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Efficacy Analysis of Fractured Bone on Hyper Spectral Imagery

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***Abstract*—Objectives:** Detection of Fractures: Assess the ability of hyper spectral imagery to accurately detect fractures in bone structures. This involves identifying spectral signatures associated with fractured bone and developing algorithms for automated detection. Classification of Fracture Types: Different types of fractures (e.g., hairline fractures, compound fractures) may exhibit distinct spectral characteristics. Objectives should include classifying fracture types based on hyper spectral data to aid in diagnosis and treatment planning. **Method:** Data Acquisition: Acquire hyper spectral imagery data containing spectral information across a wide range of wavelengths. This data can be obtained from specialized hyper spectral imaging systems capable of capturing spectral signatures of the target area. Preprocessing: Correct for atmospheric effects and sensor artifacts to enhance the quality of the hyper spectral data. Perform radiometric calibration to convert raw spectral data into quantitative reflectance or absorbance values. Remove noise and irrelevant spectral bands to focus on informative spectral features relevant to fractured bone. Region of Interest (ROI) Selection: Identify the region of interest containing the fractured bone within the hyper spectral image. Define the boundaries of the fractured area and ensure that the ROI encompasses relevant spectral information. **Findings:** Detection Accuracy: The analysis may reveal the ability of hyper spectral imagery to accurately detect fractures in bone structures. This includes the sensitivity and specificity of fracture detection compared to ground truth data or conventional imaging methods. Classification of Fracture Types: Hyper spectral imaging may enable the differentiation of different types of fractures based on their spectral signatures. Findings may include the ability to distinguish between hairline fractures, compound fractures, and other fracture types. Quantification of Fracture Severity: The study may demonstrate the efficacy of hyper spectral imaging in quantifying fracture severity parameters such as size, displacement, and fragmentation. This could provide valuable information for clinical decision-making and treatment planning. **Novelty:** Non-Invasive Imaging: Hyper spectral imaging offers a non-invasive means of assessing fractures, unlike traditional methods such as X-rays or CT scans, which involve ionizing radiation. This reduces patient exposure to harmful radiation and provides a safer alternative for imaging fractures, especially in pediatric or pregnant populations. Comprehensive Spectral Information: Hyper spectral imagery captures spectral information across a wide range of wavelengths, providing a rich dataset for analysis. Unlike conventional imaging modalities that rely on anatomical structures, hyper spectral imaging exploits biochemical and molecular signatures, offering insights into tissue composition and pathology.

Keywords: Image processing using X-ray images, Dilation Edge Detection, Hough Line.

1. Introduction

Fractures are a condition when there is disengagement or a whole the bone. Fractures typically happen when the human bone is subjected to severe weight or heavyweight. The cause of a substantial percentage of fractures is an accident or, alternatively, a fall. X-rays are typically used to identify fractures. They do a commendable job of identifying breaks, identifying the type of fracture, and treating it. Sometimes fractures are difficult to see on x-rays because of low objectives; at this instance, the medical supervisor would advise getting x-ray scans. Although x-ray image filters provide the highest solid with the best images, x-rays also enable outstanding images with the lowest expense.

2. Literature survey

In order to distinguish between the fracture and healthy bones HSI. In HSI images, a deep neural network model. It has been created in [1]·Over fitting of the deep learning model occurs on the little dataset. In order to expand the amount of the data collection, data augmentation techniques have been applied. Three tests have been conducted to assess the model's performance utilizing the Softmax and Adam optimizers. Using fivefold Cross validation, the proposed model's classification accuracy for both the healthy and damaged bones HSI is 92.44%. On 10% and 20% of the test data, respectively, the accuracy is more than 95% and 93%. The suggested model outperforms [1][2]of the 84.7% and 86% of the [2] by a significant margin.

3. Material and Methods

3.1 Pre-processing

Since the majority of the real-life data acquired is noisy, inconsistent, and incomplete, hence preprocessing of the Acquired data is very important. Image preprocessing is a necessary step in achieving high accuracy of the image, followed by the next stages. Therefore, it is required to remove these artifacts by preprocessing processes. Before further analysis [3]. The first phase involves applying preprocessing techniques such as Red, Green and Blue (RGB) to Grayscale conversion, followed by further noise removal using a Gaussian filter.

