ISSN (e): 2250 – 3005 || *Volume*, 05 || *Issue*, 04 || *April* – 2015 ||
International Journal of Computational Engineering Research (IJCER)

Instant fracture detection using ir-rays

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ABSTRACT:
Automatic detection of fractures from IR images is considered as an important process in medical image analysis by both orthopedic and radiologic point of view. X-Ray is one of the oldest and frequently used devices, as they are non-invasive, painless and economical. A bone x-ray makes images of any bone in the body and a typical bone ailment is the fracture, which are cracks in bones. Detection and correct treatment of fractures are considered important, as a wrong diagnosis often lead to ineffective patient management, increased dissatisfaction and expensive litigation. This paper proposes a fusion-classification technique for automatic fracture detection from bones, in particular the hand bones. The proposed system has four steps, namely, preprocessing, segmentation, feature extraction and bone detection, which use an amalgamation of image processing techniques for successful detection of fractures. The results from various experiments prove that the proposed system is shows significant improvement in terms of detection rate and speed of classification.

INDEX TERMS: *Preprocessing, Segmentation, Filtering, Thinning, Classifiers.*

I. INTRODUCTION

Medical image processing is a field of science that is gaining wide acceptance in healthcare industry due to its technological advances and software breakthroughs. It plays a vital role in disease diagnosis and improved patient care and helps medical practitioners during decision making with regard to the type of treatment. Several state-of-the-art equipments produce human organs in digital form. Examples of such devices include X-Ray, Computed Tomography (CT), Magnetic Resonance Imaging (MRI), Ultrasound (US), Positron Emission Tomography (PET) and Single Photon Emission Computed Tomography (SPECT). Out of these, X-Ray is one the oldest and frequently used devices, as they are non-invasive, painless and economical. A bone x-ray makes images of any bone in the body, including the hand, wrist, arm, elbow, shoulder, foot, ankle, leg (shin), knee, thigh, hip, pelvis or spine [2]. A typical bone ailment is the fracture, which occurs when bone cannot withstand outside force like direct blows, twisting injuries and falls. Fractures are cracks in bones and are defined as a medical condition in which there is a break in the continuity of the bone. Detection and correct treatment of fractures are considered important, as a wrong diagnosis often lead to ineffective patient management, increased dissatisfaction and expensive litigation. The importance of fracture detection comes from the fact that in clinical practice, a tired radiologist has been found to miss fracture cases after looking through many images containing healthy bones [1]. Computer detection of fractures can assist the doctors by flagging suspicious cases for closer examinations and thus improve the timeliness and accuracy of their diagnosis. An automatic fracture detection system consists of three main steps, namely, preprocessing, segmentation and fracture detection. Preprocessing consists of procedures that enhance the x-ray input image in a way that its result improves the fracture detection process. The segmentation process consists of two steps. The first step separates the bone structure from the IR image and the second step identifies the diaphysis region from the segmented bone structure. The third step, that is, Fracture Detection determines the presence or absence of fracture in the segmented image. In fracture detection applications, detecting a fracture accurately is often a difficult and challenging task.

II. PRINCIPLE

The principle behind bone detection using Infrared Imaging works is very simple. NIR spectrum light takes advantage of the optical window in which skin, tissue, and bone are mostly transparent to NIR light in the spectrum of 700-900 nm, while hemoglobin (Hb) and deoxygenated-hemoglobin (deoxy-Hb) are stronger absorbers of light..

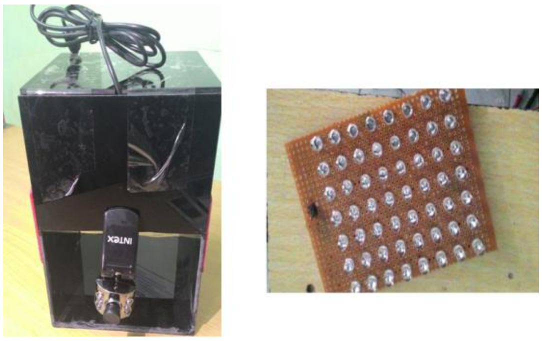

Fig 1. Prototype Model

Differences in the absorption spectra of deoxy-Hb and oxy-Hb allow the measurement of relative changes in hemoglobin concentration through the use of light attenuation at multiple wavelengths. The figure 1 shows the block diagram of the proposed model. The part to be tested is captured by the IR camera, then the image is processed by using MATLAB. The initial step is to enhance the contrast of image, subsequently the noises are removed by filtering process. Then Region of interest(ROI) is cropped for further process, where the image is binarized which helps in determining the structure of the bone. The advantage that Biometrics presents is that the information is unique for each individual and that it can identify the individual in spite of variations in the time (it does not matter if the first biometric sample was taken year ago).

