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IOT enabled Intelligent featured imaging Bone Fractured Detection System

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Abstract

In the present era, there are lots of advancements and initiatives that have been undertaken through image processing techniques and IoT (Internet of Things). Image processing has proven its valuable insights in various applications such as GIS, biomedical, security, satellite imaging, medicine, and personal image analysis. In the context of fracture detection, image improvements, feature segmentation, and feature extraction techniques are commonly implemented including in the IoT Environment. The lower long bone, hand bone, and elbow bones are the particular interest due to their high incidence of fractures. X-ray diagnosis is a common method of detecting bone fractures due to its rapid and widespread availability. X-ray imaging involves a small amount of ionizing radiation in each part of the body, which is then captured on a particular film or digital detector. X-ray images, though they may have limitations compared to other imaging modalities, provide sufficient quality for fracture detection. There are three points of motivation for this research i.e. First- ease of use of software for patients and reduce the time for doctors and patients by screening out straight forward, Second- to decrease human mistakes that can also occur from manually inspecting a massive dataset of X-ray images to become aware of fractured sections of bones in hospitals, third- use of IoT infrastructure to collecting images of X-Rays and performing processing on received data by which we can send some accurate information back to the patients. The research aims to develop an automated environment i.e IoT emulation Framework consisting of image pre-processing such as attainment of images, pre-post-processing, segment methods, feature extraction, fracture detection, and visualization. Feature Extraction algorithm includes, CLAHE object with the preferred clip limit 2.0, CLAHE to the grayscale image, Gaussian blur to overcome more noise, Canny side detection, Hough Transform for line detection, and the gradient magnitude to acquire binary edges varied out through IoT. The framework utilizes the Canny edge detection methodology and Sobel operator for image segmentation. In this heat maps of images are also observed, which provide accurate information from bone images through IoT. The proposed system illustrates extreme accuracy and effectiveness, as proved by the results acquired from numerous experiments. The automated labeling and detection of bone fractures through photo processing by way of IoT offer great potential for fast and correct diagnosis, contributing to successful treatment outcomes.

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1. Introduction

The brain, heart, lungs, and other internal structures are shielded by the bones, which have an important function in the human body. The human skeletal system, consisting of 206 bones has uniqueness in terms of size, shape, and composition. Among these bones, the largest bone is the femur, while the smallest is the ossicles. Unfortunately, bone fractures are frequently experienced by most people due to accidents and activities in daily living, because of mishaps or circumstances in which bones are put under too much pressure.

Bone fractures can manifest in the following with their own traits and implications-

A. **Oblique Fracture:** An indirect fracture refers to a smash in the bone, the place where the fracture line runs diagonally throughout the bone. This kind of fracture frequently happens due to an aggregate of twisting and bending forces utilized by the bone.
B. **Compound Fracture:** A compound fracture, additionally recognized as an open fracture, is an extreme kind of fracture the place the damaged bone pierces via the skin, exposing it to the exterior environment. This circumstance consists of an extended threat of contamination due to the open wound.
C. **Comminuted Fracture:** A comminuted fracture is characterized by the aid of the bone breaking into a couple of fragments, resulting in three or more separate pieces. These fractures frequently take place due to high-energy influences or extreme trauma.
D. **Spiral Fracture:** A spiral fracture takes place when a rotating or twisting pressure is utilized on a bone, causing it to spoil in a spiral pattern. This somewhat rupture is often regarded in extended cartilages like the femur or tibia.
E. **Greenstick Fracture:** A greenstick rupture is a rupture that takes place notably in kids whose cartilages are better physically malleable. In this break, the cartilage bends and cracks however would not ruin entirely, similar to the habit "greenstick" would break.
F. **Transverse Fracture:** A transverse fracture refers to a smash in the bone that runs straight throughout its width, forming a horizontal line. This kind of fracture is frequently brought about via a direct blow or impact.

Indeed, X-rays and CT scans are regularly used for fracture prognosis in scientific settings due to their pace and convenience. Here's a similar rationalization of their position in fracture evaluation and the use of the DICOM format:

X-rays: X-rays are broadly used to investigate fractures as they are rapid to function and supply treasured statistics about the presence, location, and alignment of a fracture. X-ray pictures are created by passing a small quantity of radiation through the body, and ensuring pictures exhibit the density variants of the underlying structures. Fractures arrive as breaks or discontinuities in the cartilage shape on the X-ray figures, permitting experimental experts to recognize the break and elect its characteristics.

CT scans: Computed Tomography (CT) scans use a mixture of X-rays and superior visualization to create specified cross-sectional snapshots of the body. CT scans are specifically beneficial for evaluating complicated fractures, assessing joint involvement, and visualizing fractures in three dimensions. They supply a greater complete view of the fracture and surrounding structures, enabling clinical practitioners to precisely diagnose and layout treatment. CT scans are barely more time-consuming than X-rays however provide increased element and precision.

In present-day hospitals, clinical images, that contain X-rays and CT scans, are repeatedly sustained and governed by the use of the DICOM (Digital Imaging and Communications in Medicines) layout. DICOM is a widely selected up to date for the exchange, depository, and spoken exchange of controlled images. It comprises each the picture facts and related affected person information, such as demographics and scientific reports, into a single file.

The DICOM structure permits convenient retrieval and showing of scientific snapshots at some point in the analysis and therapy processes. Medical practitioners can get the right of entry to affected person pics saved in the DICOM structure from more than a few imaging modalities, such as X-ray machines and CT scanners, and the usage of specialized viewing software. This allows seamless integration and sharing of scientific photographs throughout specific healthcare structures and enables collaboration amongst healthcare experts concerned with the patient's care.