3.2 Noise Cancellation

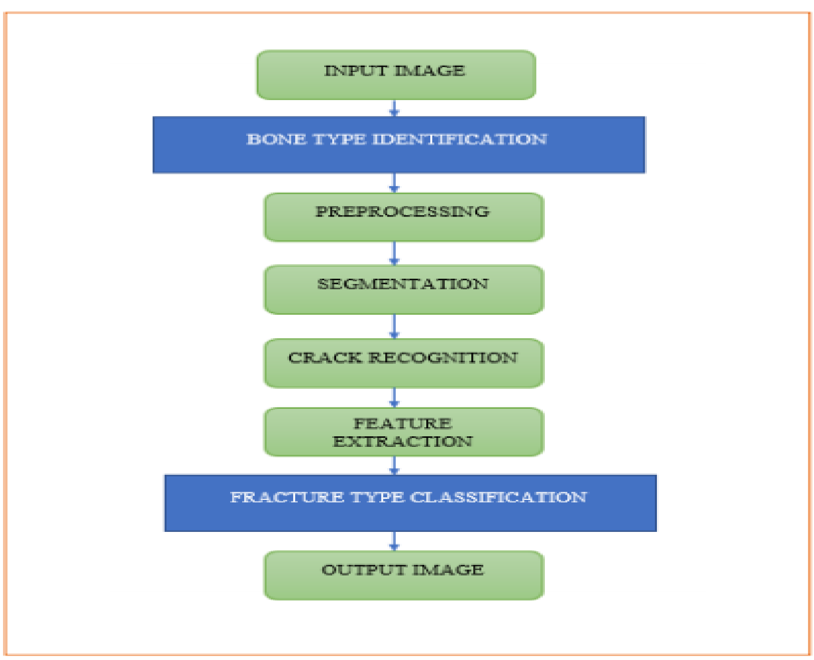

Figure. 1. Methods for detecting bone HIS fracture.

3.3 Image Optimizations

Image optimization is the process of shrinking and compressing an image to minimize its file size. This facilitates quicker image loading in the user's browser, which enhances the functionality and speed of websites. Lossless compression algorithms can be used for image optimization, maintaining good image quality [4]. Image processing techniques are used to create this algorithm. This section has a detailed discussion.

3.4 Image Optimizations

Histogram

A histogram can be a bar chart or a pie chart that shows the distribution of category values for a raster map layer that the user has defined. The colors in The Color Table of the raster Map layer will be used to display the display the graphics monitor's active display frame.

3.5 Dilation

Together with erosion, dilation Is one of the two Fundamental operators in mathematical morphology. Although there are variations that function on grayscale images as well, it is usually used to binary images. The operator's main influence on a binary image is to progressively expand the borders of Foreground pixel areas (usually represented by White pixels). As a result. The holes in the Foreground pixel regions go smaller and the areas themselves get larger.[5].

Widening thickens the image by adding an incentive to the pixel that was earlier marked apart as zero if the base Number of the pixel's neighbors likewise has an estimation of zero. Two techniques are available for enlargement. There are two types of thresholding and growing beyond the curtain. In this case, the second strategy has been used[6].

In the expansion strategy, the circle confirms that each neighboring pixel of the specific pixel that was previously marked out as zero is estimated. If, following counting, the value surpasses A certain threshold, the individual Pixels are then identified with a value. A 3 × 3 veil has been considered for enlargement in this piece. The description of the 3x3 veil used for enlargement

0	1	0
1	1	1
0	1	0

Figure.2 Mask of Dilation

3.6 Transformation of Hough

One way of separating characteristics of a certain shape within a picture is the Hough transform. Regular curves (lines, circles, ellipses, etc.) are the most frequently detected curves using the classical Hough transform since it necessitates the specification of the desired characteristics in some parametric form. When it is not possible. [9] A generalized Hough transform can be used to succinctly and analytically characterize a feature(s) can be used. We restrict the primary focus of this article to the traditional Hough Transform because of the computational difficulties of the generalized Hough algorithm. The classic Hough transforms (henceforth referred to without the classical prefix) has several uses despite its domain limits, as most manufactured parts (and many anatomical parts) studied in medicine. It's vital to understand that this transformation is linear in nature and is mostly used to find straight lines in pictures. As was explained in Figure.2, it illustrated the equation "y=ax+b" and used the plotting points (x,y) to show it graphically. Incorporating this transformation into the process has as its primary goal the identification of a straight line rather than plot points [7]. But because it relies on slot parameters, which call for an interception parameter, plotting points are needed in order to use (x,y).

