International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 07 Issue: 03 | March - 2023 Impact Factor: 7.185 ISSN: 2582-3930

BONE FRACTURE DETECTION USING DEEP LEARNING

A. Vishnupriyan[1], V. Sivakumar[2], L. Thanseerahamed[3], D. Vishal[4], Mr. M. Asan Nainar[5]

[1]*A. Vishnupriyan Information Technology & SRM Valliammai Engineering College*
[2]*V. Sivakumar Information Technology & SRM Valliammai Engineering College*
[3]*L. Thanseerahamed Information Technology & SRM Valliammai Engineering College*
[4]*D. Vishal Information Technology & SRM Valliammai Engineering College*
[5]M. Asan Nainar *Information Technology & SRM Valliammai Engineering College*

---***---

Abstract - In recent years, bone fracture detection and classification has been a widely discussed topic and many researchers have proposed different methods to tackle this problem. Despite this, a universal approach able to classify all the fractures in the human body has not yet been defined. We aim to analyze and evaluate a selection of papers, chosen according to their representative approach, where the authors applied different deep learning techniques to classify bone fractures, in order to select the strengths of each of them and try to delineate a generalized strategy. Each study is summarized and evaluated using a radar graph with six values: area under the curve (AUC), test accuracy, sensitivity, specificity, dataset size and labeling reliability. Plus, we defined the key points which should be taken into account when trying to accomplish this purpose and we compared each study with our baseline. In recent years, deep learning and, in particular, the Convolution Neural Network (CNN), has achieved results comparable to those of humans in bone fracture classification. Dens net can train the model by providing the model and the labeled image directory as inputs to Train Pytorch Model. The trained model can then be used to predict values for the new input examples.

Key Words: Bone fracture detection, MATLAB, CNN, Deep learning, Haar wavelet.

1. INTRODUCTION

Medical imaging has led to improvements in the diagnosis and treatment of numerous medical conditions. which helps physicians in detecting different types of abnormalities. There are many types - or modalities - of medical imaging procedures, each of which uses different technologies and techniques.

- Fluoroscopy.
- Radiography (X-rays).

Radiography: conventional X-ray" including mammography. All the previous techniques use ionizing radiation to generate images of the body. Digital image processing is the use of computer algorithms to perform image processing on digital images. The 2D continuous image is divided into N rows and M columns. The intersection of a row and a column is called a pixel. The image can also be a function of other variable including depth, color, and time. An image given in the form of a transparency, slide, photograph or an X-ray is first digitized and stored as a matrix of binary digits in computer memory. This digitized image can then be processed and/or displayed on a high-resolution television monitor. For display, the image is stored in a rapid-access buffer memory, which refreshes the monitor at a rate of 25 frames per second to produce a visually continuous display.

2. LITERATURE SURVEY

2.1 S. S. Sinthura, Y. Prathyusha, K. Harini, Y. Pranusha and B. Poojitha, "Bone Fracture Detection System using CNN Algorithm," 2019 International Conference on Intelligent Computing and Control Systems (ICCS), Madurai, India, 2019, pp. 545-549, doi:10.1109/ICCS45141.2019.9065305.

Identification of faults through computer-based techniques is a growing trend these days in all fields. A highly responsive system is characterized by two key features of quick detection and being highly accurate through leverage of modern techniques and efficient utilization of resources. Break in a bone or bone fracture is the result of excess external force beyond the threshold of what the bone can withstand. Canny Edge detection is an image processing methodology to detect the bone fracture through efficient use of automated fracture detection and overwhelms the noise removal problem. In today's world there are several methodologies available for edge detection like Sobel, Canny, Log, Prewitt, and Robert. However, these techniques are plagued with key shortcomings like a lack of capability to perform multiresolution analysis that result in inability to detect minor details during analysis. The other key shortcoming of the techniques is that though they work fine with high resolution and high-quality images, but can't work as well with noisy images due to their inherent lack of ability to distinguish between edges and noise components [4]. The method being proposed overcomes over these problems using CNN algorithm. The results from the simulations done reveal that the proposed method is much more efficient mechanism to perform edge detection at aggregate scales. The proposed method has also proved to be resilient enough to extract the necessary information and do the processing needed on key portions of the images and handle noise in a much better manner.

