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# Bone Fracture Detection Using Deep Learning

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ABSTRACT

According to statistics, more than 65% of the population in Delhi is at high risk of bone fractures or is already diagnosed with one. (Study conducted during 2018). Broken bones or bone fractures occur when an overwhelming amount of force is applied to a bone, which is way stronger than what a bone can withstand. This troubles the strength and the structure of the bone which will lead to an immense amount of pain and a lot of treatment to get well. When bone fractures are untreated, it will lead to numerous complications such as a nonunion or delayed union. In some cases, the bone doesn't heal at all, which means that it will remain broken until it has been treated. As a result of this, the swelling and the pain will continue to worsen over time. Most fractures heal in 6-8 weeks, but this varies tremendously from bone to bone and in each person based on many of the factors discussed above. Hand and wrist fractures often heal in 4-6 weeks whereas a tibia fracture may take 20 weeks or more. Doctors can usually recognize most fractures by examining the injury and taking X-rays. But in some cases, it is hard for them to diagnose it. This study focuses on automating the process of detecting fractures from X-rays through deep learning. The model has achieved an accuracy of almost 95%. Though that is true in the paper, The model won't perform that accurately when it comes to real-world applications as it depends on various factors such as X-ray shot style, the angle at which it has been shot etc.
This model can be fine-tuned to serve real-world applications and the need for these kinds of deep learning models in our society is undoubtedly high as the society is collectively progressing towards a better future aided by artificial intelligence, deep learning and machine learning models..

## I. INTRODUCTION

A bone fracture detection system using deep learning is a revolutionary technology that utilizes advanced algorithms to identify and classify bone fractures from medical images such as X-rays, CT scans, or MRIs. This system is designed to assist medical professionals in accurately` diagnosing fractures in patients,

particularly in emergency situations where a quick and accurate diagnosis is critical. The system uses a deep learning model that is trained on a large dataset of medical images with labeled fractures, allowing it to recognize and categorize various types of fractures with high accuracy. The model is capable of detecting fractures that may be missed by human clinicians due to their small size or subtle appearance. By incorporating a bone fracture detection system using deep learning into medical practices, healthcare professionals can improve patient outcomes by detecting fractures more quickly and accurately. This technology has the potential to significantly reduce misdiagnosis and delay in treatment, resulting in better outcomes for patients with fractures.

## II. LITERATURE REVIEW

A literature survey is a comprehensive review of existing literature related to a particular research topic. It is used to identify existing research and provide an understanding of the current state of knowledge in a particular area. It is an essential part of the research process, as it provides an overview of the relevant literature and allows researchers to identify areas where further research is needed. Literature surveys can include books, journal articles, conference papers, dissertations, and other sources.

A literature survey is an essential part of any research project. It provides an overview of the existing knowledge on a particular topic, allowing researchers to identify gaps in the literature that need to be addressed. It also serves to inform the research project, providing background information and helping to shape the research questions and hypotheses. Additionally, literature reviews can be used to identify relevant sources for further research. Therefore, the same has been conducted on the similar existing titles. Following are some of the prominent research papers that has been surveyed for improvements and advancements.

- Arm fracture detection in X-rays based on improved deep convolutional neural networks Accuracy: 89.50%, Precision: 87.50%, Recall: 87.60%, F1-Score: 87.30%
- Image-Based malware classification using ensemble of CNN architectures (IMCEC): Accuracy: 98.70%, Precision: 94.60%, Recall: 87.60%, F1-Score: 97.23%
- Segmentation and Analysis of CT Images for Bone Fracture Detection and Labeling Accuracy: 98.80%, Precision: 99.70%, Recall: 97.90%, F1-Score: 98.80%
- A Long-bone fracture detection in digital X-ray images based on digital-geometric techniques, September 2019
  Accuracy: 95.06%, Precision: 93.30%, Recall: 94.20%, F1-Score: 93.71%
- Deep learning and SURF for automated classification and detection of calcaneus fractures in CT images
  Accuracy: 97.78%, Precision: 94.88%, Recall: 96.50%, F1-Score: 97.36%

These are some of the valuable insights on various performance metrics that has been acquired through proper analysis of the models as well as the research experiments that has been conducted in the research papers that has been published earlier on a similar topic.

