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Innovative Approaches to Fracture Detection through Microwave Imaging

N. Nikhil Dev, M.Vamshi Krishna, R. Santhosh, Mr. B. Lalu

Department of Computer Science and Engineering, Guru Nanak Institutions Technical Campus, Hyderabad, Telangana, India

Associate Professor, Department of Computer Science and Engineering, Guru Nanak Institutions Technical Campus, Hyderabad, Telangana, India

ABSTRACT: Wounds not only harm the physical and mental health of patients, but also introduce huge medical costs. Meanwhile, there is a shortage of physicians in some areas, and clinical examinations are sometimes unreliable in wound diagnosis. Reliable wound analysis is of great importance in its diagnosis, treatment, and care. Currently, deep learning has developed rapidly in the field of computer vision and medical imaging and has become the most commonly used technique in wound image analysis. This paper studies the current research on deep learning in the field of wound image analysis, including classification, detection, and segmentation. We first review the publicly available datasets from various researches, and study the preprocessing methods used in wound image analysis. Second, we applied the VGG-19 Model in deep learning tasks (classification, detection, and segmentation) and their applications in different types of wounds (e.g., burns, diabetic foot ulcers, and pressure ulcers) are investigated. Finally, we discuss the challenges in the field of wound image analysis using deep learning, and provide an outlook on the research and development prospects.

I. INTRODUCTION

The Detection and monitoring of fractures in bones can be performed by using several medical imaging techniques, such as X-rays scan, Computed Tomography (CT) scan and Magnetic Resonance Imaging (MRI) scan. In general, the X-ray is the first screening test performed when the patient arrives at the hospital. Due to the high cost, CT and MRI are indicated only in cases where X-rays do not provide the necessary detail. MRI provides better contrast between cortical bone, bone marrow, muscle, and soft tissues in the body, yet it is the most expensive and slower technique. X-rays and CT scan are ionizing; therefore potentially pose some degree of health risk. The risk of falling and suffering fractures is very common in children and elderly people.Tibia fractures are the third most frequent long bone fractures in children with 15% occurrence. Considering that fractures in superficial bones are frequent, it would be beneficial to have an alternative non-ionizing and non-invasive screening method, for first response screening in ambulances, retirement houses, pregnant women, newborn, and infants, or in low-income settings. A microwave system shall achieve those objectives, being useful also for subsequent fracture healing monitoring. The system is potentially inexpensive, compact, and portable. The overall idea is to use a scanning microwave mono static radar system for detecting the bone permittivity discontinuity at the fracture. The scattered fields from healthy and injured tissues can be retrieved and processed to identify the fracture location. Microwave imaging (MWI) has been extensively studied for detection of early breast cancer, for tears in the meniscus, and for brain hemorrhage. In the reconstruction of bone profiles is investigated using a man fractured uniform phantom geometry prepared with animal tissues (tibia, fibula, muscle, and fat). The whole system is immersed in a coupling medium composed of a complex mixture. Immersion of a body part is not appropriate for a practical application, adding discomfort to the patient and sanitation issues. Moreover, the objective in is not related to bone fracture detection.

Existing System:

- The image is reconstructed using a wave migration algorithm. Tests were carried on an ex-vivo animal leg bone with an induced transversal fracture. The results showed that transversal bone fractures can be detected down to 0.35 mm thickness.

The system is attractive for a practical application because it is contactless, operated in air, non-ionizing, simple and comfortable for the patient. It can be used e.g. by first responders in the field, or in low-income settings.