2.2 Paul, C., Edward, & HildaHepzibah, S. (2015). A Robust Approach For Detection of the type of Fracture from X-Ray Images.

A bone is broken or a fracture in bone happens when an external force applied upon the bone is more than what the bone can tolerate or bear. As a result, the shape and strength of the bone is disturbed which causes excruciating pain on the bone and ends up in the loss of functioning of the bone. In some instances there will be bleeding around the injured site. The modern developments in medical imaging contributes a lot in examining the fractures in different kinds and classes of bones found in the body of the patient without much difficulty. Segmentation of an image involves a process called edge detection. The purpose of segmentation is to modify the representation of an image into fragments that is bits and pieces that are more important, useful and easier to analyse. To identify the edges, this function scans for regions in the image where the change of intensity occurs rapidly. Edge detection returns a binary image containing ones where edges are found and zeros in all other places. Different edge detection methods exist like Sobel operator, Prewitt operator, Laplacian of a Gaussian and Canny. These techniques can be applied on X-Ray medical images. Quality metrics like mean and standard deviation are applied to analyze, compare and evaluate the results. The process of detecting the type of fracture has to be done with a great precision. To improve these quality metrics,a novel edge detection algorithm is proposed and the accuracy is measure.

2.3 Peruri, Srinivasulu & Vamsi, Jollu & Kattubadi, Drutesh & Prudhvi, Gandham. (2020). Bone fracture detection using Image Processing. 5. 329-334.

The image processing technique is extremely helpful for several applications like biomedical, security, satellite imaging, personal image, medicine, etc. The implementation of image processing such as image enhancement and feature segmentation and feature excitation are used for fracture detection. This paper uses canny edge detection methodology for segmentation. The canny method produces perfect information from the bone image. The main aim of this research is to detect Bone fractures using image processing using MATLAB. The proposed system has the following steps, namely, preprocessing, segmentation, and fracture detection.in feature excitation step, the paper uses to Hough Transform technique for line detection inline-image. Feature extraction is the main task of the system. the results from various experiments show that the proposed system is very accurate and efficient Introduction: Bone fracture is a common problem in every developed countries and the number of fractures also increasing day by day very rapidly. A bone fracture may occur due to simple accidents or different types of diseases. So, for that quick and accurate diagnosis crucial to the success of any prescribed treatment. Depending upon the human experts alone for such a critical matter have cause intolerance errors. Hence the thought of automatic identification procedure has perpetually been associate degree appealing one. The main goal of the paper is to detect the bone fracture from X-ray images using MATLAB software. The lower long bone is that the second largest bone of the body. It is made up of two bones, the tibia, and the fibula. The fibula bone is smaller and thinner than the tibia. However, the tibia fracture is most commonly occurring due to it carries a significant portion of the body weight. The normal bone demonstration is given in Fig(1). Among the four modalities (X-ray, CT, MRI, Ultrasound), X-ray diagnosis is commonly used for bone fracture detection due to their low cost, high speed, and wide availability. Although CT and magnetic resonance imaging pictures provide higher quality pictures for body organs than X-ray pictures, the latter is faster cheaper, enjoy wider availability and are easier to use few limitations. Moreover, the level of quality of X-ray images is enough for bone fracture detection. The motivations of this system are: 1. Saving time for patients to lower the workload of doctors by screening out the easy case. 2. To cut back human errors as a result of doctors in hospitals manually examine an outsized variety of X-ray pictures for fracture.

2.4 D. P. Yadav and S. Rathor, "Bone Fracture Detection and Classification using Deep Learning Approach," 2020 International Conference on Power Electronics & IoT Applications in Renewable Energy and its Control (PARC), Mathura, India, 2020, pp. 282-285, doi: 10.1109/PARC49193.2020.236611.

