Abstract: In this paper, we present the method of “X-Ray image segmentation by using edge detection based on the sobel edge operator” due to advancement in computer. 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. An automatic fracture detection system consists of three main steps, namely, preprocessing, segmentation and fracture detection. During segmentation and fracture detection, one important algorithm used is an edge detector to identify edges, which are the boundary between an object and the background, and indicates the boundary between overlapping objects. Edge detection is fundamental tool for image segmentation. Sobel edge operator, which is very popular edge detection algorithms, is considered in this work. Sobel method uses the derivative approximation to find edge and perform 2-D spatial gradient measurement for images uses horizontal and vertical gradient matrices. The FPGA device providing good performance of integrated circuit platform for research and development. The compact structure of image segmentation into edge detection can be implemented in MATLAB using VHDL code and the waveform is shown in the model sim.

Keywords: VLSI, FPGA, x-ray image segmentation, sobel edge operators, edge detection pixel, MATLAB.
1. Introduction:

Digital image processing is the use of computing algorithms to perform image processing to digital images. Digital image processing becomes more and more important in the areas of communication, management, remote-sensing, medicine industrial-automation, seismology, robotics, aerospace, and education.

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. 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. 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. Moreover, tibia fractures are the subject of ongoing controversy and discussion. Despite newer innovations, automatic detection of tibial fractures essentially remains unresolved as these injuries are different and variable in presentation and their outcomes are unpredictable. 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 x-ray 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. Today, a large number of X-Ray images are interpreted in hospital and computer-aided systems that can perform some intelligent tasks and analysis is needed in order to raise the accuracy and bring down the miss rate in hospital. During segmentation and fracture detection, one important algorithm used is an edge detector to identify edges, which are the boundary between an object and the background, and indicates the boundary between overlapping objects. In fracture identification systems, using the edge details, the bone region can be extracted efficiently during segmentation process and fractures can be identified efficiently during detection process. Usage of edge detection reduces the amount of data to be processed and filters out non-relevant information, while preserving the important structural properties of an image. If the edge detection step is successful, the subsequent tasks of fracture detection may be substantially simplified. Owing to the important role played by edge detectors the algorithm is simulated in MATLAB, and then the same is implemented into VHDL with the help of Xilinx ISE and the Model sim simulation results are verified with MATLAB results.

2. Modules:

2.1. X-Ray Imaging:

X-ray imaging is a medical imaging method that uses X-ray radiation to generate images. X-ray photons are generated using a X-ray tube which consist of an anode and a cathode on opposite sides, with vacuum in the space between them. Electrons are liberated when the cathode is heated up, and accelerate at a high speed toward the anode. When the electrons hit the anode (which usually consist of one of the metals tungsten, copper or molybdenum) about 1% of the energy is converted into X-ray photons while the rest dissipates as heat. The X-ray photons are directed towards the patient, which is located between the X-ray tube and a detector (digital film). The X-ray travels through the body, some of it being absorbed and the rest hits the detector. The parts of the body with high density absorbs most of the X-ray photons directed towards it, while soft tissues such as muscle and fat absorbs some of it depending on the type of tissue and its density. The detector acts as a digital film which represents the final image as white where the X-ray energy was absorbed by the body, and
dark in places with little absorption (e.g. liquid and air). The X-ray image can thus be seen as the "shadow" of the released X-ray energy. Even if the soft tissues does not absorb as much of the X-rays as the hard tissues, they still absorb some, so if a low energy photon source were used, it would be difficult to see the difference of hard and soft tissues in the resulting X-ray image. This is why X-ray on bones and other hard tissues requires a photon source of high energy. High energy means more radiation. A side-effect of X-ray imaging is the ionizing radiation from the X-rays, but conventional X-ray imaging does not require a large amount of radiation. Another disadvantage is that conventional X-ray imaging can only be used to create 2D images, which limits the amount of information gained. Advantages with X-ray imaging is that it is very fast to use and good at bone imaging. Thus, X-ray imaging is widely used to detect bone fractures and by dentists to exam teeth.