## III.PROPOSED SYSTEM

Detecting bone fractures using deep learning is a promising field that can aid medical professionals in accurately diagnosing and treating patients. A proposed system for bone fracture detection using deep learning and a web app could be designed as follows:

**Data Collection:** The first step in designing a bone fracture detection system is to collect a large dataset of bone X-ray images with and without fractures. The dataset should be well-labelled to train the deep learning model effectively.

**Preprocessing:** The collected data needs to be pre-processed, which involves cropping and resizing the images to a standard size, normalizing the pixel intensities, and removing noise from the images.

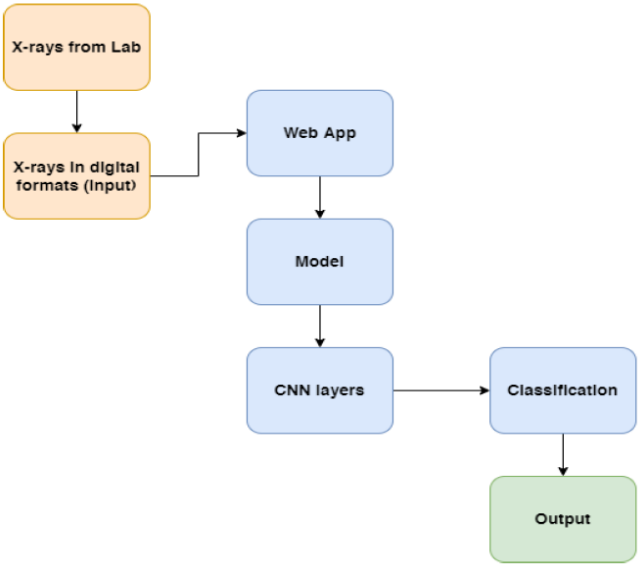
**Training the Deep Learning Model:** The preprocessed dataset can be used to train a deep learning model, such as a convolutional neural network (CNN), to identify fractures in bone X-ray images. The model can be trained using various optimization techniques like Adam, SGD, and RMSprop.

**Web App Development:** Once the deep learning model is trained, it can be integrated into a web app. The web app should have a user-friendly interface that allows the user to upload bone X-ray images and get the diagnosis.

**Results:** Once the web app is deployed the user will be able to input x-ray images that would be classified into whether they have a fracture or not.

The model is usually hosted in a remote server which will be a sandboxed environment (if done commercially) and therefore this will ensure that the malware is never actually executed for it to infect anything. The model which will be predicting the ransomware will primarily be based on a Convolutional Neural Networks (CNN). CNNs are used for image-based classification because of their ability to learn features from the images. CNNs have the capability to extract features from the images and to identify patterns that can be used to classify images. CNNs also have the ability to generalize, which means that they can be used to classify images that they have not seen before. Ensemble methods are used to combine multiple machine learning models to generate a more accurate prediction. The idea is that combining multiple models that have different strengths will yield better results than any single model alone. In the case of a low accuracy for a CNN, an ensemble method could be used to combine the predictions of multiple CNNs to improve the overall accuracy.

**UML Diagrams:**




## IV.IMPLEMENTATION

This section contains the structure of Deep Learning techniques used to draw inference from the given dataset. The dataset is already cleaned and checked such that it has no errors or any corrupted files which damages the training process and the output. The necessary models required for the training is being imported mainly keras.models, keras.layers, keras.applications.inception_v3 from the TensorFlow module. The image size is predefined to (224,224) which is optimum for large dimension images. The further reduction of images will affect the features and make it hard for the models to read inferences from the dataset.

