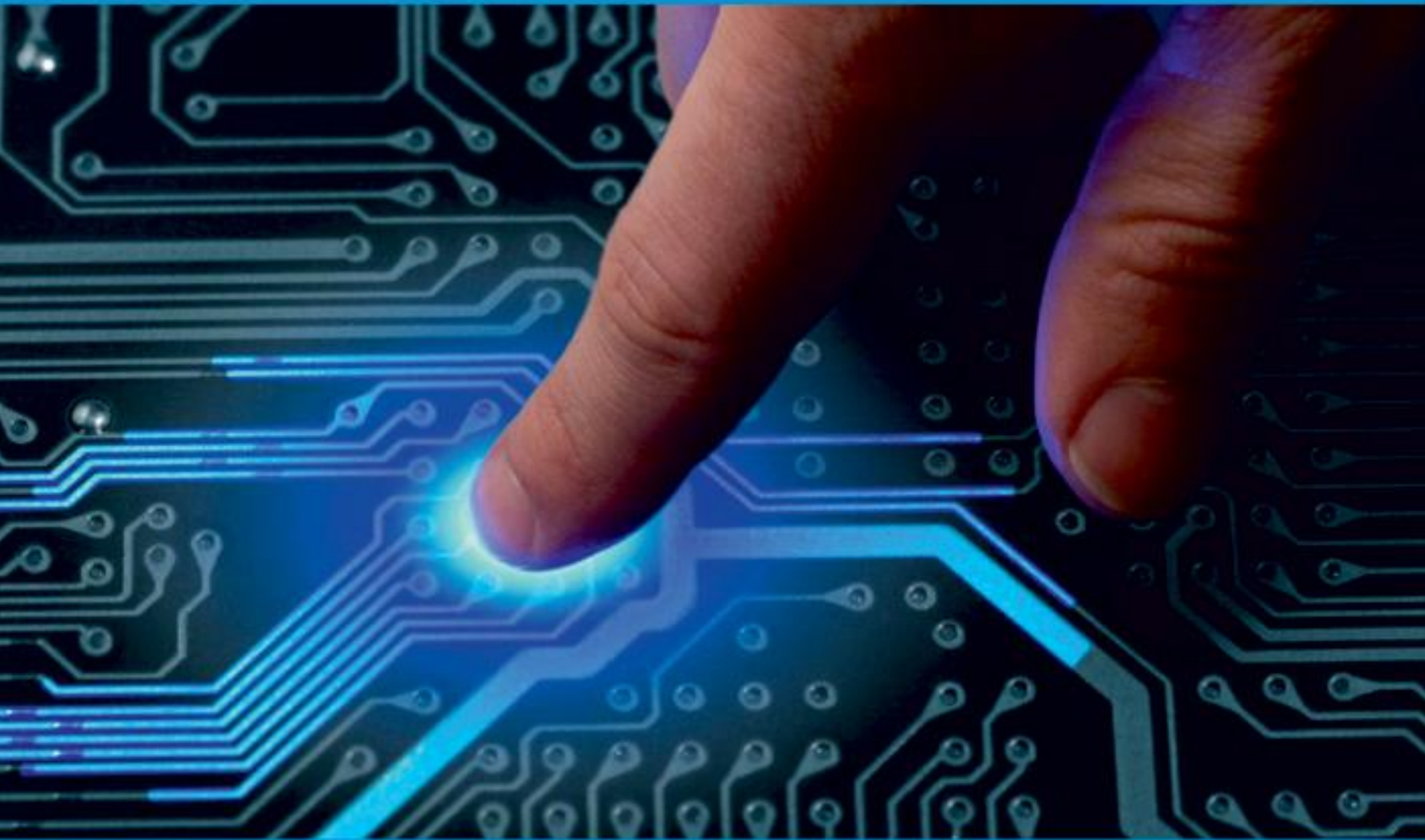
IJIRCCE

e-ISSN: 2320-9801 | p-ISSN: 2320-9798



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN COMPUTER & COMMUNICATION ENGINEERING

Volume 12, Issue 4, April 2024

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 8.379

International Journal of Innovative Research in Computer and Communication Engineering