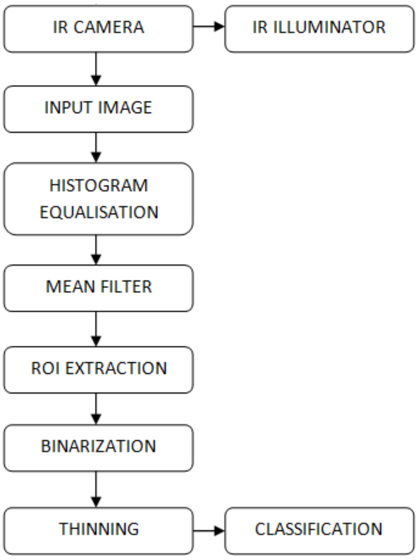

Fig 2. Block Diagram

III. PREPROCESSING

Pre-processing is a common name for operations with images at the lowest level of abstraction -- both input and output are intensity images. The aim of pre-processing is an improvement of the image data that suppresses unwanted distortions or enhances some image features important for further processing. There are two process carried out in pre-processing:

A. Adaptive Histogram Equalization(AHE)
B. Filtering

A. ADAPTIVE HISTOGRAM EQUALIZATION:

The important step in preprocessing is the histogram equalization. This is an extension to traditional Histogram Equalization technique. It enhances the contrast of images by transforming the values in the intensity image. Unlike histogram equalization, it operates on small data regions (tiles), rather than the entire image. Each tile's contrast is enhanced, so that the histogram of the output region approximately matches the specified histogram. The neighboring tiles are then combined using bilinear interpolation in order to eliminate artificially induced boundaries. The contrast, especially in homogeneous areas, can be limited in order to avoid amplifying the noise which might be present in the image [3].

Captured Image ***AHE***

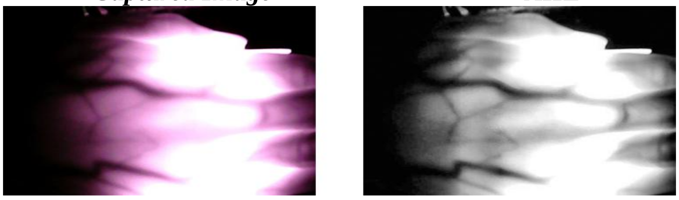

Fig.3 Histogram Equalization stage

B. FILTERING

Filtering is a technique for modifying or enhancing an image. For example, you can filter an image to emphasize certain features or remove other features. Image processing operations implemented with filtering include smoothing, sharpening, and edge enhancement. Here we have used mean filtering
enhancement. Here we have used mean filtering.

AHE *Filtered output*

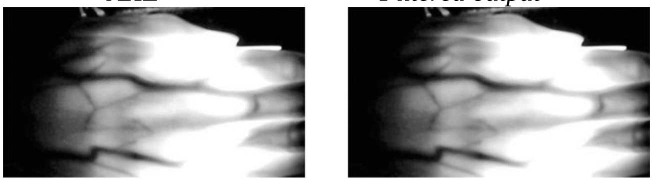

Fig.4 Filtering stage

- **MEAN FILTER:**

Mean filtering is a simple, intuitive and easy to implement method of smoothing images, i.e. reducing the amount of intensity variation between one pixel and the next. It is often used to reduce noise in images [4]. The idea of mean filtering is simply to replace each pixel value in an image with the mean (`average') value of its neighbors, including itself. This has the effect of eliminating pixel values which are unrepresentative of their surroundings.

IV. SEGMENTATION

Segmentation partitions an image into distinct regions containing each pixels with similar attributes. To be meaningful and useful for image analysis and interpretation, the regions should strongly relate to depicted objects or features of interest. Image segmentation is a process in which regions or features sharing similar characteristics are identified and grouped together. Meaningful segmentation is the first step from low-level image processing transforming a greyscale or colour image into one or more other images to high-level image description in terms of features, objects, and scenes. The success of image analysis depends on reliability of segmentation, but an accurate partitioning of an image is generally a very challenging problem.
Segmentation has one main objectives:

1) The one objective is to crop the image for further analysis known as Region of Interest (ROI).

C. REGION OF INTEREST

A region of interest (ROI) is a portion of an image that you want to filter or perform some other operation on, which is a binary image that is the same size as the image you want to process with pixels that define the ROI set to 1 and all other pixels set to 0. You can define more than one ROI in an image.

