IJBPAS, May, 2024, 13(5): 2048-2059

ISSN: 2277–4998

International Journal of Biology, Pharmacy and Allied Sciences (IJBPAS)

'A Bridge Between Laboratory and Reader'

www.ijbpas.com

BONE FRACTURE DETECTION USING CANNY EDGE METHOD IN MATLAB: A STATISTICAL REVIEW

SOWMYAVALLI R[1], STAVELIN AK[2*], PRERANA M[3]

1: Post-graduate student, Division of Medical Statistics, School of Life Sciences, JSS AHER, Mysore, India

2: Assistant Professor, Division of Medical Statistics, School of Life Sciences, JSS AHER, Mysore, India

3: Research Scholar, Division of Medical Statistics, School of Life Sciences, JSS AHER, Mysore, India

***Corresponding Author: Dr. Stavelin Abhinandithe K: E Mail: stavelin.ak@jssuni.edu.in**

Received 19th May 2023; Revised 18th July 2023; Accepted 16th Aug. 2023; Available online 1st May 2024

https://doi.org/10.31032/IJBPAS/2024/13.5.7974

ABSTRACT

Image analysis is the method that involves extracting beneficial information via primarily digital images, photographs, using image processing techniques. The tasks of image recognition may range from as simple as reading the barcoded tags to as complex as identifying an individual on the basis of their face. Canny edge detection is used to extract beneficial structural information from different vision artefacts while reducing the amount of data to be processed significantly. This technique has been used in many computer vision systems. A set of 26 articles, between the years 2012 to 2022 were reviewed to get an idea about the about image processing for bone fractures using canny edge detection method. Canny edge detection, Sobel edge detection, edge detection method, Prewitt edge detection, log edge detection, Roberts edge detection, GLCM method were adopted by the researchers to analyse the perfect information from the bone image, also detect the human lower leg bone fracture and to develop an intelligent classification system that would detect and classify bone fracture. All the statistical analysis incorporated gave convincing and clearer idea about the Canny edge method for detecting the bone fractures, 2D images, face recognition, CT Scan images, pattern recognition to obtain an enriched image or to draw out some beneficial details from it.

Keywords: Bone Fracture, Image analysis, Canny Edge Method, Image processing, Machine Learning

INTRODUCTION

Bone fracture is a common issue in human beings because of accidents or added reasons like bone cancer. Fracture can happen in any part of our body like heel, wrist, rib, hip, ankle, chest, leg, etc. **[1]**. X-ray/CT images are required to identify the fractures, as they are not visible to the naked eyes. Often, these images fail to provide sufficient details required to make a diagnosis. There are 206 bones in the human body and all of which come in various shapes, sizes, and structures **[2]**. Humans suffer from bone fractures on a regular basis. Fractures are categorised in a variety of ways. This study focuses on fracture diagnosis methods that rely solely on X-ray and CT images, as these are the most commonly utilised modalities. Diagnostic tools of medical imaging like Computed Tomography (CT), Magnetic Resonance Imaging (MRI), and x-rays are examples of tools that aid physicians to detect various types of abnormalities.

Images related to medical data are saved in DICOM (Digital Imaging and Communications in Medicine) format in modern hospitals, which incorporates text in the images. X-ray images (also known as radiographs) are one of the most popular techniques to discover issues in the human body's bones and other organs **[3]**. Bones are solid organs that protect several vital organs in the human body, including the heart, brain, and lungs. Despite their stiffness, bones can be fractured. Simple, oblique, compound, comminute, spiral, greenstick, and transverse fractures are among the various forms of bone fractures. The created method is aimed to identify bone fractures. This can be performed by utilising numerous image processing approaches and methodologies investigated in shattered regions. Digital photographs require a great amount of memory to store and can take a long time to download when fetched from the internet. Doctors commonly use X-ray scans to assess the existence of a fracture and its location.

Image processing fundamental

Image processing involves converting image into digital form and performing certain operations on it. This is done to get an enriched image or to extract beneficial information from it. Generally, the image processing system involves treating images as 2-D signals while applying previously set signal processing methods to them.

The essential steps in image processing include image restoration, image preprocessing, image feature extraction, analysis, image compression, image synthesis, and image registration **[5]**.

1. Image Acquisition

This step is crucial in the processing of a digital image. Receiving a photograph that has already been converted to digital format

may make it simple **[4]**. Scaling and other pre-processing tasks are typically carried out during the image acquisition phase.

2. Image Enhancement

It is a simple and aesthetically pleasing components of the digital picture processing. Techniques of enhancement are used to establish the detail that conceals or simply highlights some image features that are of interest. Altering the contrast and brightness are concepts of image analysis.