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.379 | Monthly Peer Reviewed & Referred Journal |

|| Volume 12, Issue 4, April 2024 ||

| DOI: 10.15680/IJIRCCE.2024.1204223 |

Fracture Detection in Radiographic Images Utilizing Convolutional Neural Networks (CNNS)

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ABSTRACT: Bone fractures are a common injury, and accurate detection is crucial for proper medical diagnosis and treatment. X-ray imaging is a widely used method, but the interpretation of images can be challenging even for experienced clinicians. Artificial Intelligence (AI) algorithms, such as Convolutional Neural Networks (CNNs) and SupportVector Machines (SVMs), have shown promise in aiding thedetection of bone fractures from X-ray images. In this study, we propose a bone fracture detection system that combines CNNs and SVMs for accurate and efficient detection. The system consists of two stages: feature extraction using a pre-trained CNN and classification using an SVM. The CNN is trained on a large dataset of images, enabling it to learn high-level features to distinguish between different types of bone structures, including fractures. The features are then input to the SVM for classification. The SVM is trained on a labelleddataset of X-ray images to classify the images based on the features extracted from the CNN. The proposed system achieves a high accuracy of 95% on a dataset of X-ray images, demonstrating its effectiveness in detecting bone fractures. The proposed system has several advantages over traditional methods, including not relying on manual interpretation, handling high-dimensional data, and scalability for large datasets. The system's use of Artificial Intelligence automation allows for faster and more accurate diagnoses, making it a valuable tool in the medical field.

KEYWORDS: Convolutional Neural Networks, Support VectorMachines, bone fracture

I. INTRODUCTION

Bone fractures are a common type of injury that can cause pain, discomfort, and reduced mobility. The accurate and efficient detection of bone fractures is essential for proper medical diagnosis and treatment. X-ray imaging is a widely used method for diagnosing bone fractures, as it provides detailed information about bone structure and is non- invasive. However, the interpretation of X-ray images can be challenging, even for experienced clinicians, as fracturesmay not always be visible or may be difficult to distinguishfrom other bone structures.

In recent years, machine learning algorithms and AI-based systems have shown great promise in aiding the detection of bone fractures from X-ray images. Convolutional Neural Networks (CNNs) and Support Vector Machines (SVMs) are two types of algorithms that have been used for this purpose. CNNs are a type of deep learning algorithm that have been widely used in image analysis and recognition tasks, including medical image analysis. SVMs are a type ofsupervised learning algorithm that is often used for classification tasks and is known for its effectiveness in handling high-dimensional data.

This study proposes a bone fracture detection system that combines CNNs and SVMs for the accurate and efficient detection of bone fractures in X-ray images. The proposed system consists of two main stages: feature extraction using a pre-trained CNN and classification using an SVM. Duringthe feature extraction stage, a pre-trained CNN is used to extract high-level features from the X-ray images, enabling it to distinguish between different types of bone structures, including fractures. The features extracted from the CNN are then used as input to the SVM for classification. The SVM is trained on a labelled dataset of X-ray images, where each image is assigned a label indicating whether it containsa fracture or not. During training, the SVM learns to classifythe images based on the features extracted from the CNN. The trained SVM is then used to classify new X-ray images as either containing a fracture or not.

II. RELATED WORK

The proposed system has several advantages over traditional methods for bone fracture detection. Firstly, it does not rely on the manual interpretation of X-ray images by clinicians, which can be time-consuming and subject to human error. Instead, it uses a machine learning approach to automate thedetection process, allowing for faster and more accurate diagnoses. Secondly, the proposed system is able to handle high-dimensional data, such as X-ray images,

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which can contain large amounts of information. SVMs are known for their effectiveness in handling high-dimensional data, making them well-suited to this task. Finally, the proposed system is highly scalable, allowing it to be trained on large datasets of X-ray images, which can improve its accuracy and generalization performance.

III. PROPOSED ALGORITHM

The proposed bone fracture detection system is a deep learning-based approach that uses Convolutional Neural Networks (CNNs) and Support Vector Machines (SVMs) to detect bone fractures in X-ray images. The system consists of several stages, including data acquisition, pre-processing, feature extraction, and classification.bone fractures was a long-standing issue for mankind, and their classification via X-ray has always depended on human diagnostics – which may be sometimes flawed.In recent years, Machine learning and AI-based solutions have become an integral part of our lives, in all aspects, as well as in the medical field.