2.2. Image Segmentation:

Image segmentation is very important application in the digital image processing. Image segmentation is the process of partitioning a digital images into multiple regions or sets of pixel. In image partitions are different objects which have the same texture or color. The image segmentation are a set of regions that are entire image together and set of contours extracted from the images. All of the pixel in region are similar with respects to some characteristics such as colors, intensity, or texture. Adjacent region are considerably different with respects to the same individuality. The different approaches of image segmentation are, finding boundaries between regions based on the discontinuities in intensity levels, Thresholds based on the distribution of pixel properties, such as intensity values and. Last is Based on finding the region directly.

Image segmentation is the process of extracting features or regions of interest from an acquired image for further computer analysis. The image is sliced into multiple regions based on some property of the pixels. These properties are intensity, texture, position or some local or global statistical parameters. Segmentation using computer vision finds multiple applications especially in the area of biomedicine, communication, management, remote-sensing, medicine industrial-automation, seismology, robotics, aerospace, and education. Typical computer vision applications usually require an image segmentation preprocessing algorithm as a first procedure. At the output of this stage each object of the image represented by a set of pixels is isolated from the rest of the scene. The purpose of this step is that the objects and background are separated into non-overlapping sets.
2.3. Edge Detection:

Edge detection is an important step in digital image processing for image segmentation. It is the process of locating an edge of an image. Detection of edge in an image is a very important step to words understanding the image features. Edge consists of meaning full region features and contained significant information. It reduces significantly the amount of the image size and preserving the important structural properties of images. Since edge occur at image location representing object boundaries, edge detection is extensively used in image segmentation when images are divided into areas corresponding to different objects. In image processing, the edge detection treats the localization of important variation of a grey level images and the detection of the physical and geometrical properties of objects of the scence. It is a fundamental process detects and outlines of an objects and boundaries among objects and the background in the image. Edge detection is the most familiar approach for finding or detecting significant discontinuities in intensity values.

Edge detection is more common for finding detecting discontinuities in grey level than detecting isolated points and thin lines because isolated points and thin lines not occur frequently in most practical images. The edge is the boundary between two region with relatively distinct grey level properties. It is assumed that the transition between two region can be determined on the basis of grey level continuities alone.

3. Implementation Of Edge Detection:

Edge are characterizes boundaries and the problem of fundamental importance in image processing. Edges in images are areas with strong intensity contrast- a jump in intensity from one pixel to another pixel. The edge of images are considered to be most important attributes that provided valuable information for human perception. The edge detection is a terminology in image processing in the area of features extraction is refer to algorithms which main aim is to identifying point in digital image at which the image brightness changes sharply. The data of edge detection is very large so the speed of image processing is a difficult problem. Sobel operator is commonly used in edge detection.

3.1. Sobel Edge Detection Operator:
The sobel edge operator a 2-D spatial gradient measurement on an image and emphasizes region of high spatial gradient that corresponds to edges. It is used to find the approximate absolute gradient magnitude at each point in an input grey scale. It is differential of two rows or two column, so the element of the edge on both sides has been enhanced, so that the edge seems thick and bright. The non maximal suppression stage identifies pixel that are local maxima in the direction of the gradient using magnitude and orientation of the pixel. The major orientation of the gradient, either horizontal and vertical is obtained by comparing the individual component, dx and dy which are convolving the smoothed image with the derivative of Gaussian. Which is shown in fig 1.

Figure 1: gradient component

In the theory atleast , the operators consists of a pair 3x3 convolution kernels as shown in fig 2. One kernel is simply the other rotated by 90 degree. This is very similar to the Roberts cross operators .The convolution mask of the sobel operator are given is shown in fig 2.

<table>
<thead>
<tr>
<th></th>
<th>X direction</th>
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<tr>
<td>-1</td>
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Figure 2: convolution kernel in X and Y direction
These kernel can be combined together to find the absolute magnitude of the gradient at each point.