Original image ***Cropped image***

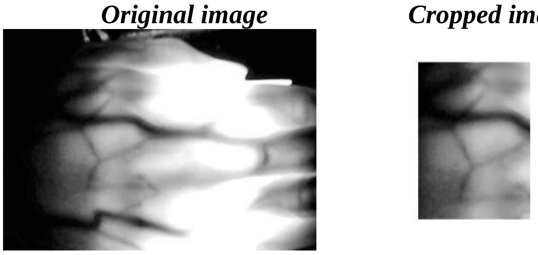

Fig.5 Auto cropping result

The regions can be geographic in nature, such as polygons that encompass contiguous pixels, or they can be defined by a range of intensities. In this case we have used the pixels to crop the region of interest.

In this stage the ROI is determined using auto cropping approach. Using cropping we segment the image smoothly. Image cropping process is less complexity in process and time, since the area under process will be reduced. Two types of cropping technique were used; manual and automatic cropping. Manual cropping is achieved using Matlab® function (imcrop), but it may cause false cropping rectangle and it is tedious work [5]. While automatic cropping is saving more work and it is reducing a processing time over and above the cropping rectangle is truly detecting.

V. BINARIZATION

The Binarization technique is aimed to be used as a primary phase in various manuscript analysis, processing and retrieval tasks. So, the unique manuscript characteristics, like textual properties, graphics, line drawings and complex mixtures of the layout-semantics should be included in the requirements. On the other hand, the technique should be simple while taking all the document analysis demands into consideration. The threshold evaluation techniques are adapted to textual and non-textual area properties, with the special tolerance and detection to different basic defect types that are usually introduced to images. The outcome of these techniques represents a threshold value proposed for each pixel. These values are used to collect the final outcome of the binarization by a threshold control module [6].The Simplest method for image binarization is thresholding. The output of the thresholding process is a binary image whose gray level value 0 (black) will indicate a pixel belonging to a print, legend, drawing, or target and a gray level value 1 (white) will indicate the background. Thresholding divides the image into patches, and each patch is thresholding by a threshold value that depends on the patch contents [7]. In order to decrease the effects of noise, common practice is to first smooth a boundary prior to partitioning.To perform a change of representation, to achieve this we have used a thresholding algorithm known as Otsu's algorithm.

D. Otsu's ALGORITHM

Otsu's method is used to automatically perform clustering-based image thresholding, or, the reduction of a graylevel image to a binary image. The algorithm

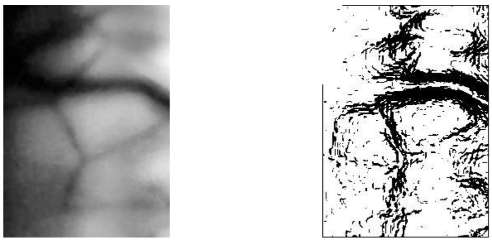

Fig.5 Binarized Output

assumes that the image contains two classes of pixels following bi-modal histogram (foreground pixels and background pixels), it then calculates the optimum threshold separating the two classes so that their combined spread (intra-class variance) is minimal.

VI. THINNING

Thinning is an image processing operation in which binary valued image regions are reduced to lines that approximate the center skeletons of the regions [8]. It is usually required that the lines of the thinned result are connected for each single image region, then these can be used to infer shape and topology in the original image. Thinning techniques have been applied in many fields such as automated industrial inspection, pattern recognition, biological shape description and image coding etc. the main objective of thinning is to improve efficiency, to reduce transmission time [9]. The skeleton of an object is a line connecting the points midway between the boundaries. The skeleton refers to the "bone‟ of an image.

VII. CLASSIFIERS

Classification includes a broad range of decision-theoretic approaches to the identification of images (or parts thereof). All classification algorithms are based on the assumption that the image in question depicts one or more features and that each of these features belongs to one of several distinct and exclusive classes [10]. The classes may be specified a priori by an analyst (as in supervised classification) or automatically clustered into sets of prototype classes, where the analyst merely specifies the number of desired categories.

The intent of the classification process is to categorize all pixels in a digital image into one of several land cover classes, or "themes". This categorized data may then be used to produce thematic maps of the land cover present in an image. Normally, multispectral data are used to perform the classification and, indeed, the spectral pattern present within the data for each pixel is used as the numerical basis for categorization.

CONCLUSION

This paper proposes new approach of fracture detection at emergencies. It is compact, reliable and very cost effective when compared to conventional methods of detection. These results are promising at this particular wavelength (450nm). Further we are planning to improve our results with different IR wavelengths and various algorithms to improve the quality of the resultant output.

ACKNOWLEDGEMENT

We express our sincere gratitude to our concerned guides Asst.Prof.Mrs.N.Revathy, Departmentof Electronics and communication engineering, for their inspiring guidance towards the progress on the topic "Resonant Electricity Transfer" and their valuable information for the development of our paper. We would like to get experts comments to help improve our paper.

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