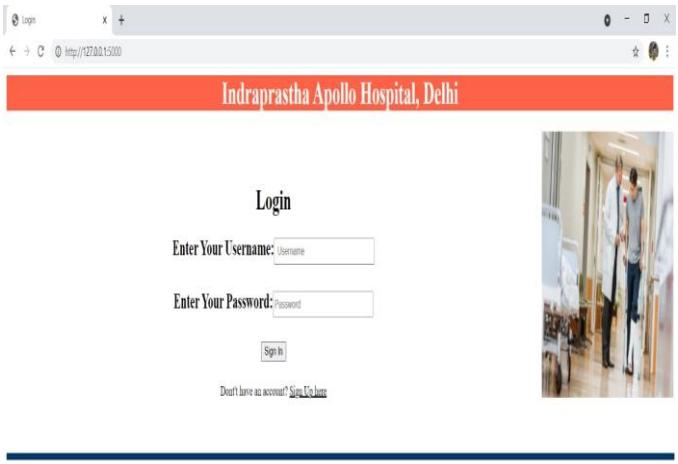

Fig -4: Front Page (a)

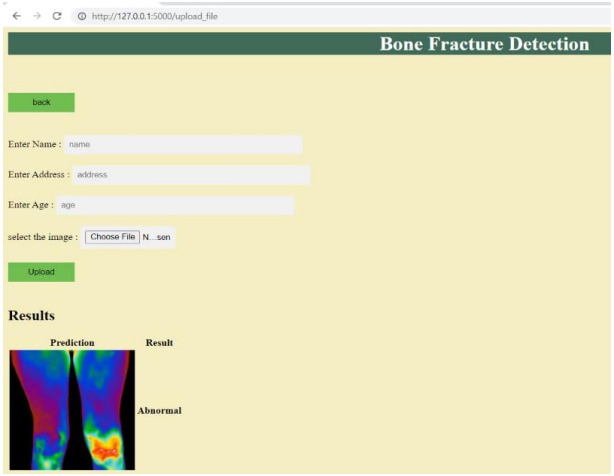

Fig -5: Front Page (b)

Here we have our web pages shown in fig-4 and fig-5, we have to create an account for sign in, and after that we can login by using our username and password. Next is our bone fracture detection page in that we have to enter patient's information like name, address and age of the patient and upload a thermal image, click on upload and we will get result within a few seconds. Our login information as well as patient's information is stored in MySQL permanently.

VIII. CONCLUSION

Infrared thermal imaging is becoming a more accurate alternate medical diagnostic tool for abnormal temperature pattern measurements. Besides, better temperature sensitivity spatial resolution and non-contact nature, IRT is an absolutely harmless methodology. Thermal images can be stored digitally and can be post-processed. In spite of that, the DL algorithm use the methods, which gives us the accurate output, by comparing it with the reference data.

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