X-ray checks [11], additionally referred to as radiographs, are in many instances, diagnose and consider bone fractures. A bone fracture takes place when there is a wreck or cracks in a bone, frequently due to trauma or immoderate pressure utilized to the bone. The X-rays are emitted via the physique and are absorbed in another way by means of the bones and surrounding tissues, developing a shadow-like picture on a movie or digital detector. This image, called a radiograph, allows healthcare professionals to visualize the bones and assess any fractures or abnormalities present. The X-ray images provide information about the location, extent, and type of bone fracture. They can help to determine the alignment of the bone fragments, whether there are displaced or misaligned bones, and if there are any additional complications, such as bone fragments penetrating surrounding tissues. X-rays are particularly effective in diagnosing fractures because they can reveal even small cracks or hairline fractures that may not be visible through other imaging techniques. They are commonly used for assessing fractures in different parts of the body, including the arms, legs, spine, ribs, and skull. It is fundamental to spotlight the achievable dangers related to the publicity of ionizing radiation, such as X-rays. While the radiation dose used in diagnostic X-ray checks is commonly regarded as secure for most individuals, it is vital to work out caution, in particular in positive conditions such as pregnancy.

Ionizing radiation has the possibility to harm cells and genetic material, and unborn children are viewed as more sensitive to its effects. However, it is necessary to be aware that the chance of damage to the fetus from diagnostic X-ray examinations is normally low, particularly when suited precautions are taken. In the case of pregnant women, it is beneficial to inform the healthcare company about the pregnancy earlier than the present process of an X-ray examination. This permits the healthcare group to examine the necessity of the X-ray and think about choice imaging strategies if appropriate. They can weigh the plausible advantages of acquiring the diagnostic records towards the possible dangers to the growing fetus. In such conditions, an X-ray is deemed critical all through pregnancy, healthcare carriers will normally take unique precautions to decrease radiation publicity for the mother and the fetus. This can encompass the usage of lead shielding, such as lead aprons or stomach shielding, to shield the stomach and growing fetus from needless radiation exposure.

It is essential for pregnant girls to have open and obvious conversations with their healthcare professionals concerning any worries or questions about radiation publicity during diagnostic imaging. This will make sure that knowledgeable selections can be made, balancing the want for the correct prognosis with the well-being of the mom and the unborn child. Ultimately, whilst X-rays are usually viewed as secure when used appropriately, it is necessary to take precautions, in one-of-a-kind occasions like pregnancy, to reduce plausible dangers and make certain the protection of each the affected person and the fetus.

2. Problem Definition

X-ray tests are incredibly widespread, with millions of examinations conducted annually. The primary purpose of an X-ray examination is to identify fractures in bones. Additionally, an X-ray examination can detect any abnormal positioning of the joint's bones. The interpretation of X-ray results is the domain of doctors, so it is important to consult with a doctor to obtain the findings from X-rays. Timely and accurate diagnosis plays a critical role in determining the effectiveness of prescribed treatments. Since only Expert Doctors have the expertise to analyze X-ray images and human errors can occur, there is a need for caution.

Relying solely on human experts for such crucial matters has led to unacceptable errors. Consequently, the concept of automating the diagnostic process has always been appealing. Bone fractures can take a type of forms, including natural, indirect, compound, comminuted, spiral, greenstick, and transverse.

This research aims to detect fractures in bones. The research paper findings involve figuring out the kind of fracture with the help of the IoT Environment. The developed IOT-enabled intelligent featured imaging bone fractured detection system communicates the information over the cloud for X-ray effects with the best feasible stage of accuracy.

3. Motivation

There are several factors that contributed to the development of software to assist physicians in diagnosing and examining X-ray images for bone fractures:

- **Numerous bone fractures occur:** Millions of bone fractures occur annually around the globe which makes them the most common injuries. Due to the frequency of fractures, doctors are required to consider multiple X-ray images daily in order to accurately diagnose and treat patients, which requires a lot of extra effort.
- **Potential for permanent harm:** If fractures are not treated properly or are treated incorrectly, the affected area may sustain permanent damage. Therefore, doctors must accurately diagnose patients and provide excellent treatment as soon as possible. Misdiagnosis or delayed treatment can have serious repercussions, highlighting the need for reliable and eco-friendly diagnostic tools.
- **X-ray image evaluation difficulties**: Despite its extensive use for over a century, X-ray technology has its limitations. Additionally, X-rays may not always reveal specific details about the bone, making it difficult for doctors to accurately identify fractures. Additionally, extensive knowledge and experience are required to effectively classify distinct types of fractures, which are not always readily available.
- **Crisis conditions and time limitations**: Specialists consistently need to act quickly in crisis circumstances; the spot there's no time to waste. This time pressure can also make it hard to make accurate predictions and increase the chance of making mistakes. The technology trends for clinical specialists in the examination strategy can help assist the dynamic technique and upgrade impacted individual results.
- **The significance of correctly classifying fractures:** The correct classification of the fracture among the preferred types is crucial to the success of the cure and prognosis for the fracture. Doctors are able to select the

most effective treatment strategy and anticipate potential issues or long-term effects for accurate classification. Software assistance can enhance the accuracy of fracture classification, ensuring improved treatment plans.