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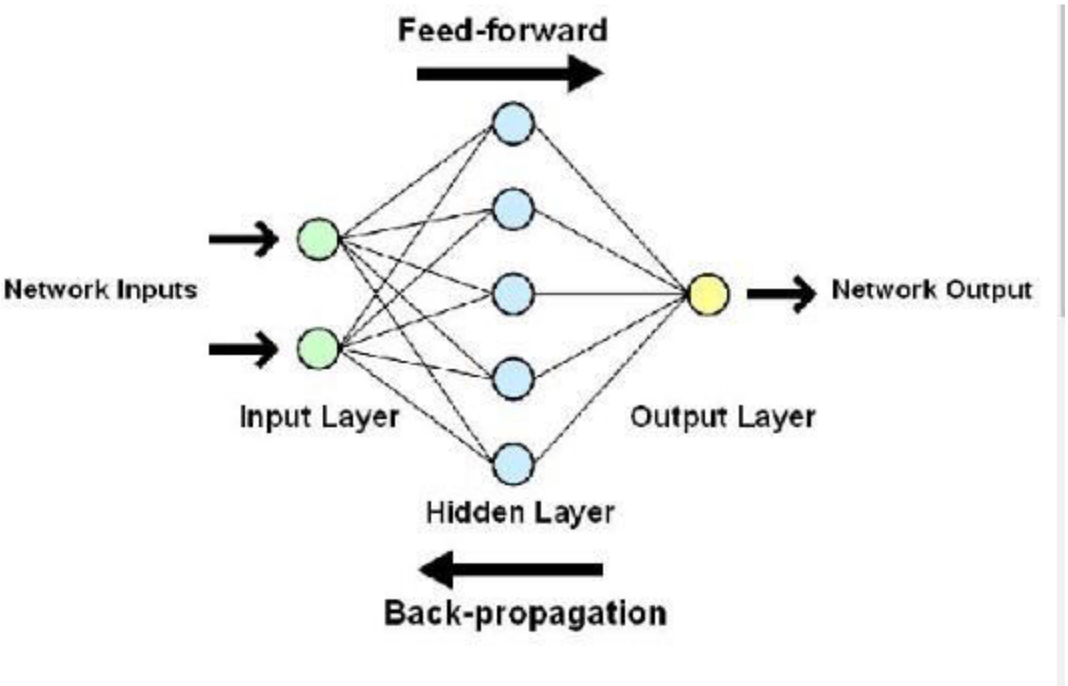
Proposed System:

- Our study addresses the feasibility of contactless MWI detection of thin transverse bone fractures, considering simultaneously the practicality of the setup for a real application and trying to overcome the shortcomings of the previous studies.
- This includes eliminating the need for immersion liquids that are otherwise widely used to reduce the skin artifact but are not practical for a field-operated system. Contactless operation brings new challenges for fracture detection since the skin response now largely overshadows the fracture response. We note that unlike irrigated tissues such as tumors, the contrast from bone tissue cracks may be very weak.

System Architecture:



Modules Explaination:

1 Dataset:
In the first module, we developed the system to get the input dataset for the training and testing purpose. We have taken the dataset from Bone Fracture Detection.

2 Importing the necessary libraries:
We will be using Python language for this. First we will import the necessary libraries such as keras for building the main model, sklearn for splitting the training and test data, PIL for converting the images into array of numbers and other libraries such as pandas, numpy, matplotlib and tensorflow.

3 Retrieving the images:
We will retrieve the images and their labels. Then resize the images to (224,224) as all images should have same size for recognition. Then convert the images into numpy array.

4 Splitting the dataset:
Split the dataset into train and test. 80% train data and 20% test data.

Artificial Neural Networks:
The objectives behind the first module of the course 4 are:

- An artificial neural network is an attempt to simulate the network of neurons that make up a human brain so that the computer will be able to learn things and make decisions in a humanlike manner.
- ANNs are created by programming regular computers to behave as though they are interconnected brain cells.

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5 Building the model:

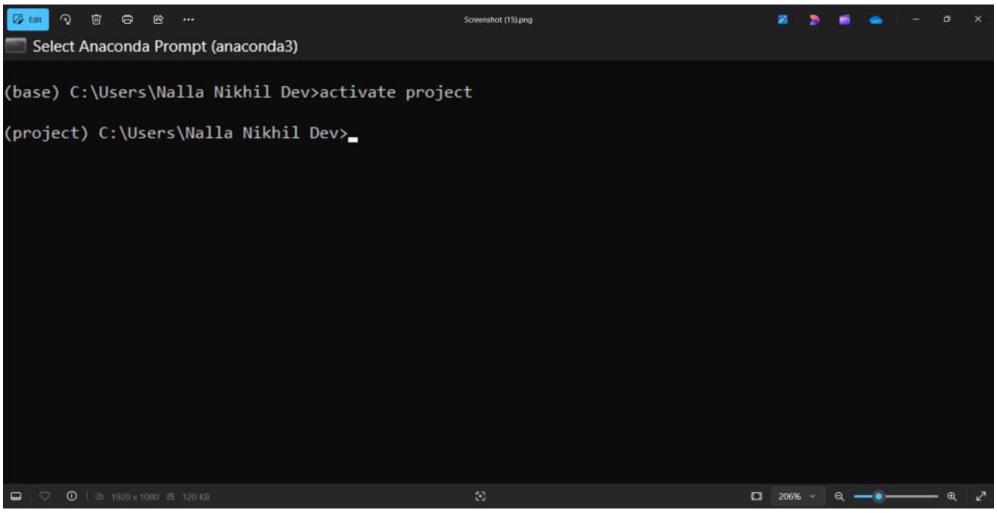
- ANN is made of three layers namely input layer, output layer, and hidden layer/s.There must be a connection from the nodes in the input layer with the nodes in the hidden layer and from each hidden layer node with the nodes of the output layer.

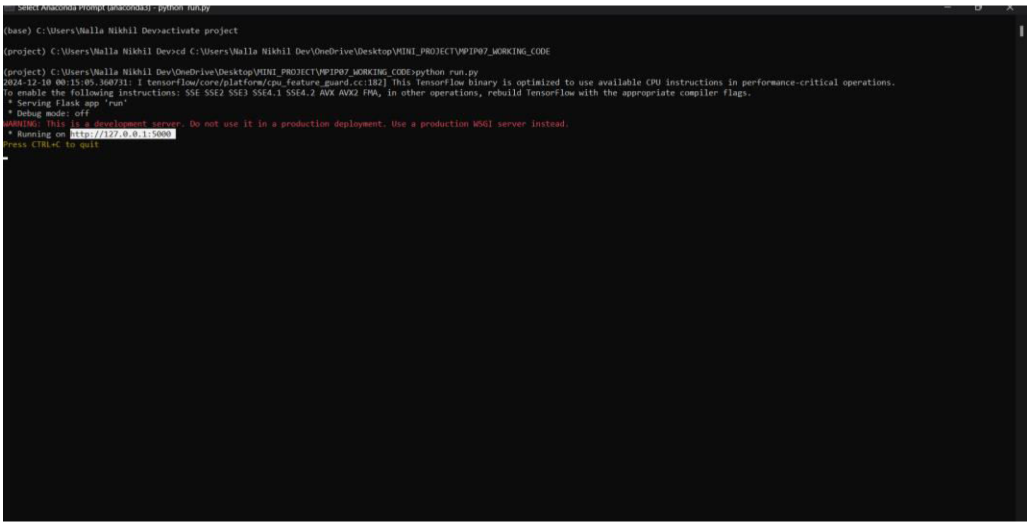
6. Apply the model and plot the graphs for accuracy and loss:
We will compile the model and apply it using fit function. Then we will plot the graphs for accuracy and loss. We got average validation accuracy of 97.6% and average training accuracy of 99.3%.

7. Accuracy on test set:
We got an accuracy of 99.7% on test set

8. Saving the Trained Model:
Once you're confident enough to take your trained and tested model into the production-ready environment, the first step is to save it into an .h5.