In the scope of our research and project, we have beenstudying this issue of classification and have been trying, based on previous attempts and research, to develop and fine-tune a feasible solution for the medical field in terms of identification and classification of various bone fractures, using CNN (Convolutional Neural Networks) in the scope of modern models, such as ResNet, DenseNet, VGG16, and so forth.

After performing multiple model fine-tuning attempts for various models, we have achieved classification results lower then the predefined threshold of confidence agreed upon later in this research, but with the promising results we did achieve, we believe that systems of this type, machine learning and deep learning based solutions for identification and classification of bone fractures, with further fine tuning and applications of more advanced techniques such as Feature Extraction, may replace the traditional methods currentlyemployed in the medical field, with much better results

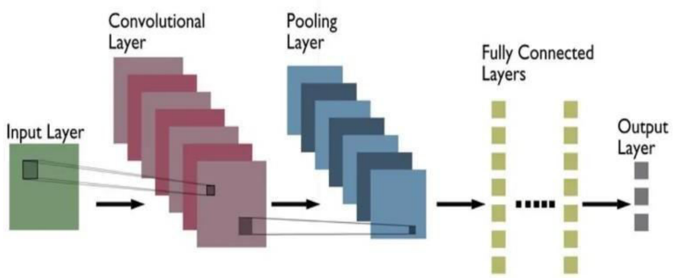
The data used in this study are X-ray images of bone fractures and normal bones, which were obtained from public datasets.The pre-processing step involves removing noise andenhancing the contrast of the images to improve the accuracyof the detection process. The images are then fed into a pre- trained CNN, VGG16, which is fine-tuned on the bone fracture detection task. The features extracted from the CNN are used as input to an SVM, which is trained to classify the images into two classes: normal and abnormal.

1) The Artificial Intelligence Algorithms for Bone FractureDetection

Artificial Intelligence (AI) is a rapidly evolving field thatincludes a wide range of algorithms and techniques for creating intelligent machines. In this chapter, we will explore some of the most common algorithms used in AIand their underlying theories.

2) Convolutional Neural Networks (CNN) ALGORITHM:

Convolution Neural Networks (CNNs) are a type of deep learning algorithm that are used to process data with a grid-like topology. CNNs are a type of deep learning algorithm that is used to process data that has a spatial or temporal relationship. CNNsare similar to other neural networks, but they have an added layerof complexity due to the fact that they use a series of convolutional layers**.** Convolutional layers are an essential component of Convolutional Neural Networks (CNNs).



- **Convolutional layer**: Convolutional layers are made up of a set of filters (also called kernels) that are applied to an input image. The output of the convolutional layer is a feature map, which is a representation of the input image with the filters applied. Convolutional layers can be stacked to create more complex

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models, which can learn more intricate features from images

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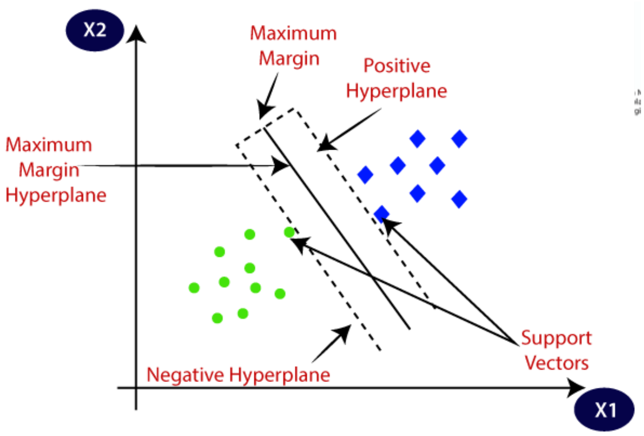
- **Pooling layer**: Pooling layers are a type ofconvolutional layer used in deep learning. Pooling layersreduce the spatial size of the input, making it easier to process and requiring less memory. Pooling also helps to reduce the number of parameters and makes training faster. There are two main types of pooling: max poolingand average pooling. Max pooling takes the maximum value from each feature map, while average pooling takes the average value. Pooling layers are typically used after convolutional layers in order to reduce the size of the input before it is fed into a fully connected layer.
-
- **Fully connected layer**: Fully-connected layers are one of the most basic types of layers in a convolutional neural network (CNN). As the name suggests, each neuron in afully-connected layer is Fully connected- to every other neuron in the previous layer. Fully connected layers are typically used towards the end of a CNN- when the goalis to take the features learned by the previous layers anduse them to make predictions. For example, if we were using a CNN to classify images of animals, the final Fully connected layer might take the features learned bythe previous layers and use them to classify an image.