The training path and validation path is predefined to the path leading to the folder in which the training and validation datasets are kept.

```
IMAGE_SIZE = [224, 224]

train_path = 'Datasets/train'
valid_path = 'Datasets/test'
```

```
inception = InceptionV3(input_shape=IMAGE_SIZE + [3], weights='imagenet', include_top=False)
```

```
for layer in inception.layers:
    layer.trainable = False
```

```
folders = glob('Datasets/train/*')
```

```
x = Flatten()(inception.output)
```

```
prediction = Dense(len(folders), activation='softmax')(x)
model = Model(inputs=inception.input, outputs=prediction)
```

In the above figure, the object for the inception model is created by passing the image size (224,224). This is necessary for image classification like the one used in this project.

The weight parameter is passed as "ImageNet" which is a famous parameter that has pre-defined weights so that the training of the model is a lot easier than checking for the perfect weights from scratch.

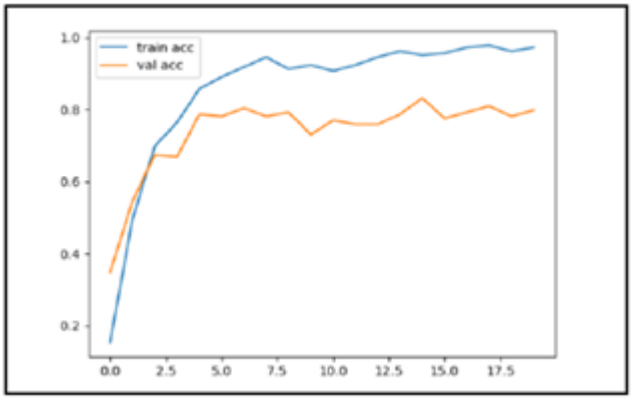
The "include_top" attribute is given as false which tells the object to exclude the input layer from the inception model and give a specific input layer.

The trainable attribute of all the layers is given as false to retain the weights in the model which helps the model to run on the pre-trained weights, helping the model to run faster and more efficiently. Then a "flatten" layer is added to the output layer of the inception model which brings an image to a one-dimensional array format which will, in turn, reduce the work load of the model to find the features of a particular image.

After the "flatten" layer a "dense" layer is created by passing the number of folders and the activation function is set as "SoftMax". The activation function basically decides whether a neuron should be activated or not. So, it bounces the value of the net input.

The SoftMax parameter tells that the activation function is basically a multinomial probability distribution where it works on the principle of winner takes all. The SoftMax is used as an activation function when the output class is more than two.

$$\sigma(\vec{z})_i = \frac{e^{z_i}}{\sum_{j=1}^{K} e^{z_j}}$$

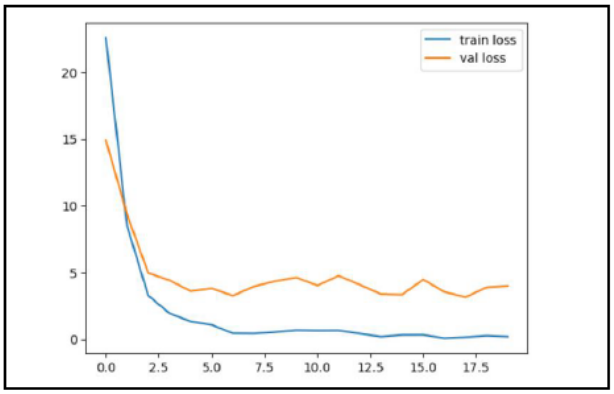



## EVALUATION OF THE MODELS

### 1. Models from X-Ray Dataset – Inception V3

Inception v3 was trained for 20 epochs and achieved an accuracy rate of 95.1% to 97.2% during training. The validation accuracy was also quite high, ranging from 80.1% to 82.2%. However, the validation loss was found to be too high, which indicates that the model may be overfitting on the training data. As a result, this model may not be the most optimal for the task at hand, and further tuning or experimentation may be required to improve its performance.