3.7 Bone HIS Densitometry

The art and science of determining The bone mineral content (BMC) and bone mineral density (BMD) individual skeletal locations or the entire body is collectively referred to as "bone densitometry*." The values of the bone measurement are used to evaluate the strength of the bone, help diagnose conditions linked to low bone density (particularly osteoporosis), track the effectiveness of treatment for these conditions, and forecast the likelihood of more fractures. Bone HSI densitometry is a method that quantifies bone HSI thickness fast and precisely, much like an X-ray. The conditions osteopenia and osteoporosis, in which the mineral content and bone HSI thickness are low and the risk of breaking is elevated, are the main uses for it. It estimates the amount of calcium present in bone HSIs. All things considered, a bone HSI will undoubtedly shatter in those whose "mineral" bone HSI densities are typically lower than the average reading. Rather than identifying if a bone HSI breaks or not, bone HSI densitometry may forecast the likelihood of a break. Hip replacement is a therapeutic operation in which an implanted hard item replaces the hip joint.

The division of "bone HSIs in x-beam pictures" is a crucial advancement in PC assisted analysis, medical procedure, and treatment, above all other therapeutic endeavors mentioned above. For restorative picture division, there are three primary methodologies: manual division, self-loader division, and programmed division. Each of them has benefits and drawbacks[8]. The most accurate but laborious division is done manually by space experts. To support precise division, the self-loader division requires the client to provide a small number of sources of information. Since programmed division does not require any customer input, it is far more difficult to obtain precise results. The Grainy tone feature is used to provide a grayscale version of the colorful objects. In this cycle, all blended data are eliminated. Then the image can be divided into the region of interest using the texture feature. The tip in the first line helps the system to recognize the location of a major fracture in the picture. Classifier is a particular kind of algorithm that is used to filter data based on classes that have labels. Here the Decision Tree classifier is used. The Classifier uses an ensemble learning approach.

3.8 Classification

Images from various classifiers are classified using classification. In the classification process, there are primarily six different classifiers employed. These include the Extra Tree, KNN, DNN, Random Forest, Decision Tree, and Support Vector Machine. These classifiers are used to categorize whether an image is cracked or not and to produce a few static results, such as accuracy, precision, and recall. Therefore, the below-mentioned many options for filters, features, and classifiers. This procedure will continue because the subsequent data from the measurements will include all potential outcomes. The most crucial factor in terms of results is any classifier's performance. The primary duty of classifiers is to categorize an image into multiple groups, and in order to achieve the best and most accurate results, we employ several neural network and tree-based algorithms.

Different classifiers may be used to do this. As we progressed through this chapter, our suggested system offered six distinct classifiers for locating the results in various ways. In a very early stage of this procedure, the image is filtered using a few different versions, including Median and Gaussian. These filters allow for the removal of noise problems or the preparation of high-quality images. The segmentation procedure is then responsible for concentrating on the principal item rather than the entire image in the following stage. The major region or item that decreases the other unnecessary portions of the image will be shown to us as a result of this procedure. According to the last step, the subsequent step is crucial since the feature extraction process determines many things, or you could say that the extraction is a crucial step for the classification process itself. Histogram of Oriented Gradients and Gabor Wavelet Transform are two of the key approaches used in this feature extraction. Both are joined by the Shape and Grey Level Co-occurrence Matrix features. After this level of work is finished, our classifiers are finally taking over.

Classify And Train. Confusion Matrix with Trained Data Set

- **Practice Data**

According to the basic kind of training data application, model, or new system specifications. This method employs AI or ML to educate the data set in accordance with previously provided findings or judgments that assist the computer in comprehending the item.

- **Data for Validation**

This data collection is a next stage in the process that uses machine learning to validate the data. This model validation is one way to guarantee that a model is accurate when making predictions for work that will go in the appropriate direction. This sort of data carries out this activity to determine whether or not the model is able to find the appropriate model samples.

- **Data Testing**

The final level of this data set implementation works practically on machine learning and AI's prediction stage. This level is quite similar to the one above that involves verifying the data set, but the primary distinction between the two is that evaluating the data does not raise the accuracy of predictions. It is only done to verify the sample's degree of correctness.