The bone is a major component of the human body. Bone provides the ability to move the body. The bone fractures are common in the human body. The doctors use the X-ray image to diagnose the fractured bone. The manual fracture detection technique is time consuming and also error probability chance is high. Therefore, an automated system needs to develop to diagnose the fractured bone. The Deep Neural Network (DNN) is widely used for the modeling of the power electronic devices. In the present study, a deep neural network model has been developed to classify the fracture and healthy bone. The deep learning model gets over fitted on the small data set. Therefore, data augmentation techniques have been used to increase the size of the data set. The three experiments have been performed to evaluate the performance of the model using SoftMax and Adam optimizer. The classification accuracy of the proposed model is 92.44% for the healthy and the fractured bone using 5 fold cross validation. The accuracy on 10% and 20% of the test data is more than 95% and 93% respectively. The proposed model performs much better than [1] of the 84.7% and 86% of the [2].

2.5 R. Mukesh and P. Dass, "Detection by Clinicians Comparison of Intelligence Bone Fracture Detection System with SIFT algorithm for Identification of Bone Fracture," 2022 3rd International Conference on Intelligent Engineering and Management (ICIEM), London, United Kingdom, 2022, pp. 533-537, doi: 10.1109/ICIEM54221.2022.9853197.

The aim of the study was to detect by clinicians' comparison of the innovative Intelligence Bone Fracture detection system (IBFDS) with a sift algorithm for the identification of bone fracture. Material and Methods: The input images of X-Rays are collected from Kaggle.com. The sample size of 2 groups was 20. The data set contains bone fractures which are considered as an input image. MATLAB (2013) is used to compare an Intelligence bone fracture detection system with a deep neural network for accurate fracture detection. SPSS version 21 was used for the statistical analysis. A total of 20 samples were processed for the 2 groups to better accurately detect the bone fracture using a g power of 80%. Results: The comparison of IBFDS over the deep neural network was done independent sample t-test using SPSS software. The accuracy appeared for Innovative IBFDS was 91.67% and for the neural network was 83.56. Significance was observed for the comparison of parameter accuracy through SPSS Version 2.1 and the accuracy for SIFT was minimum (77.34 ± 6.40) followed by IBFDS (64.69±13.68). The Independent sample test revealed statistical significance and got P (0.003). Conclusion: The SIFT algorithm has better accuracy than IBFDS for bone fracture detection.

2.6 R. S. Upadhyay and P. Tanwar, "A Review on Bone Fracture Detection Techniques using Image Processing," 2019 International Conference on Intelligent Computing and Control Systems (ICCS), Madurai, India, 2019, pp. 287-292, doi: 10.1109/ICCS45141.2019.9065874.

The bone fracture emerges as the common health challenge in human beings, which occur due to the accident or other causes like bone cancer etc. The fracture possibly can occur in any bone of the human body like wrist, hip, heel, ankle, rib, leg, chest and so on. But sometimes the X- ray images of bone fracture lacks the sufficient details required for diagnosis. Recently, image This paper exhibits an investigation of picture preparing strategies for bone crack recognition. This paper will assist the healthcare practitioners by studying diverse strategies for bone break location by efficiently utilizing the picture handling and to plan new methods to improve the precision of crack identification. The strategies have been recorded with simplicity of understanding. The paper is the first of its sort to review the bone break location strategies crosswise over various modalities.