3. Image Restoration

The goal of the field of image restoration is to improve the appearance of photographs. In contrast to augmentation, picture restoration is objective because the majority of restoration techniques are on the basis of probabilistic or mathematical models of picture degradation.

4. Colour Image Processing

Due to the internet's vastly increased use of digital photography, colour image processing has progressively significant. Colour modelling and digital processing, for example could be included.

5. Wavelets and Multiresolution Processing

The building blocks to represent images at changing resolutions are called wavelets. To compress the data and for pyramidal representation, images are continually divided further into smaller areas.

6. Compression

Compression discusses the methods to minimise storage bandwidth or amount, which is essential to save or transfer a picture. Compressing the data is crucial, particularly while using internet.

7. Morphological Processing

It deals with tools to extract image components that are beneficial in the representation and description of shape.

8. Segmentation

It is a technique to divide an image into its various components. Mostly, one of the most challenging function in digital image is processing autonomous segmentation. The procedure goes a long way towards resolving image issues that call for individual object identification when using a strong segmentation strategy.

9. Knowledge Base

Knowing where specific pieces of an image's information are known to be placed might be as simple as that, which will cut down on the time spent looking for it. A knowledge base that contains satellite photos of a particular region that are of high-resolution, in connection with applications of change-detection can also be as intricate as a connected list of all important potential flaws in the materials under inspection.

10. Representation and Description

Almost always, representation and description come after a segmentation process, which produces raw pixel data that frequently depicts the region's boundaries or all of its points. Selecting a representation is but one step in the process of converting raw

data into a form that a computer can understand. The focus of description is on identifying characteristics that produce quantitatively valuable information or are essential for separating one class of things from another.

11. Object recognition

Recognition of an object is a process that gives labels, like, "vehicle" to an object, based on its descriptors.

Applications of image processing

Image processing has a huge range of applications. Almost every field in science and technology can use the methods of image processing. Following are some of the applications of image processing:

1. Medicine

Images from X-rays, MRIs, and CAT scans are reviewed and evaluated, together with images of cells and chromosome karyotypes. The applications of medical background are concerned with processing chest X-rays, cineangiograms, transaxial tomography projection images, and other images used in radiology, nuclear magnetic resonance (NMR), and ultrasonic scanning. These photos might be used to screen and monitor patients, find tumors or other diseases in patients, or even just to keep an eye on them.

2. Agriculture

Satellite/aerial images of land, for example, to begin the usage of land for different purposes, or to explore the appropriateness of various places for different crops, or to check fruits and vegetables to identify fresh and good food from that of the old.

3. Document processing

It is used to scan and transmit paper documents in order to convert them into digital pictures, compress the images, and store them on magnetic tape. When reading papers, it is also utilized to automatically recognize and detect printed properties.

4. Radar imaging system

Images from radar and sonar systems are utilized for missile guidance and maneuvering, target detection, and target recognition for a variety of targets.

5. Defense/Intelligence

Target acquisition and guidance is used in real-time smart bomb and missile guidance systems to identify and track targets. Reconnaissance photo-interpretation is used to automatically analyse earth satellite images to find sensitive targets or military threats.

LITERATURE REVIEW

Although bones are inflexible, they can bend or "give" somewhat in response to an external stimulus. The bones will, however, break if the strain is too severe, just like a plastic ruler will if it is bent too far. Simple fractures, open (complex) fractures, hairline fractures, greenstick fractures, complicated fractures, avulsion fractures, comminuted fractures, and compression fractures are among the

several types of fractures that can occur. In the processing of digital and medical images, edge detection is a crucial step. Canny edge detectors are frequently employed in computer vision and medical imaging to identify object boundaries and detect changes in sharp intensity. John Canny presented it at MIT in 1983. Because of its benefits, the Canny edge detection method is widely employed in edge detection algorithms. If a pixel's gradient magnitude is higher than that of the pixels on both of its sides in the direction of maximum intensity change, the pixel is classified as an edge by the Canny edge detector. Canny edge detects bone edge accurately, but fractured edge cannot be detected; whereas, a clear fractured edge can be detected by sobel edge. The processed image is then given as an input to classify image with the aid of SVM; here, the image is categorized into un-fractured and fractured.

Binash Shikah *et. al*. employed python programming tool to load image, to process image and for user interface development. The obtained results demonstrated the performance of the bone fracture detection system with certain restrictions and a good accuracy of 85% **[6]**. Pinaki Pratim Acharjya *et. al*. discovered that, in terms of the appearance of the image and the localization of object boundary, the performance of the clever edge detection operator outperformed that of Zero crossing, Sobel, Prewitt, Roberts, and LoG (Laplacian of Gaussian). They have used Matlab as the software tool that was used **[7]**.