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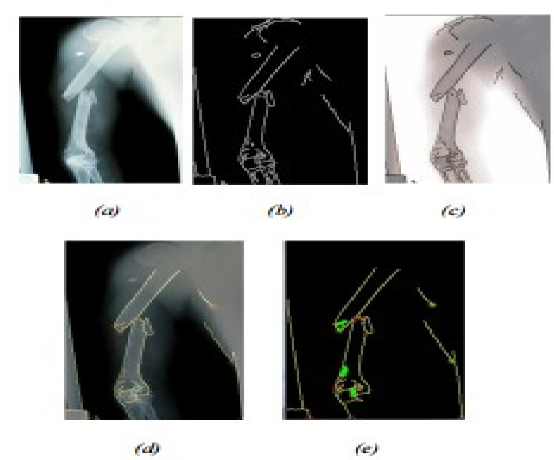
4. Results

Figure 3 depicts steps 1–5 in Chapter 3 for starting the bone. HIS Fracture detecting procedure. Shape detection has been used after the Dilation Edge Detection algorithm has processed the initial image output. To determine the end of a line, use shape detection. The location of the fracture can be used to determine the end of a line. This program can lower the unnecessary parameter that is classified as the undamaged portion (Chapter 2). There are numerous Outputs from this procedure, including the original image to be processed, two Images processed using the Dilation Edge Detection Method, and two Images that display the fracture detection result to the viewer. Figure 3 will provide those five results. Figure 3 shows the user uploading an x-ray image (a). The system will then process the image Dilation Figure 3(b) illustrates edge detection. Figure 3 (c) displays the output of image processing by combining the picture of dilation Edge detection results and inversion of the original image submitted by the user. In Figure 3(d), the system will detect the end of each line. In Figure 3(e), the technology will automatically recognize fractured bone HSIand where it is located[10].



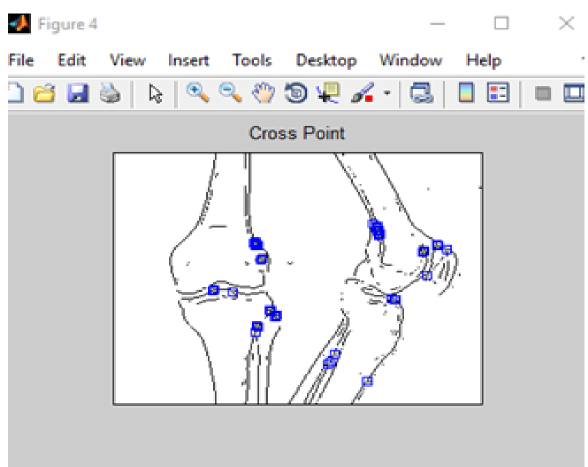
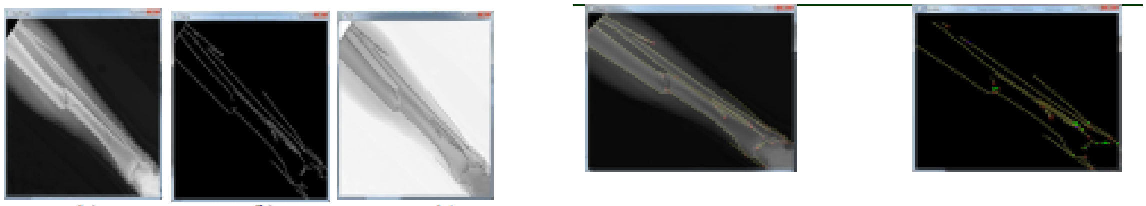


Figure.3 (a) Input Image (b) Output Image with dilation Detection (c) Invert Output Image Hough Line Detection (d) Output an image Dilation Edge detection on each edge (e) Output image with fracture detection.

To clarify the system's performance, we chose to process the remaining photos. Here's an example of image processing results[11]:



(a) (b) (c) (d) (e)