The learning rate is too high, which causing the model to oscillate and converge to a suboptimal solution. Additionally, the data itself may be inadequate as the amount of data gathered is rather less compared to what is considered as an optimal amount.




### 2. Models from X-Ray Dataset – VGG16:

After training the VGG16 model on the dataset for 20 epochs, it showed an accuracy range of 93.6% to 98.7% with a validation accuracy of 92.1% to 95.0%. Comparing the results with the previous two models, VGG16 showed the best performance. Additionally, the validation loss of VGG16 was the lowest among all the models, which indicates that the model was not overfitting to the training data. The training loss was also very low, further demonstrating the efficiency of the model. Based on these metrics, VGG16 is the most optimal model for classifying benign and malicious APKs.

The VGG16 model performed exceptionally well during the training process, with both low training and validation losses. One possible reason for this is the architecture of the VGG16. VGG16 has a deeper network structure with smaller filter sizes and fewer parameters than ResNet50 and Inception V3. This allows the model to learn and generalize well to new data, preventing overfitting during training. Additionally, the VGG16 model uses convolutional layers with a small kernel size of 3x3, which helps capture finer details in the input images. This, in turn, allows the model to learn more complex features from the data, leading to better performance. All these factors had contributed to its superior performance and low training and validation loss.

### 3. Models from X-Ray Dataset – Average Ensemble:

Ensemble methods are commonly used in deep learning to improve the performance of models by combining the predictions of multiple models. In this case, an average of the predictions of Inception V3, ResNet50, and VGG16 was taken, resulting in an accuracy range of 91% to 93.0% and a validation accuracy range of 89.9% to 91.1%. While the validation loss for the ensemble method is slightly higher than that of VGG16, the accuracy and validation accuracy are still within a reasonable range. It can be argued that the ensemble model with average as the combining method is a slight improvement over the individual models in terms of accuracy and validation accuracy. However, the difference in validation loss between the ensemble model and VGG16 is not significant, and VGG16 still outperforms the ensemble model in that aspect. It's worth noting that ensembles can often lead to better generalization and less overfitting, which is an important aspect in deep learning.

### FEATURES

The primary objective for this model and research is to make sure that it can be used to solve a real-world problem. In the current case of android safety, daemon services can be used to provide security through this model.

It is feasible to deploy a pre-trained deep learning model as a daemon process in Android that triggers automatically upon initiation of an APK installation. This can be achieved through utilizing an Android service, which is a background task that performs a specific operation without user interaction. Upon starting the service, the pre-trained model is loaded and initialized. To trigger the service when an APK installation is initiated, a Broadcast Receiver can be utilized to listen for the "PACKAGE_ADDED" system-wide event, which is triggered whenever a new package is encountered for installation on the android device. Upon receiving this event, the broadcast receiver can initiate the Android service to load and initialize the pre-trained model for detecting malicious behaviour, such as ransomware.

## V. CONCLUSION

While doing this project, I was able to gain a deeper understanding of how deep learning techniques work and what kinds of deep learning techniques should be used for various scenarios. The development of this project has clearly illustrated the problems faced while diagnosing a fracture even after taking an X-ray report. It is hard to do it without years of experience at least. The articles and other research papers which are on the same title has proven very helpful to me in the development phase as they gave me an insight on what are the different techniques available and what are the different ways to use these techniques.

The long-term scope of a project like this is pretty high as it concerns the healthcare industry. This project can be further developed as it is still not as accurate as it is supposed to be. Further training this model with a better dataset will help immensely. Other than that,

from the user's point of view, there are certain things that can be improvised in this project such as bulk x-ray processing etc. This concludes the report of my mini-project on this topic.