4. Recent Work

For detecting bone fractures, several algorithms have been developed recently. Vijay et al. invented a filter for Gaussian explosion replacement; this portion supplies an inclusive overview of the history. The exclamation level is first supposed from the strident representation, and therefore a threshold is used to entirely change the center pel utilizing the mean of the total of the encircling pixels. The invention has a larger top signal-to-noise ratio (PSNR) and a mean absolute error (MAE) than different leaking algorithms like mean, beginning-decorated mean, Weiner, K-wealth, mutual, and three-cornered. DICOMs are usually debased by distributing in differing forms. Al-Khaffaf projected reaching the K-fill invention to remove buzz and established the number of silver or angry pixels in a three-by-three casement. Assuming the clamor that is designed as the result of two chaotic processes demolishing the photographs: a Poisson and a Gaussian, this design licenses administration to usually determine the scale horizon of the Poisson issue and the plan and vacillation of the Gaussian.
Finally, Zain et al. have addressed the issue of image enhancement and dot reduction using a filtering technique. The subsequent step involves function extraction. Chan et al. present an approach for capability determination, employing three distinct methods wavelet and curvelet transformation. Among the two other techniques, the Haar approach demonstrates the highest accuracy rate. In another study, Tian proposed a machine that utilizes the dimension of the femoral neck-shaft angle to detect fractures in femur bones. Subsequent studies by Lim, Yup, and Lum proposed an innovative approach for X-ray image analysis. They integrated Gabor, Markov Random Field, and gradient depth elements extracted from the image and fed them into Support Vector Machines (SVM) classifiers. Surprisingly, their findings revealed that this combination of three SVM classifiers significantly enhanced accuracy and sensitivity compared to the conventional use of character classifiers.
He et al. [9] suggested employing a "hierarchical" SVM classifier for femur fracture detection on the basis of this observation. Mahendran introduced a novel approach for identifying cracks in the tibia bone using a combination grouping technique. They initiated their process by applying several pre-processing steps, including segmentation, part detection, noise removal, and binary conversion. To classify the detected parts, the authors employed three commonly used classifiers: feed-forward lower back propagation neural networks (NN), support vector machines (SVM), and naive Bayes (NB). The final classification was achieved through a straightforward majority voting method. The segmentation process was crucial in their approach, and Chai has proposed using a GLCM-based (Grey Level Co-occurrence Matrix) method for the segmentation process.
This suggested system emphasizes the importance of the Feature Extraction Scheme for identifying broken bones. Applying the Contrast Limited Adaptive Histogram Equalisation (CLAHE) with a desired clip limit of 2.0 is one of the image processing methods used to improve the greyscale image. Image processing tools utilize a combination of Canny edge detection, Hough Transform for line recognition, and Gaussian blur to effectively identify fractures by reducing noise and obtaining binary edge through gradient magnitude computation. This combination enhances the accuracy and reliability of fracture detection in images.
The Grey Level Co-occurrence Matrix (GLCM) is a crucial technique for analyzing image texture, used to extract and select features. Haralick introduced GLCM in 1973, and it has since become a fundamental method in the field of image texture analysis. Image textures are intricate visual patterns made up of regions or objects that exhibit smaller patterns that can be identified by brightness, color, form, size, and other attributes. The distribution of various grey levels is examined using statistical sampling using GLCM in order to depict the structure of image textures. The GLCM approach is employed to extract textural features like entropy, contrast, correlation, and homogeneity from the given data.
In a paper [25] written by K. Shafique, B. A. Khawaja, et al. titled "Internet of Things (IoT) for Next-Generation Smart Systems: A Review of Current Challenges, Future Trends and Prospects for Emerging 5G-IoT Scenarios", provide the knowledge about the current challenges and more related to IoT (Internet of Things), in context of next-generation smart systems. IoT can be integrated with 5G networks to offer significant benefits in various fields to create advanced systems. The implementation of the IoT (Internet of Things) surroundings is established by way of an IoT emulation and simulation-based framework right here with a load-balancing IoT architecture. The network delays and processing instances through sending a few messages to each fog server and cloud server. Fog computing is exactly the place where any hassle can be solved at fog levels, so there is no want for the cloud if no longer cloud infrastructure.

5. Proposed Implemented Framework

The implemented work has been done with IoT and the angle of the bone is taken for the segmentation part. In this research, if the bone is not in the correct position, it can be deducted. Each bone has its own angle which is given to the software.

The following steps are involved in the proposed implementation framework:

a) Data Sets collection of X-ray images as an input i.e. captured through the IoT Framework
b) Pre-processing on images for reduction of extra noises
c) valid x-ray image collected from the client's sides after the patient's bone scanning
d) Apply Segmentation Schemes on the above
e) Proper Segmented Images After Segmentation
f) Apply Fracture Detection Schemes on segmented results
g) True Positivity for false and true detection of fractured image and non-fractured images to get close accuracy
h) Detected Images of Fractured bone after the above steps