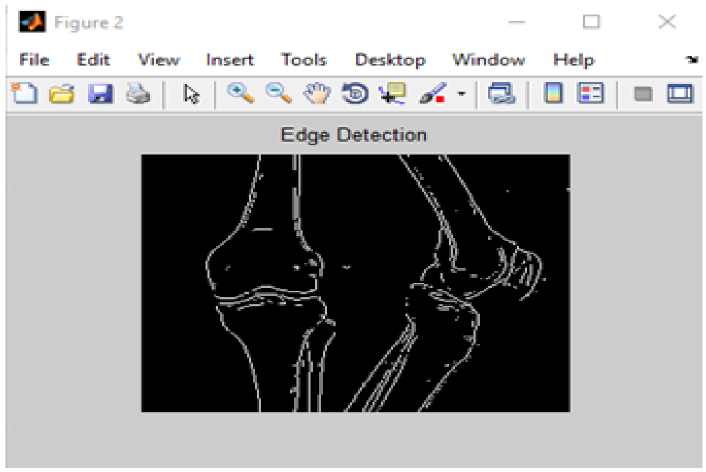
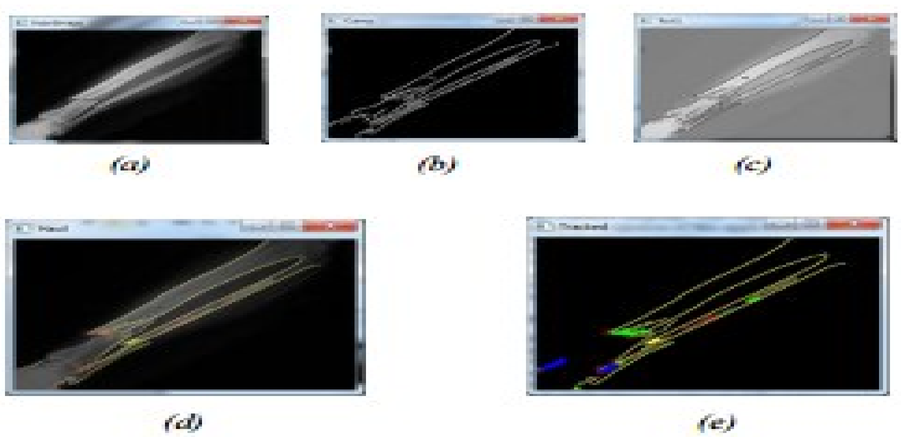


Figure 4 shows (a) the input image and (b) the output image edge Detection (c) Invert the output image Dilation Detection (d) Output Image for Hough line Detection using edge detection in each edge (e) Output Image with fracture detection.



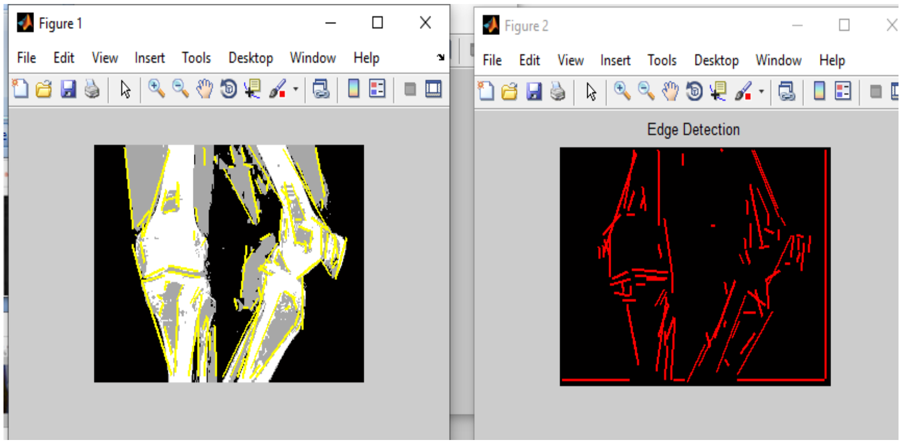
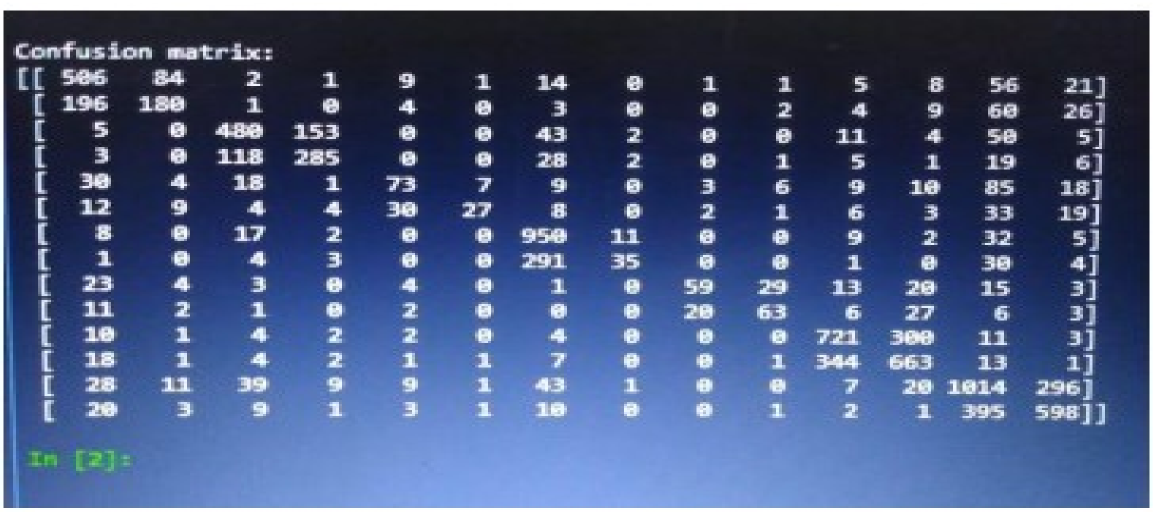