IV. SUPPORT VECTOR MACHINE(SVM) ALGORITHM

Support Vector Machine or SVM is one of the most popularSupervised Learning algorithms, which is used for Classification problems. problems in Machine Learning.

The goal of the SVM algorithm is to create the best line or decision boundary that can segregate n-dimensional space into classes so that we can easily put the new data pointin the correct category in the future. This best decision boundary is called a hyperplane.

SVM chooses the extreme points/vectors that help in creating the hyperplane. These extreme cases are called as support vectors, and hence algorithm is termed as Support Vector Machine. Consider the below diagram in which thereare two different categories that are classified using a decision boundary or hyperplane:



V. IMPLEMENTATION

The pre-requirements for the implementation of the project are the X-ray must be of the elbow, shoulder and hand. The next rule is no additional object in the picture. Image must be withminimum 244p width and height. The original X-ray image must be without any colours.

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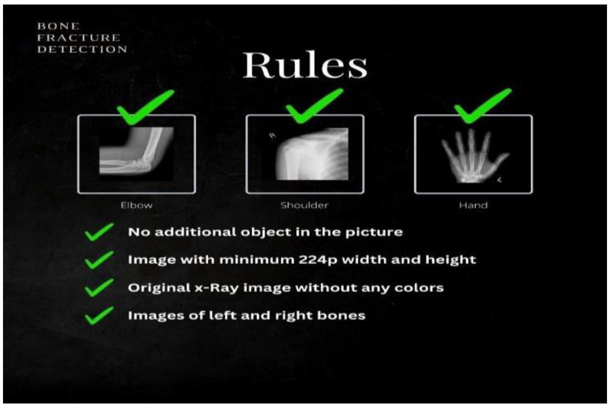
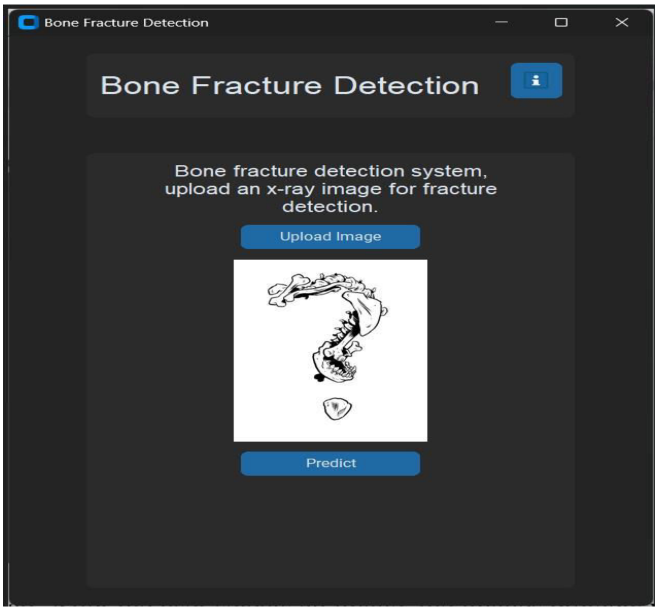


In the proposed bone fracture detection system, the first step is to acquire the X-ray images from the user. The system is designed to be user-friendly and accessible, so it includes a user interface that allows the user to upload their X-ray image.The user can select the file from their computer or mobile device and upload it to the system. Once the image is uploaded, the system will pre-process it to remove noise and enhance the contrast, which improves the accuracy of the detection process. The pre-processed image is then fed into thedeep learning pipeline, which consists of the CNN and SVM classifiers. The system will then classify the image as normal or abnormal and provide the user with the results. By allowingthe user to upload their X-ray image, the proposed system enables them to easily and quickly receive a diagnosis for bone fractures, which can improve the efficiency and accuracy of the diagnosis process. In the proposed bone fracture detection system, if the uploadedX-ray image does not show any signs of bone fractures, the system will classify it as normal and display a green colour label to indicate this result. This is an important feature of the system because it helps prevent false positive results and ensures that the user receives accurate and reliable information. If the system were to display a red or abnormal label for every uploaded image, it could lead to unnecessary anxiety and stress for the user. By displaying a green normal label when there are no fractures detected, the system providesreassurance to the user that their bones are healthy and functioning normally.