3. SYSTEM ARCHITECTURE

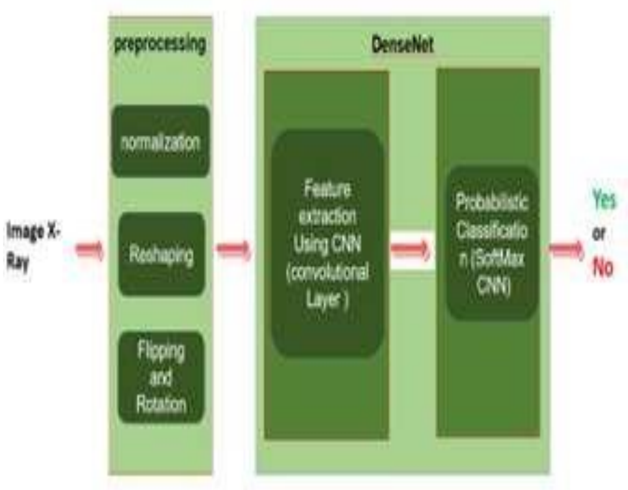

Fig.1 Block diagram

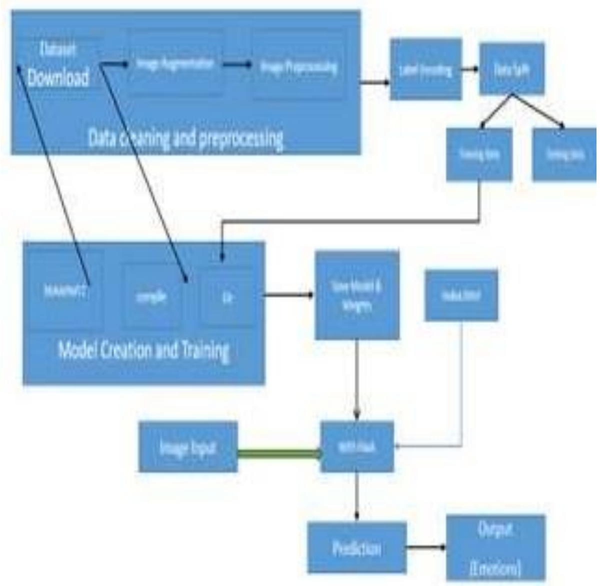

Fig.2 Flow diagram

4. METHODOLOGY

4.1 DEEP LERANING

DEEP LEARNIG is a sub-discipline of Machine Learning. The main idea that characterizes DL inside ML is the Neural Network, a model that is able to detect and extract the best features for the target task automatically, without the necessity to involve a previous step to the model training of feature extraction. In Deep Learning, the feature extraction process is merged with the learning process. Therefore, the selection is trainable, and the model itself is able to decide which features to use without having to choose which attributes should be extracted. The only drawback of this is that it requires much larger training data sets, a comprehensive data pre-processing pipeline, and an empirical hyperparameter tuning process.

4.2 CONVOLUTIONAL NEURAL NETWORK

A Convolutional Neural Network is a class of neural networks specialized in dealing with grid-like topological data with close spatial relations, such as images or sequences. The principal difference between a vanilla ANN and a CNN is the limited connectivity and shared weights among the filters of the CNNs, as usually, only the last part of a CNN is a fully connected network. The main drawback that causes the vanilla ANN not to be suitable for image tasks is that the network size leads to an easy over-fitting, while CNN's do not, as the neurons are not connected to all other neurons in the previous layers but connected only to a small region of neurons, which results in less

International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 07 Issue: 03 | March - 2023 Impact Factor: 7.185 ISSN: 2582-3930

trainable parameters, and therefore, less risk of over-fitting. CNN's have three basic types of blocks. The main one, which has the trainable parameters are the convolutional layers, consisting of several small filters (e.g., 3x3 or 5x5), which are convolved with the input of the layer, learning features from the given spatial location. Each filter produces a feature map when sliding through the whole network, combining them channel-wise to create the next layer‘s input. Another important type is the Pooling layer, which helps to downsample and compress the given data, reducing the previous layer‘s feature maps, which helps to reduce over-fitting, reduces the number of parameters and hence, the training time, and makes the model more robust to variations in the position of the features. A CNN usually consists of a stack of convolutional layers interspersing pooling layers, always applying a non-linear activation function after the convolutional layer. The convolutional part‘s result is flattened into a one-dimensional vector and passed through a classifier, which is usually a fully-connected network, an ANN. We can see a schematic architecture of a traditional CNN. However, fewer and fewer modern model architectures use fully connected layers, being fully-convolutional models or using other approaches.