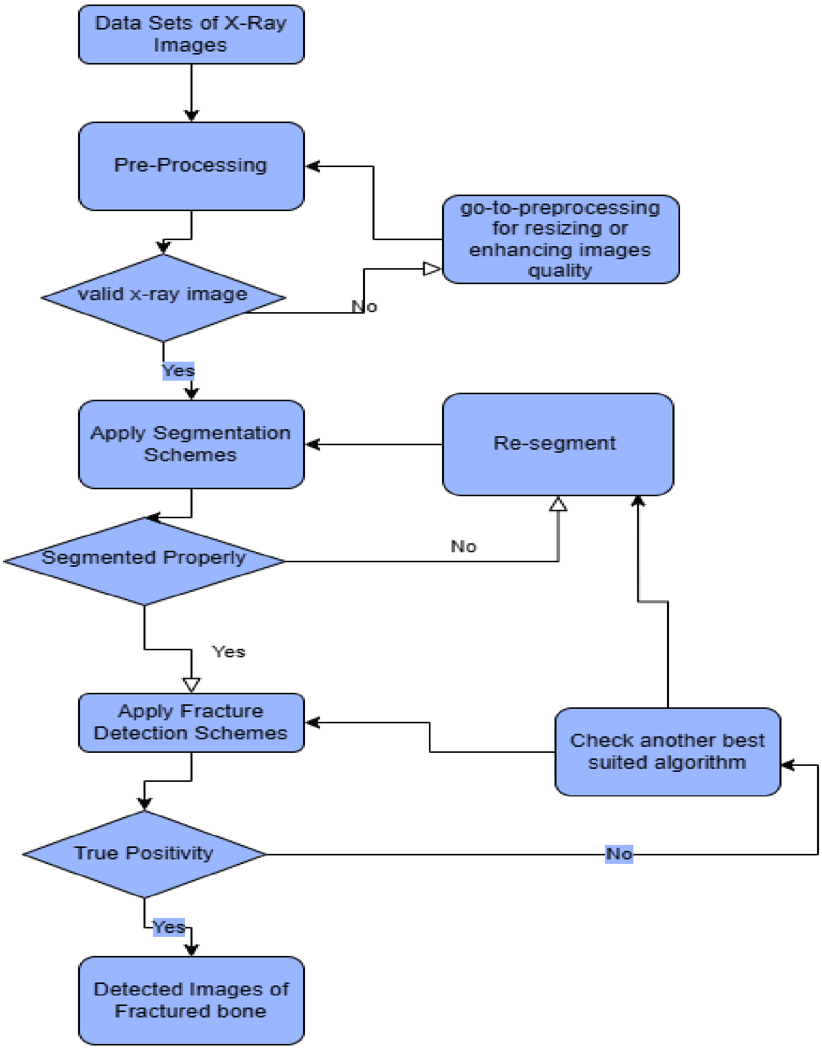


Figure 1: Flow Chart to apply Scheme

The following steps are required to successfully detect the bone fracture using X-ray figures and an IoT environment:

a) X-ray figure data sets as an input:

A set of X-ray images is first gathered from the creation of an IoT environment. X-ray images of both fractured and un-fractured bones are included in this collection from one end device. The fracture detection system takes these pictures as input.

b) Initial Processing:

The X-ray images are subjected to pre-processing procedures before fracture detection can begin. Noise reduction, image enhancement, contrast adjustment, and resizing are all examples of pre-processing steps for this automated

IoT system. The images will be standardized and of higher quality because of these steps, which will allow for more analysis.

c) Accurate X-ray image:

The validity of the pre-processed X-ray image for analysis is verified at this point. This involves ensuring that the image is of sufficient quality for accurate detection and contains relevant bone structures.

d) Utilize Segmentation Methods:

Segmentation is the method involved with parceling a picture into significant areas. Segmentation techniques are used to distinguish the bone region from the background and other non-bone structures in an X-ray image when detecting bone fractures. The objective is to detach the bone region to zero in explicitly on the area of interest.

e) Properly Segmented:

The segmented image is examined to ensure that the bone region has been correctly isolated following the application of segmentation schemes. This step helps ensure that the bone structure has been successfully separated from the rest of the image during the segmentation process.

Figure 2: Fractured Images

f) Use methods for detecting fractures:

The segmented image is subjected to fracture detection algorithms or schemes during this phase. The segmented bone region is analyzed by these algorithms to find indications of fractures or abnormalities. Fractures in the segmented area can be identified using a variety of methods, including edge detection, shape analysis, and texture analysis.

g) Real Time Optimism:

The fracture detection algorithm determines whether the segmented bone region has a fracture. A true positive is one that the algorithm correctly identifies as a fracture. True positivity indicates that a fracture in the X-ray image has been successfully detected by the system.

h) Images of broken bone that were found using the IoT:

The bone fracture detection system's output consists of images of fractured bones. These images can help medical professionals diagnose and treat patients because they highlight the areas in the X-ray images where fractures can be seen.