## VI. REFERENCES


[1]. Dangers of Bone fractures if left untreated - Article https://www.midatlanticorthonj.com/blog/dangers-of-bone-fractures-if-left-untreated

[2]. Everything about fractures and fracture healing https://northazortho.com/ask-the-expert/everything-you-need-to-know-about-fractures-an d-fracture-healing/

[3]. Gray-level co-occurrence matrix bone fracture detection. WSEAS TRANSACTIONS on SYSTEMS, January 2011Authors: Hum Yan Chai, Lai Khin Wee, Tan Tian Swee, Sheikh Hussain

[4]. BFDS: Intelligent bone fracture detection system. Authors: R.A. Aliev, W. Pedrycz, M. Jamshidi, J. Kacprzyk

[5]. Bone Fracture Detection Using Edge Detection Technique, November 2017 Authors: Nancy Johari & Natthan Singh

[6]. Long-bone fracture detection in digital X-ray images based on digital-geometric techniques, September 2019 Authors: Oishila Bandyopadhyay, Arindam Biswas, Bhargab B.Bhattacharya

[7]. Detection of Bone Fracture using Image Processing Methods, 2015 Authors: Anu T C, Mallikarjunaswamy, Mysuru Rajesh Raman

[8]. Ankle Fracture Detection Utilizing a Convolutional Neural Network Ensemble Implemented with a Small Sample, De Novo Training, and Multiview Incorporation

[9]. Court-Brown, C., Caesar, B.: Epidemiology of adult fractures: a review. Injury 37(8), 691–697 (2006)

[10].Segmentation and Analysis of CT Images for Bone Fracture Detection and Labeling ByDarshan D. Ruikar, K.C. Santosh, Ravindra S. Hegadi

[11].G. N. Balaji, S. V. Suryanarayana, J. Sengathir, Enhanced Boykov's graph cuts based segmentation for Cervical Cancer Detection , EAI Endorsed Transactions on Pervasive Health and Technology: Vol. 7 No. 28 (2021): EAI Endorsed Transactions on Pervasive Health and Technology

[12].Deep learning and SURF for automated classification and detection of calcaneus fractures in CT images Author links open overlay panelYoga Dwi Pranata a, Kuan-Chung Wang a, Jia-Ching Wang a, Irwansyah Idram b, Jiing-Yih Lai b, Jia-Wei Liu c, I-Hui HsiehXing, X., Jin, X., Elahi, H., Jiang, H., & Wang, G. (2022).

[13].Performance of some image processing algorithms in TensorFlow Damir Demirović, Emir Skejić, Amira Šerifović-Trbalić University of Tuzla, Faculty of Electrical Engineering, Franjevačka 2, 75000 Tuzla, Bosnia and Herzegovina

[14].Remote Sensing study based on IRSA Remote Sensing Image Processing System Ling Peng, Zhongming Zhao, Linli Cui, Lu Wang Department of Image Processing, Institute of Remote Sensing Applications, CAS

[15].Bone Fracture Detection Using Deep Supervised Learning from Radiological Images: A Paradigm Shift Tanushree Meena and Sudipta Roy

[16].Twister segment morphological filtering. A live method for live zebrafish embryos confocal images processing. M.A.Luengo-Oroz, E.Faure, B.Lombardot, R.Sance, P.Bourgine, N.Peyrieras ´ and A. Santos

[17].Expectation Maximization Reconstruction of Positron Emission Tomography Images Using Anatomical Magnetic Resonance Information B. Lipinski, H. Herzog, E. Rota Kops, W. Oberschelp, and H. W. Muller-Gartner

[18].Measuring the Geometrical Parameters of Steel Billets during Molding Process Using Image Processing Mohammadiha , M. Sahraeian , B. Vosoughi Vahdat , A. Azizi and A. Shah Ahmad.

[19]. Detection of Bone Fracture using Image Processing Methods, 2015 Authors: Anu T C, Mallikarjunaswamy, Mysuru Rajesh Raman
[20]. Long-bone fracture detection in digital X-ray images based on digital-geometric techniques, September 2019 Authors: Oishila Bandyopadhyay, Arindam Biswas, Bhargab B.Bhattacharya
[21]. Bone Fracture Detection Using Edge Detection Technique, November 2017 Authors: Nancy Johari & Natthan Singh

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