4.3 DATA STATISTICS

Our original data set has a total of 13,606 studies. However, we read the data and the labels from different sources, and we detected few mismatches of studies with missing labels or vice versa. After removing these cases, we have 13,538 potential studies that we can use to train and validate our model. One of the first problems that we notice when we inspect the data is the data unbalance for broken and not broken classes, having 4,214 studies tagged as broken and 9,324 as not broken, which results in a proportion of 31.13% and 68.87% respectively. Data unbalancing is a recurrent problem in real-world data sets that may affect the training process. It may not be something problematic, depending on the application. If we consider an example where class A happens occurs 99% of the time and B only the 1%, the model will tend to classify any sample as class A, obtaining a 99% of accuracy. The model will be correct, and it is unlikely that any other model improves the performance. However, in some cases, the critical task is to see what happens with the B class, even if it only occurs once in a few times. This last situation is precisely the case that we face with our problem and data, where we are interested in detecting fractures, the minority class. A solution to this problem is to intentionally bias the data to get a model that, even though it may perform worse in terms of accuracy, can give us better results regarding what we are interested in detecting. We address this problem with some solutions in the next chapter. The number of instances for each study varies a lot. We can observe the histogram of the number of radiography instances for each study. To generate the histograms, we first remove an outlier study that has 195 instances. This study corresponds to a set of axial radiography images, and we opt to discard it from our data set. From the histograms of broken studies and not broken studies, we can see that both classes follow the same distribution of the number of instances per study, so we can simplify the analysis and consider the overall histogram of all the studies.

5. OUTPUT

333 The application of deep learning in bone fracture detection has shown promising results. Various studies have been conducted using different deep learning models such as convolutional neural networks (CNNs).

For example, in a recent study published in the Journal of Digital Imaging, a deep learning model was developed using a CNN to detect distal radius fractures in X-ray images. The model achieved an accuracy of 92% in detecting fractures, outperforming traditional machine learning methods.

Another study published in the Journal of Medical Systems used a deep learning model based on a hybrid CNN architecture to detect hip fractures in X-ray images. The model achieved an accuracy of 96.6% in detecting fractures, demonstrating its potential for clinical use. Overall, the results of these studies suggest that deep learning models have the potential to improve the accuracy and efficiency of bone fracture detection in medical imaging, which could have a significant impact on patient outcomes and healthcare costs.