6. Intelligent IoT-enabled Algorithm environment.

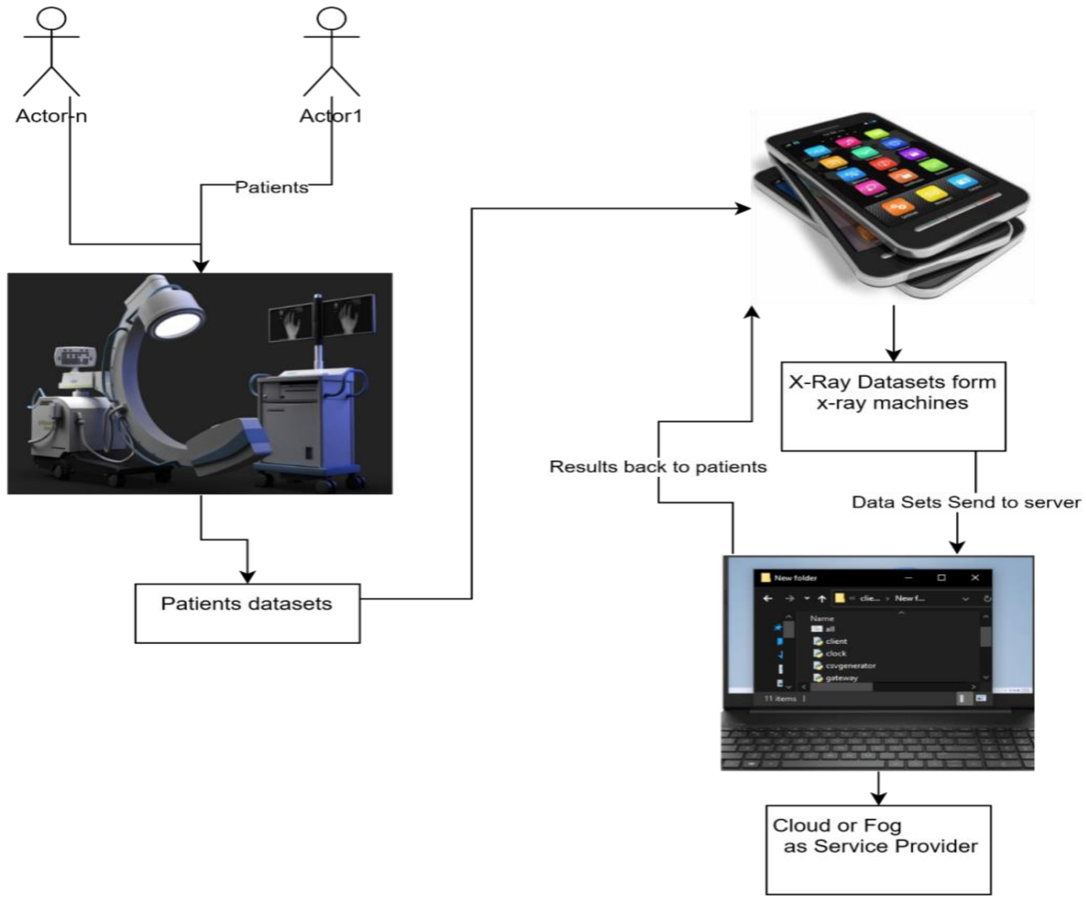


Figure 3: Fracture Detection with IoT framework

In the research, we actualized the IoT Environment with bone broken discovery technique as in Figure 3. In this, we are considering the patients as on-screen characters, here, initially X-ray machine will produce the X-Ray pictures by filtering the patient's broken portion, once the patient collects the pictures of X-rays from X-Rays suppliers and will forward them to Cloud or Fog as administrations supplier to distinguish the break portion for the affirmation in nonattendance of the real specialists, and our framework will do a few preparing on the gotten information from patients and after that send the comes about after identifying the genuine time broken report to the patients.

7. Results

Table 1 below contains information on input images, including their filenames, dimensions (width and height), and size in kilobytes (KB). A breakdown of the table is given below:

Each row represents an individual image, and the columns provide the following information:

1. **Image:** This column indicates the filename of each image. For example, the first image's filename is "OIP.jpg," the second image's filename is "th (1).jpg," and so on.
2. **Width:** This column displays the width of each image in pixels. The width indicates the horizontal size of the image.
3. **Height:** This column shows the height of each image in pixels. The height represents the vertical size of the image.
4. **Size (KB):** This column provides the size of each image file in kilobytes (KB). The size indicates the amount of disk space occupied by the image file.

Table 1: Describing Data Sets

Image	Width	Height	Size (KB)	Image Count(int)	loadtime
lh1.jpg	208	251	6.05957	1	0.031241
lh2.jpg	208	238	7.773438	2	0.046867
lh3.jpg	193	323	9.981445	3	0.046867
lh4.jpg	208	273	7.424805	4	0.062483
lh5.jpg	205	304	7.766602	5	0.062483
OIP.jpg	162	197	4.100586	6	0.078105
pnglh1.jpg	259	189	4.939453	7	0.078105
pnglh2.png	115	189	6.061523	8	0.093728
pnglh3.png	120	120	4.524414	9	0.10937
th (1).jpg	190	328	7.058594	10	0.10937
th (2).jpg	232	268	11.98633	11	0.124969
th (3).jpg	194	321	7.618164	12	0.124969
th (4).jpg	276	226	7.78418	13	0.14059
th.jpg	229	272	7.198242	14	0.14059

By referring to the above table, the quick access of the dimensions and file sizes of the respective images i.e. bone left and right-hand images with different algorithms (Figure 4, Figure 5, Figure 6, Figure 7, Figure 8, Figure 9, Figure 10, and Figure 11) are listed.

In computer vision and image processing, heatmap images to actual images are needed to be compared. Heatmap images depict the importance or intensity of particular regions or features in an image. Object detection, image segmentation, and saliency detection are all common methods used to create them. Colors are used in heatmaps to highlight areas of interest; warmer colors, like red, indicate greater intensity or significance.
The original images that were taken or obtained from a dataset are called actual images. They serve as the baseline or point of comparison and can be RGB or grayscale images.
The next step is visualization to see how the highlighted areas in the heatmap correspond to the actual objects or features in the original image, heatmap and actual images can be viewed side by side.