Figure 5 shows the input image (a) and the output image (b) Dilation Detection (c) Invert the output image in Dilation Detection (D) Output a picture with Hough line Detection of every edge

(e) Output image with fracture detection.

Table 1 summarizes the findings of multiple attempts to determine the location of the fracture.



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Confusion matrix:
[[ 506   84    2    1    9    1   14    0    1    1    5    8   56   21]
 [ 196  180    1    0    4    0    3    0    0    2    4    9   60   26]
 [   5    0  480  153    0    0   43    2    0    0   11    4   50    5]
 [   3    0  118  285    0    0   28    2    0    1    5    1   19    6]
 [  30    4   18    1   73    7    9    0    3    6    9   10   85   18]
 [  12    9    4    4   30   27    8    0    2    1    6    3   33   19]
 [   8    0   17    2    0    0  950   11    0    0    9    2   32    5]
 [   1    0    4    3    0    0  291   35    0    0    1    0   30    4]
 [  23    4    3    0    4    0    1    0   59   29   13   20   15    3]
 [  11    2    1    0    2    0    0    0   20   63    6   27    6    3]
 [  10    1    4    2    2    0    4    0    0    0  721  300   11    3]
 [  18    1    4    2    1    1    7    0    0    1  344  663   13    1]
 [  28   11   39    9    9    1   43    1    0    0    7   20 1014  296]
 [  20    3    9    1    3    1   10    0    0    1    2    1  395  598]]

In [2]:
```

Table 2: Accuracy of fracture Detection

Classifier Name	Accuracy	Precision	Recall
SVM	76.78	73.42	74.23
RF	82.23	83.34	83.45

DT	85.65	84.84	84.78
KNN	78.76	77.45	77.48
DNN	87.94	86.75	86.73
ET	92.13	91.85	90.96

A confusion matrix represents the statistical categorization of issues. Another term for it is the error matrix[11]. This enables us to extract the visual performance of an algorithm. The actual data set results as well as the classifiers' predictions of previous results were used to build this confusion matrix. The sample above makes use of Extra Tree's confusion matrix, which aids in improving picture accuracy and obtaining the desired system outcome[12].

The product of classifiers trained on image data is the confusion matrix. It displays the confusion matrix of the training classifier. This section will provide further details on how the suggested system operates. The system's work will be helpful in helping people comprehend the necessary actions to take in order to achieve the intended results [13]. The key facets of working will be explained in this part.

This section specifies the types of the system will need inputs and a method for identifying bone HSI fractures[14]. Before performing any operation that makes it simple and dependable to locate the precise edge region, this part will cover the processing applied to the image to make it crisp and clean[15]. This will also clarify the application of segmentation and the method of fracture identification.

As the algorithm will make the real-time process understandable, the fundamental operating principles of the system are described[16]. In order to do that, we shall comprehend the entire process from manual treatment to our suggested approach[17].

5. Conclusion

Research indicates that the medical community uses a number of fracture detecting methods. As time permits, more advanced educational systems are required. Although the preceding approaches were yielding results, there is still room to improve in a lot of areas, [18] including precision, crack type, and relevant information. We designed our proposed solution with straightforward functionality in mind, based on this medical domain criterion.

As per our proposed study, we have used the common x-ray input image to distinguish between various bones HSI breaks under various conditions in seven different classes. As the initial step is assessing the x-ray image quality, we have utilized two different filters [19]. Both filters will help turn images from low quality into the desired high quality. The next step, called segmentation, will crop off any extraneous areas of the image so that the focus is on the important object and not the full image. Another step in our proposed method involves extracting information from a picture using GLCM and a mix of HOG and GWT. These effective methods for form extraction are suitable for extraction procedures [20].

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