Bashir Olaniyi Sadiq *et. al*. presented the edge detection techniques as a pre-processing stage and fundamental of the number plate extraction system. Among the various edge detectors used, the one that used a collection of pixel-based approach showed better performance when compared to others using visual comparison **[8]**. Poonam Dhankhar & Neha Sahu pesented a review of different approaches for image segmentation based on edge detection techniques. Results showed that LoG and Canny edge detectors produced almost same edge map. For a particular image, the Canny result was superior to all others because different edge detections perform better in various situations **[9]**.

Vaishnav Kalbhor *et. al*. proposed a method to overcome problems using CNN algorithm. The results from the simulations showed that the recommended method was a better option to perform edge detection at comprehensive scales. The method recommended had also proved to be strong enough to extract the required information and do the needed processing and handle noise better than the edge detectors that are currently available **[10]**. Alhat Asmita *et. al*. showed a GUI programme to locate the area where the bone was shattered using a CNN-

based picture segmentation technique. The proposed picture segmentation system is indicated by the Affected Area Location. When compared to other well-known edge recognition algorithms like Sobel, Prewitt, and Canny, the system detects bone structure and fracture edges more accurately even when there is noise. The broken part of the image was readily seen using the projected CNN-based image segmentation technique **[11]**. An adaptive strategy was put forth by Isaack Kamanga to enhance the clever edge identification technique. Due to its effective localization, detection, and one response to one response, the suggested method has proven to be an effective edge detector **[12]**.

Rocky S Upadhyay & Prakash Singh Tanwar performed an automatic fracture detection and identification process using canny edge detection techniques. Canny edge discovery strategy was used for segmentation. An ideal data can be used from the bone picture to produce Canny strategy. All possible bone fracture detection used this system **[13]**. Ramnarayan *et. al*. provided an effective way for the detection of the edges of all type of images. Canny edge detection reduces human effort to detect solution for algorithms and in many domains. This provided an affordable platform to solve problems. This edge detection improves accuracy and all possible edges according the parameter can be easily detected **[14]**.

Weibin Rong *et. al*. presented the theory of gravitational field intensity, replacing the image gradient, to get gravitational field intensity operator. Based on the mean of image gradient magnitude and standard deviation, two adaptive threshold selection methods were put forward for two different kinds of typical images (one had less edge information, the other had rich edge information) respectively. The enhanced Canny algorithm was easy and simple to realize. Experimental results showed that more useful edge information and more robust to noise can be preserved with the algorithm **[15]**. Ehsan Akbari Sekehravani *et. al*. developed and improved Canny edge detection's accuracy for noisy photos. It was determined that the suggested approach may undoubtedly overcome noise disorders, maintain edge-useful data, and similarly increase the edge detection's precision **[16]**.

Xiaoju Ma *et. al*. used grey image of 2 cases with noise for the experiments. The studies' findings demonstrated that the improvised Canny edge detection operators could balance noise reduction from obtaining additional edge information, that they have good edge detection continuity, and that they can identify the image's edge detail. The improvised approach benefits from minimal computational cost and quick

calculation times based on the picture adaptive calculation **[17]**.

J.A. Tsanakas *et. al*. suggested using the Canny edge detection operator and common thermal image processing as diagnostic tools for module-related problems that cause hot-spot heating effects. Results revealed that each investigated module's hot-spot formations were caused by particular faulty cells **[18]**. An improvised steganography method based on the less sensitive HVS system that alters in the sharp edge regions was presented by Kumar Gaurav and Umesh Ghanekar. In the MSB based modified image, edge locations that can be optimised by the dilation morphological operator were found using the Canny edge detection approach. The message embedding process has been improved using the XOR method **[19]**.

Canny edge detection and Sobel edge detection algorithms were used by S.Vijayarani & M.Vinupriya to extract edges from pictures of the face, that are utilised to detect faces. Performance factors like accuracy and speed were analysed to find out the most suited algorithm. Results showed that the Canny edge detection algorithm suited well, when compared to Sobel edge detection algorithms **[20]**. Allam Mousa proposed an edge detection method, which enables Plate Recognition System via practical situations, like different environmental or meteorological conditions. To scan the plate area, convert and resize it, towards a grey scale before image filtering, in order to remove minor objects, image processing tools were used. Identification of the acquired objects are such that the numbers object is recognized. The standard deviation of the Gaussian filter (sigma) was used to control the details of the obtained image. This approach allows the system to zoom smoothly to the exact frame of the plate. Hence, unwanted objects can be easily removed and the license plate could be recognized **[21]**.