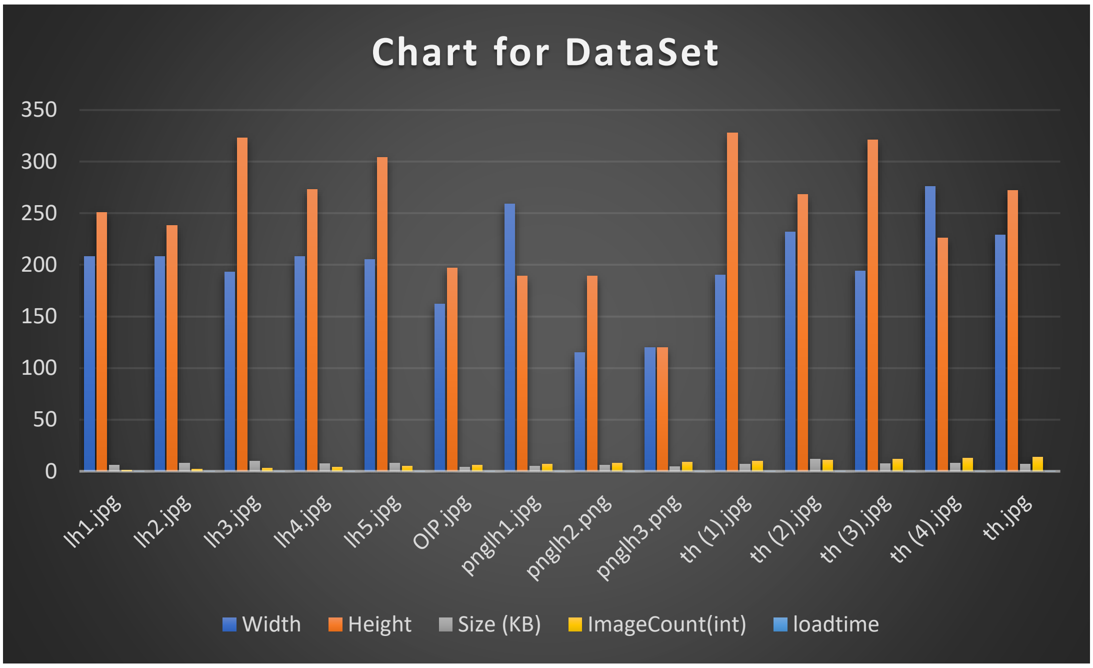


Figure 4: Datasets Visualization Chart

Figure 5: Texture Mapping in Fractured Bone Dataset

Figure 6: Compared

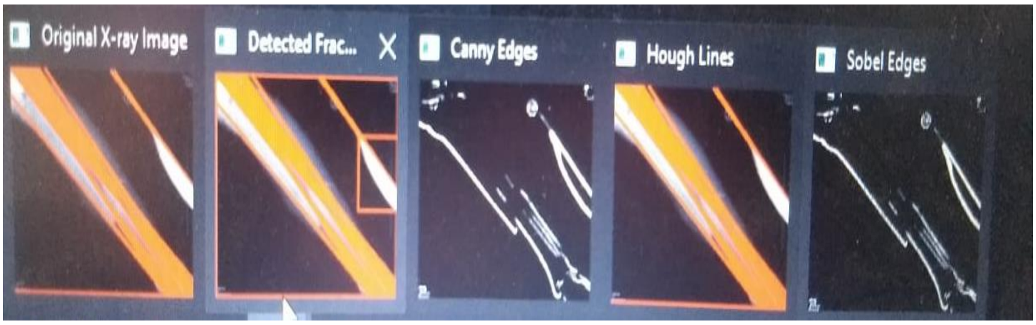


Figure 7: Comparison of Leg Bones images with different algorithms

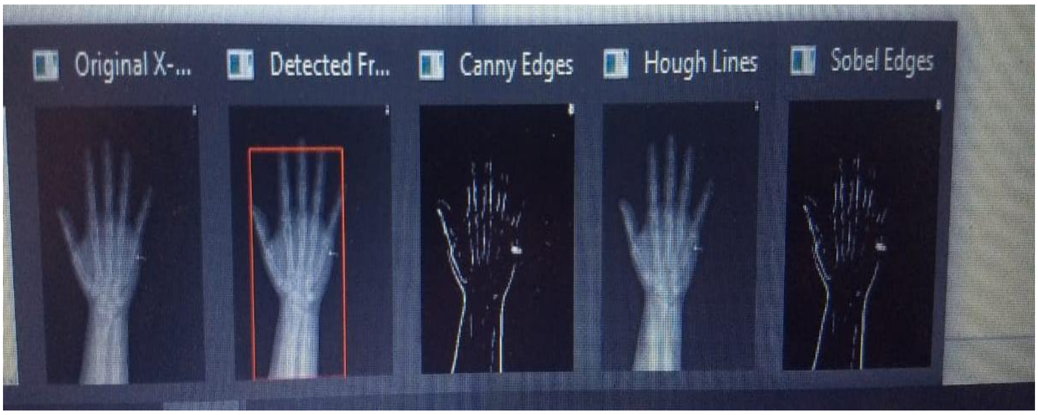


Figure 8: Comparison of bone left-hand palm fingers Images with different algorithms

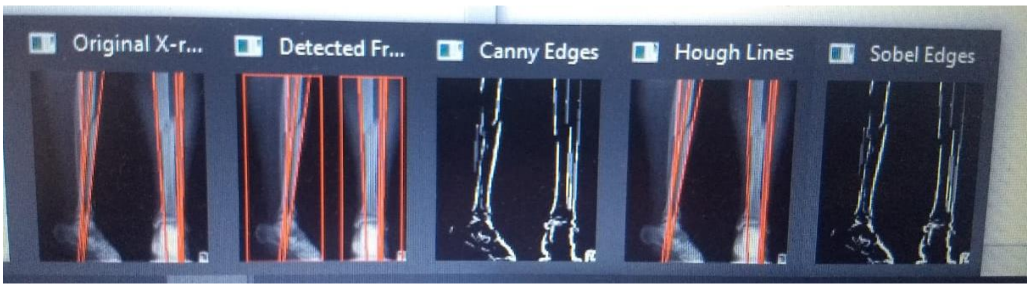


Figure 9: Comparison of bone left and right legs Images with different algorithms