II. RESULTS





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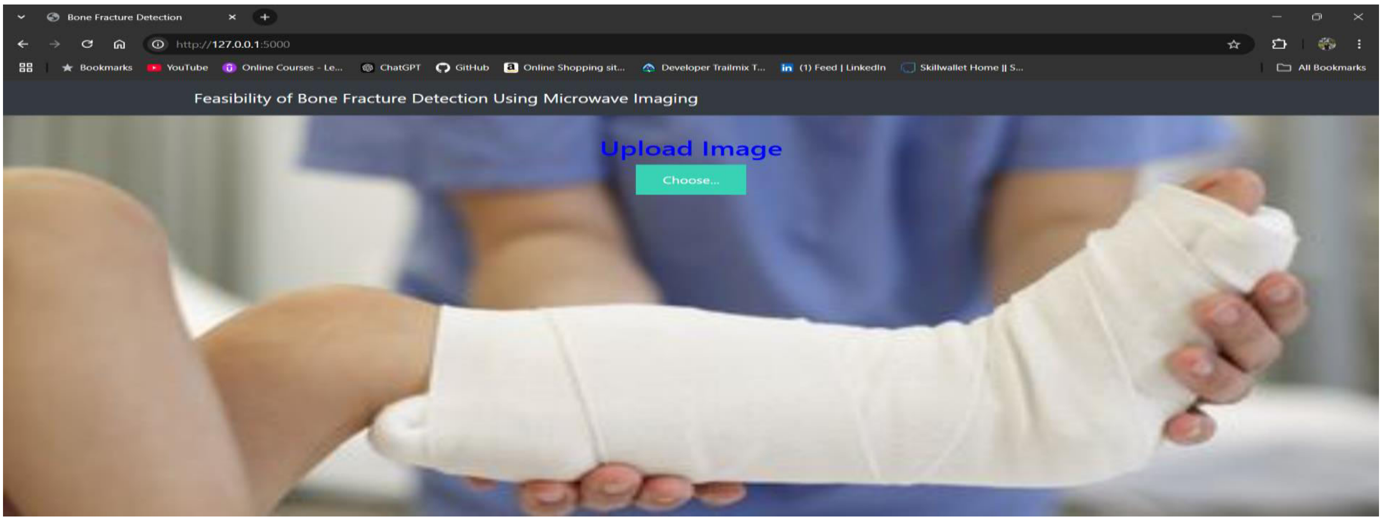

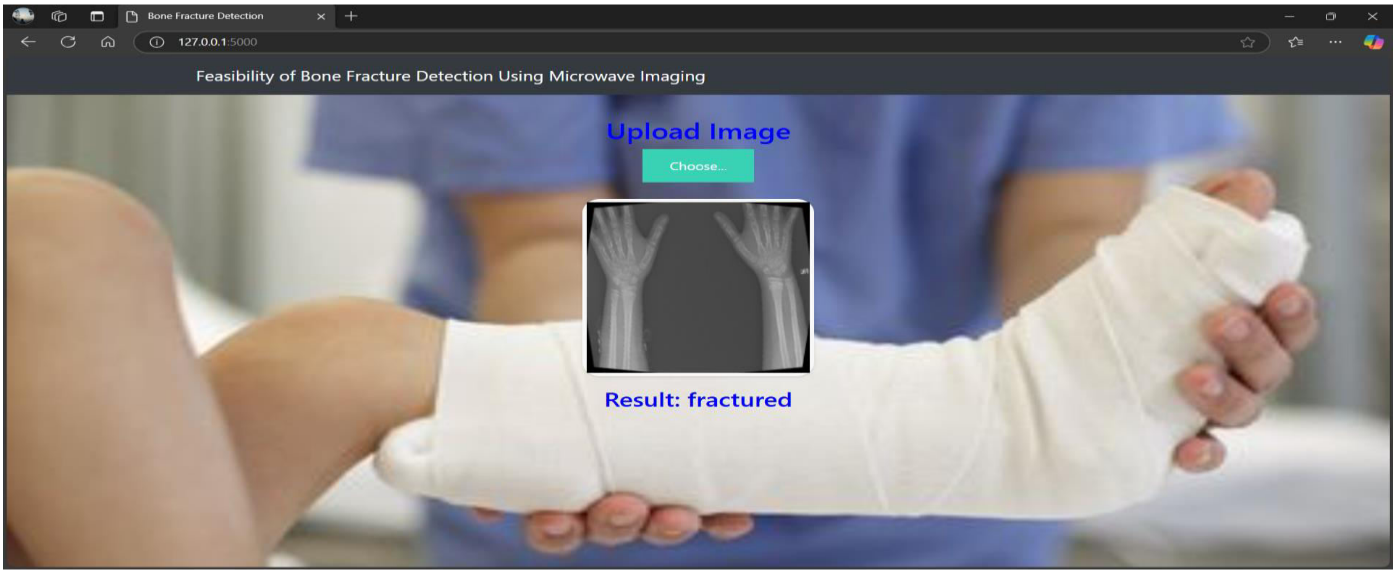

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