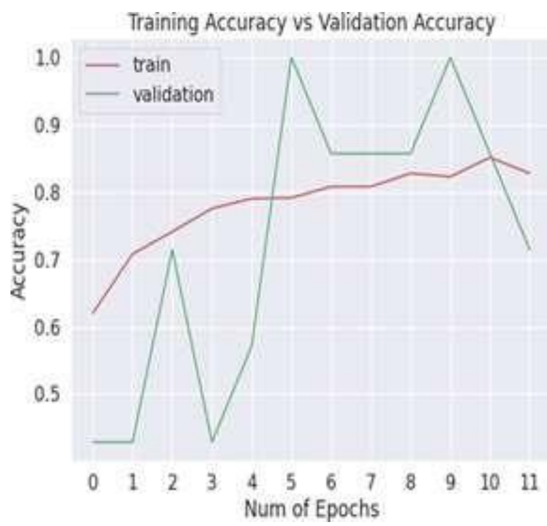

Fig.3 Training and validation Accuracy Graph

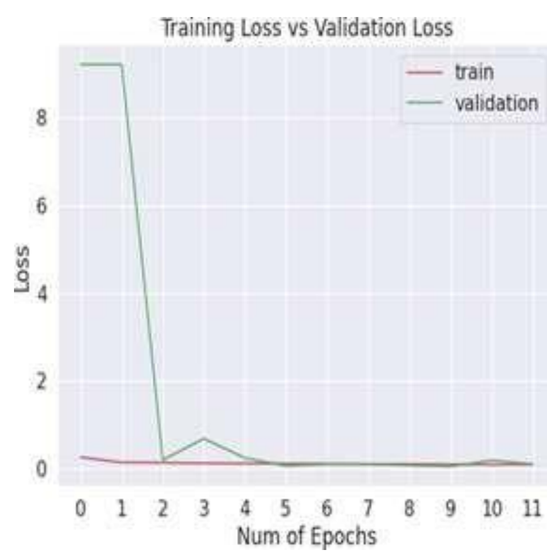

Fig.4 Training and validation Loss Graph

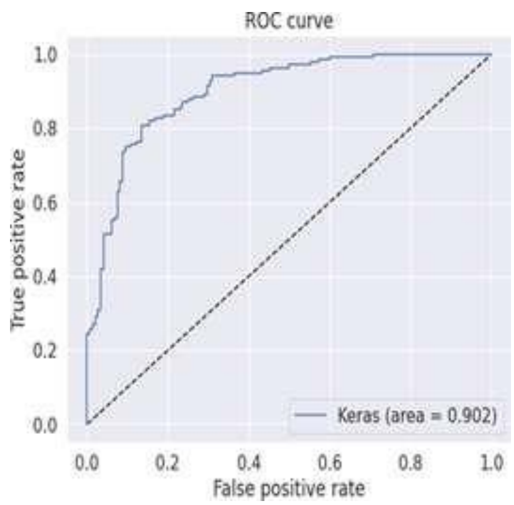

Fig.5 ROC Curve

6. CONCLUSION

This project presented the image processing technique to detect the bone fracture. The fully automatic detection of fractures in leg bone is an important but difficult problem. According to the test results, the system has been done to detect the bone fracture. A conclusion can be made that the performance of the detection method affected by the quality of the image. The better the image quality, the better the result system got.

7. ENHANCEMENTS

In the future, the project can be further developed into artificial Intelligence which will analysis the bone fracture and give the most accurate results.

The system will be developed to give a detail report about the fractured bone and will give the suggested treatment for the fractured bone.

ACKNOWLEDGEMENT

We are grateful to our internal guide Mr. M. Asan nainar, M.E., Assistant Professor (Sel.G) for his invaluable guidance and encouragement, this project would not have been successful.

REFERENCES

1. International Osteoporosis Foundation. Broken Bones, Broken Lives: A Roadmap to Solve the Fragility Fracture Crisis in Europe; International Osteoporosis Foundation, 2018.
2. Dimililer, K. IBFDS: Intelligent bone fracture detection system. Procedia Comput. Sci. 2017, 120, 260–267.
3. Tripathi, Ankur Mani, et al. ―Automatic detection of fracture in femur bones using image processing." 2017 International Conference on Innovations in Information, Embedded and Communication Systems (ICIIECS). IEEE, 2017.
4. Johari, Nancy, and Nathan Singh. "Bone Fracture Detection Using Edge Detection Technique." Soft Computing: Theories and Applications. Springer, Singapore, 2018. 11-19.
5. Dhiraj B. Bhakare, Prajwal A. Jawalekar, Sumit D. Korde. ―Novel Approach for Bone Fracture Detection Using Image Processing ― International Research Journal of Engineering and Technology (IRJET) 2018.
6. Myint, San, Aung Soe Khaing, and Hla Myo Tun. "Detecting leg bone fracture in x-ray images." Int. J. Sci. Technol. Res 5 (2016): 140-144.
7. Shubhangi D.C, Raghavendra S. Chinchansoor, P.S Hiremath, Edge Detection of Femur Bones in X-ray images – A Comparative study of Edge Detectors, Department of Computer Science, PoojyaDoddappaAppa College of Engineering, Gulbarga – 585103 India, Volume 42-No.2, March 2012.
8. Mahmoud Al-Ayyoub, IamailHmeidi, Haya Rababaha, Detecting Hand Bone Fractures in X-Ray Images, Jordan University of Science and Technology Irbid, Jordan, Volume 4. No.3, September 2013.
9. S.K. Mahndran, S. SanthoshBaBoo, An Enhanced Tibia Fracture Detection Tool Using Image Processing and Classification Fusion Techniques in X-Ray Images, Sankara College of Science and Commerce, Coimbatore, Tamil Nadu, India, Online ISSN: 0975-4172 &Print ISSN: 0975-4350, Volume 11 Issue 14 Version 1.0 August 2011.
10. S.K. Mahndran, S. SanthoshBaBoo, An Ensemble Systems for Automatic Fracture Detection, IACIT International Journal of Engineering and Technology, Vol.4, No. 1, February 2012.
11. Rashmi, Mukesh Kumar, and Rohini Saxena, Algorithm and Technique on Various Edge Detection: A Survey, Department of Electronics and Communication Engineering, SHIATS- Allahabad, UP. -India, Vol. 4, No. 3, June 2013.
12. Mahmoud Al-Ayyoub, Duha Al-Zghool, Determining the Type of Long Bone Fractures in X-Ray Images, Jordan University of Science & Technology, Irbid 22110, Jordan, E[1]ISSN: 2224-3402, Issue 8, Volume 10, August 2013.