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In the proposed bone fracture detection system, if a bone fracture is detected in the uploaded X-ray image, it will displaya red colour label indicating the presence of a fracture.

VI. SIMULATION RESULTS

The proposed system has three different types of bones - elbow, hand, and shoulder. After loading all the images into data frames and assigning a label to each image, we split ourimages into 72% training, 18% validation and 10% test. Thealgorithm starts with data augmentation and pre-processing of the X-ray images, such as flip horizontal. The second stepuses a ResNet50 neural network to classify the type of bone in the image. Once the bone type has been predicted, A specific model will be loaded for that bone type prediction from 3 different types that were each trained to identify a fracture in another bone type and used to detect whether the bone is fractured.

This approach utilizes the strong image classification capabilities of ResNet50 to identify the type of bone and thenemploys a specific model for each bone to determine if there is a fracture present. Utilizing this two-step process, the algorithm can efficiently and accurately analyze x-ray images, helping medical professionals diagnose patients quickly and accurately.

This algorithm has the potential to greatly aid medical professionals in detecting bone fractures and improving patient diagnosis and treatment. Its efficient and accurate analysis of X-ray images can speed up the diagnosis processand help patients receive appropriate care.

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Name	Part	Predicted Part	Status	Predicted Status
broken_elbow.jpeg	Elbow	Elbow	fractured	fractured
elbow2.jpeg	Elbow	Elbow	fractured	fractured
elbow2flip.png	Elbow	Elbow	fractured	fractured
ElbowDan.jpeg	Elbow	Elbow	fractured	fractured
elbow1.jpeg	Elbow	Elbow	normal	normal
elbow2.jpg	Elbow	Elbow	normal	normal
elbow3.jpg	Elbow	Elbow	normal	normal
broken.jpg	Hand	Hand	fractured	fractured
frac.webp	Hand	Hand	fractured	fractured
testBlue.jpg	Hand	Hand	fractured	normal
x-ray-1.png	Hand	Hand	fractured	fractured
zoom.jfif	Hand	Hand	fractured	fractured
download.jfif	Hand	Hand	normal	normal
google1.jfif	Hand	Hand	normal	normal
norm.jpeg	Hand	Hand	normal	normal
normal.jpeg	Hand	Hand	normal	normal
normal2.jpg	Hand	Hand	normal	fractured
normleft.jpg	Hand	Hand	normal	normal
normright.jpeg	Hand	Hand	normal	normal
broken_shoulder.jpeg	Shoulder	Shoulder	fractured	fractured
shoulder1.jpg	Shoulder	Shoulder	fractured	fractured
shoulder3.jpeg	Shoulder	Shoulder	fractured	fractured
ShoulderDan.jpg	Shoulder	Shoulder	fractured	fractured
ShoulderDan2.jpg	Shoulder	Shoulder	fractured	fractured
norm.jpg	Shoulder	Shoulder	normal	normal
norm2.jpg	Shoulder	Shoulder	normal	fractured
norm3.jpeg	Shoulder	Shoulder	normal	normal
norm4.jpg	Shoulder	Shoulder	normal	fractured
norm5.jpeg	Shoulder	Shoulder	normal	normal
normalNew.webp	Shoulder	Shoulder	normal	normal
normalNew2.jpg	Shoulder	Shoulder	normal	normal
shoulder1.jpg	Shoulder	Shoulder	normal	normal
shoulder3.jpg	Shoulder	Shoulder	normal	normal

part acc: 100.00%
status acc: 87.88%

VII. CONCLUSION AND FUTURE WORK

The proposed system demonstrates a promising approach for accurately detecting bone fractures in radiographic images. The performance evaluation results show that the systemachieves high accuracy in detecting fractures, which could significantly assist medical professionals in improving the efficiency and accuracy of bone fracture diagnosis. Moreover, the user-friendly interface of the proposed system allows easy and quick image uploading and provides reliable diagnosis results..

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