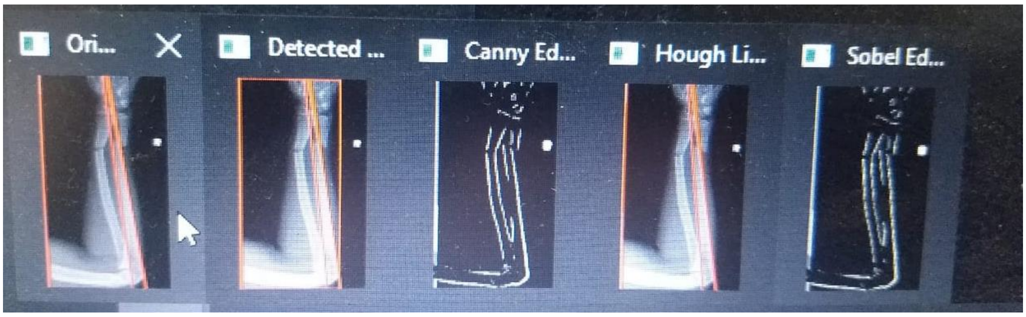


Figure 10: Comparison of bone left-hand Images with different algorithms

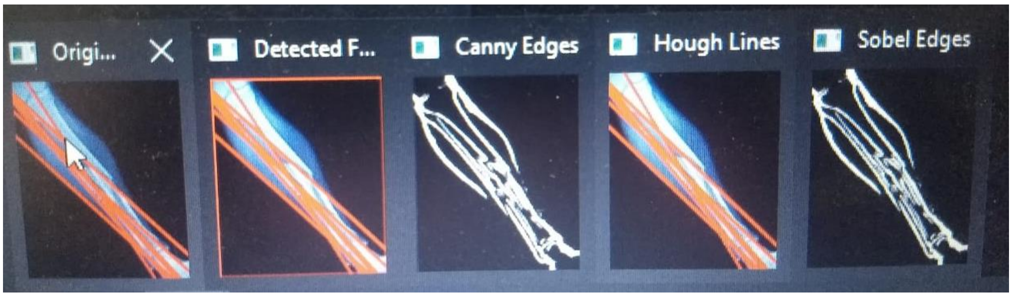
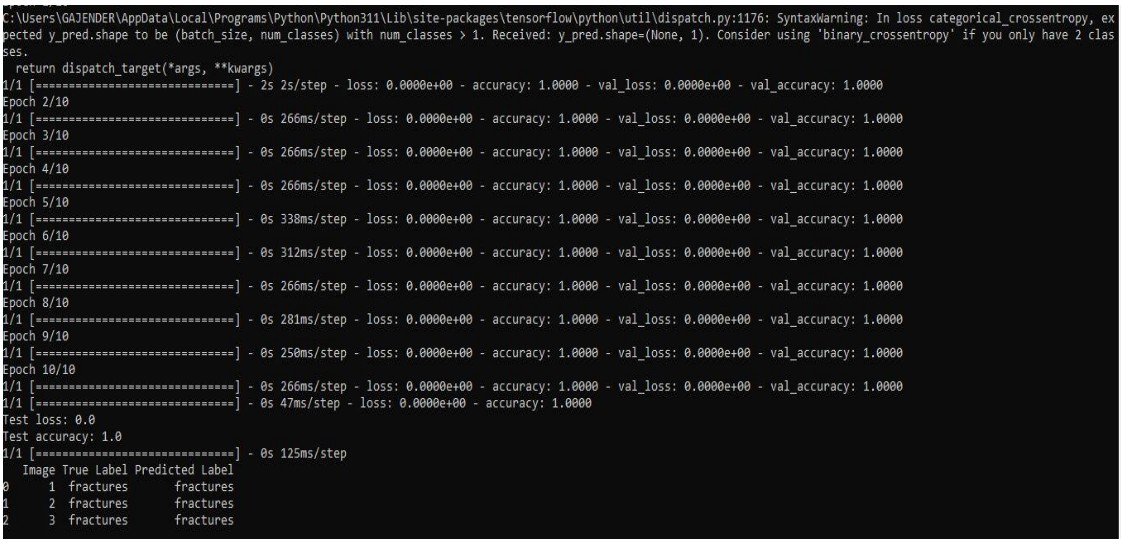


Figure 11: Comparison of leg images with different algorithms

Overlaying the heatmap on top of the actual image is one common method. Alpha blending is used to combine the heatmap with the original image and assign transparency to it. The resulting image overlays the actual image to provide a visual representation of the highlighted areas. Quantitative or qualitative evaluation can be used to make the heatmap-to-image comparison. Metrics like intersection over union (IoU) and pixel-wise comparison can be used in quantitative evaluation to measure the overlap between the highlighted areas and the ground truth. Visual inspection of the correspondence between the heatmap and the actual image is necessary for qualitative evaluation. Applications like object localization, semantic segmentation, medical imaging, and anomaly detection benefit from comparing heatmap images to actual images. It aids in comprehending the precision and dependability of the generated heatmaps and can direct subsequent processes of analysis or decision-making.

Comparing heatmap images with the actual images allows for the assessment of various electronic system vision algorithms' progress and helps in interpreting their outputs. This process provides valuable insights into the detected features or regions of interest within the images. The following generated outputs help to visualize heatmap images from the datasets below:



```
C:\Users\GAJENDER\AppData\Local\Programs\Python\Python311\Lib\site-packages\tensorflow\python\util\dispatch.py:1176: SyntaxWarning: In loss categorical_crossentropy, ex
pected y_pred.shape to be (batch_size, num_classes) with num_classes > 1. Received: y_pred.shape=(None, 1). Consider using 'binary_crossentropy' if you only have 2 clas
ses.
  return dispatch_target(*args, **kwargs)
1/1 [==============================] - 2s 2s/step - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 0.0000e+00 - val_accuracy: 1.0000
Epoch 2/10
1/1 [==============================] - 0s 266ms/step - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 0.0000e+00 - val_accuracy: 1.0000
Epoch 3/10
1/1 [==============================] - 0s 266ms/step - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 0.0000e+00 - val_accuracy: 1.0000
Epoch 4/10
1/1 [==============================] - 0s 266ms/step - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 0.0000e+00 - val_accuracy: 1.0000
Epoch 5/10
1/1 [==============================] - 0s 338ms/step - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 0.0000e+00 - val_accuracy: 1.0000
Epoch 6/10
1/1 [==============================] - 0s 312ms/step - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 0.0000e+00 - val_accuracy: 1.0000
Epoch 7/10
1/1 [==============================] - 0s 266ms/step - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 0.0000e+00 - val_accuracy: 1.0000
Epoch 8/10
1/1 [==============================] - 0s 281ms/step - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 0.0000e+00 - val_accuracy: 1.0000
Epoch 9/10
1/1 [==============================] - 0s 250ms/step - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 0.0000e+00 - val_accuracy: 1.0000
Epoch 10/10
1/1 [==============================] - 0s 266ms/step - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 0.0000e+00 - val_accuracy: 1.0000
1/1 [==============================] - 0s 47ms/step - loss: 0.0000e+00 - accuracy: 1.0000
Test loss: 0.0
Test accuracy: 1.0
1/1 [==============================] - 0s 125ms/step
   Image True Label Predicted Label
0      1  fractures       fractures
1      2  fractures       fractures
2      3  fractures       fractures
```

Figure 13: Classification Using CNN

The model's training and evaluation process is the output here. The data are broken down as follows:
1/1 -2s 2s/step - loss: 0.0000e+0.1; precision: value loss: 1.0000 value accuracy: 0.0000e+00 1.0000: The model's progress in training can be seen on this line. Each training batch's loss and accuracy values are displayed. The loss in this instance is 0.001, and the accuracy for the training set is 0.099 (approx 100 percent).