Zuraini Othman & Azizi Abdullah introduced a technique that can calculate the threshold values from background and foreground image pixels using global and local image analysis. 4 different dataset images like Berkeley, DRIVE, Persian and CASIS V2 were used for the experiments; and according to the results, this method performed better than the Canny method and the other adaptive methods [22]. X M Zhao *et. al*. proposed a new way to regulate the adaptable parameters and constructed an adapted Canny edge detection algorithm. The outcomes demonstrated that, in most instances, the suggested approach can produce improved edge detection results. As a pre-segmentation stage, it is helpful for object boundary closing as well **[23]**.

Zorana Stosic & Petar Rutesic presented an edge detection algorithm, especially adjusted to process brain MRI images.

Another standard edge detection methods were compared with the projected method; and, it was noted that it produced better detail edge detection. Results showed that the projected algorithm was more noise-resilient and was better in edge and detail detection when compared to the standard Canny algorithm **[24]**. Stefanus Kieu Tao Hwa *et. al*. focused on TB detection, contrast-enhanced Canny edge detected (CEED-Canny) x-ray images were projected, and deep learning was applied. The lung x-ray edge detected pictures were created using the CEED-Canny. The first type of feature, which was developed, was taken from the enhanced x-ray images, and the second type, which was taken from the edge detected pictures. The diversity of errors made by the base classifiers were increased by the projected variation of the features, which improved TB detection. The accuracy, sensitivity, and specificity of the projected ensemble method's results were 93.59%, 92.31%, and 94.87%, respectively, comparable to their earlier work **[25]**.

Li-Hua Gong *et. al*. To increase the resilience and invisibility of the watermarking algorithm, a combination of Canny edge detection, contour let transform, and singular value decomposition was developed. Results demonstrated that the projected watermarking scheme showed better imperceptibility and robustness against common attacks **[26]**. Mingjie Wang *et. al*. proposed an improved Canny edge detection algorithm to deal with the prevailing issues in traditional algorithms. Their experimental results showed that the improved algorithm could reduce the false positive rate, enhance accuracy of detection and was also robust in pedestrian detection **[27]**.

Aisha Baloch *et. al*. proposed a model that was simulated and validated in MATLAB. The current works are used to validate the proposed design. The implementation outcomes showed that the proposed system, which was utilised to detect and categorise vehicles, executes in about 8 ns with a 128MHz clock, the shortest and most efficient computation time for the smart city **[28]**. The Canny algorithm's fundamentals and current issues were researched by Han DD *et al*. With the Otsu technique selected threshold, the split outcomes would be better. An improved adaptive threshold method was provided to combat the threshold problem. Results showed that the projected method could efficiently extract edge of the images **[29]**.

To increase the effectiveness of thermal image recognition, a threshold selection approach on the basis of the local maximum inter-class variance algorithm was added to the Canny edge-detection algorithm by Youcun Lu *et. al*. According to the verification, the provided method outperformed Sobel, Roberts, Prewitt, and

LoG in terms of identifying hollowing edge contour. Results demonstrated the effectiveness of the improvised Canny edge-detection method, which not only rendered subjective considerations irrelevant but also enabled full-automatic and batch processing **[30]**. Shital Bankar *et. al*. presented a method for recognise plant disease based on histogram matching, color and edge detection. The methodology used, is divided into two major phases. First phase deals with training of healthy sample and diseased sample; whereas the second phase deals with the training of test sample and produces result based on the histogram matching and edge detection **[31]**.

DISCUSSION AND CONCLUSION

There are different types of medical imaging tools available to detect various types of abnormalities; such as Computed Tomography (CT), X-ray, ultrasound, Magnetic Resonance Imaging (MRI), etc. When applied to X-ray images of the lower leg bone, they primarily compare the Canny edge detector's performance to that of other edge detectors like Sobel, Prewitt, and Robert. According to the experimental findings, a clever operator delivers better outcomes and a clear picture of the bone structure. Following edge detection, they also talked about the effectiveness of the Hough transform, which is used to find the straight lines and angles at which bone fragments are detected. Every edge point in the edge map is supposed to be transformed by the Hough transform into every conceivable line. Finally, our method determined whether or not there is a fracture in the image. Canny edge detection is also helpful for detecting fracture in lower jaw usually fracture identifies in lower jaw is difficult as compared to other parts of the body but finally it identifies the location of fracture.

This paper reviewed different image processing technique using canny edge detection method to detect the bone fracture. Fully automatic fracture identification in the leg bone is a significant but challenging issue. According to the different test results, different detection method has been adopted by many researchers to detect the bone fracture. Among different methods adopted by researcher, canny edge detection method proves to be more superior with respect to accuracy and efficiency when compared to other methods.

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