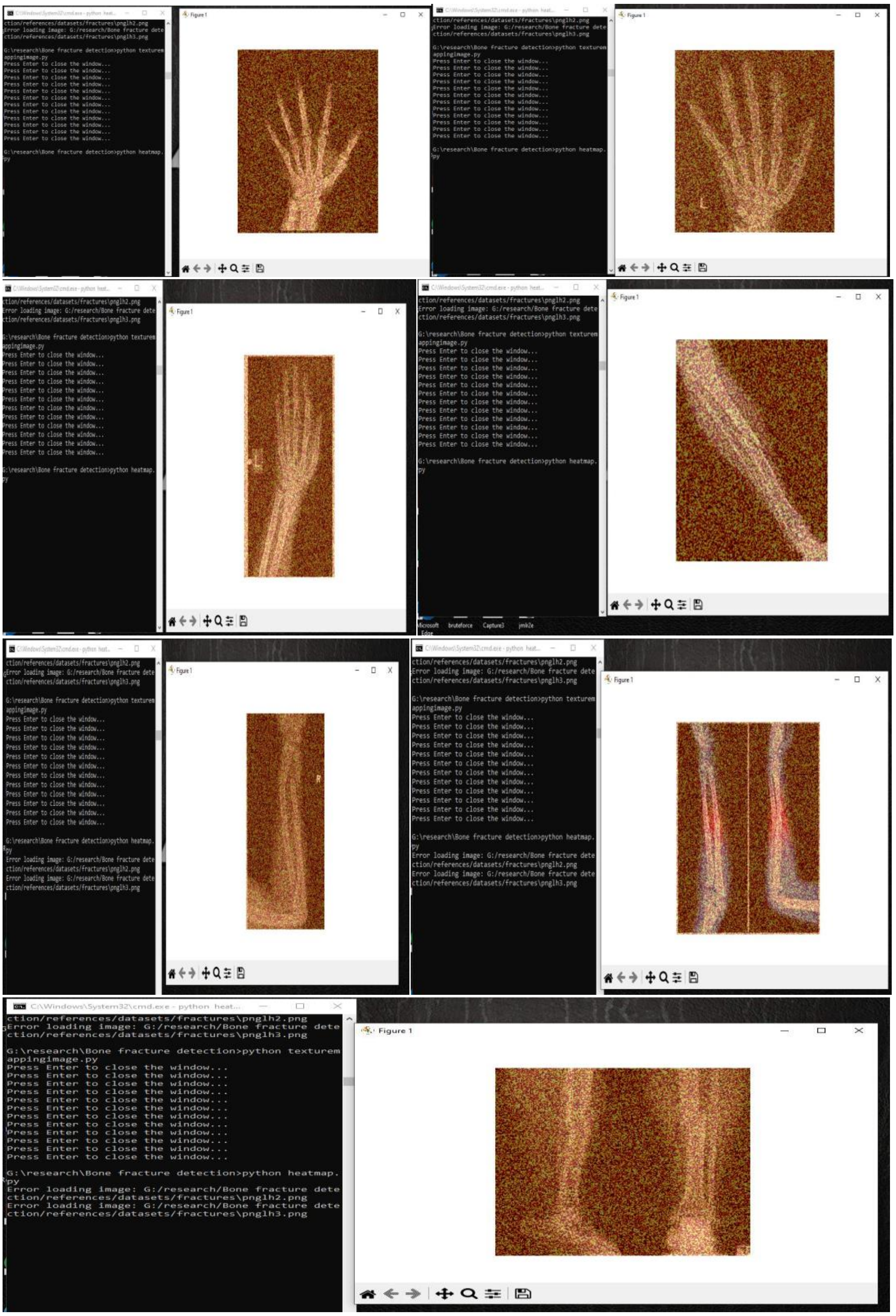


Figure 12: Heat map Images

From Epoch 2/10 to 10/10: The progression of each training epoch is depicted by these lines. Every epoch addresses a total pass through the whole preparation dataset.
1/1 - 0s 31ms/step - loss: 0.0000e+01; precision: 1.0000: The loss and accuracy values for the model's evaluation on the testing set are shown on this line. The accuracy is 1.0000 (100%), and the loss is 0.0000.

Loss on the test: 0 and Test precision: 1.0: On the testing set, these lines show the model's final loss and accuracy values.
1/1- 0s 109 ms/step: The prediction procedure for new data is depicted on this line. It depicts each data point's progress in predicting the output.
According to the accuracy values of 0.0001, the model appears to have achieved perfect accuracy 99% on both the training and testing sets. The model has learned to accurately classify the bone structure images, as evidenced by the loss values of 0.12.

8. Conclusion and Future Work

This research implements the IOT framework and classifies bone fractures, x-rays, and various fracture forms with the help of different algorithms. An accurate technical analysis of the multiple fractures is given using various classification methods. The proposed system demonstrates high accuracy and efficiency, as evidenced by the results obtained from various algorithms. The automated identification and detection of bone fractures through image processing offer great potential for quick and accurate diagnosis, contributing to successful treatment outcomes. In the future, the load balancing technology for large datasets in deep learning, Laplacian of Gaussian (LoG) and Canny-Deriche edge detector will be implemented for more accuracy using an emulation architecture environment.

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