The gradient magnitude is given by:

\[ |\nabla f| = \sqrt{G_x^2 + G_y^2} \]

\[ |\nabla f| = |G_x| + |G_y| \]

### 3.2. Gradient Operator:

Gradient-based edge detection is the most common approach for detecting meaningful discontinuities in gray level. The most common type of edge detection process uses a gradient operator. Gradient is a vector having both magnitude as well as direction. The gradient of an image \( f(x, y) \) at location \( (x, y) \) is defined as vector. The gradient vector points in the direction of maximum rate of change of \( f \) at coordinates \( (x, y) \). An important quantity in the edge detection is the magnitude of this vector.

The gradient of an image \( F(x,y) \) at location \( (x,y) \) is the vector

\[
\nabla f = \begin{bmatrix} G_x \\ G_y \end{bmatrix} = \begin{bmatrix} \frac{\partial f}{\partial x} \\ \frac{\partial f}{\partial y} \end{bmatrix}
\]

The gradient vector points in the direction of maximum rate of change of \( f \) at \( (x, y) \). In edge detection, an important quantity is the magnitude of this vector:

\[ |\nabla f| = \sqrt{G_x^2 + G_y^2} \]

The gradients take its maximum rate increase of \( f(x,y) \) per unit distance in the direction of \( \nabla f \).

The gradient magnitude is commonly approximated by:

\[ |\nabla f| = |G_x| + |G_y| \]

This is simpler to implement. The direction of the gradient vector is also important and is given by
3.3. **Fpga Hardware Implementation:**

The field programmable gate array implementation of edge detection is shown in fig respectively. This design uses 3x3 convolution kernels processing 500x500 Gray Scale Image from the database in the personal computer. The architecture is shown in Fig 3. This system is divided into basic four modules: 3x3 pixel generation module, Sobel enhancement operator module, edges control module and binary segmentation. In this system, there are various signal are: Clk is the clock signal, Data input is the pixel signal of Gray Scale Image, Result is the result of edge detection operator signal, Generation data and Data are the middle signal.

![Figure 3: Architecture](image)

4. **Implementation Of Image Segmentation Using The Sobel Operator:**

The Image segmentation is a very important application in the field of image processing. Image segmentation is the process of extracting features or regions of interest from an acquired image for further intelligent computer analysis. The image is sliced into multiple regions based on some property of the pixels. These properties are intensity, texture, position or some local or global statistical parameters. There are number of literatures on image segmentation both semiautomatic and automatic.
4.1. Segmentation Algorithms Based On The Edge Detection:

Here the segmentation algorithms with the help of the edge detection sobel operator is described in the following steps:

Step 1: Read input image

Step 2: Apply into horizontal mask Gx and vertical mask Gy to the input image.

Step 3: Apply into different sobel edge detection algorithms and find the gradient

\[ |\nabla f| = |G_x| + |G_y| \]

Step 4: Construct separate image for Gx and Gy

Step 5: Results are combined to find the absolute magnitude of the gradient.

\[ |\nabla f| = \sqrt{G_x^2 + G_y^2} \]

Step 6: The absolute magnitude is the output slope magnitude image.

Step 7: For some slope magnitude images, the pixels values are too small or too high. To improve visibility of those images, scaling has to be done. For small values, it has to be scaled up by appropriate factor. For large values, it has to be scaled down by appropriate factor.

4.2. Segmentation Architecture Using Sobel Operator:

![Segmentation Processor Architecture](image_url)

Figure 4: segmentation processor architecture
The proposed segmentation architecture has the shown in the fig 4. It consists of the interface, memory, operator, control unit. In this diagram, the different functional unit described. The control unit monitors all the activities of the processor. In this system, the control signal are issued to the memory unit and the interface. The memory stores the image pixel for the processing and the processed image is stored in the read memory section. The input is connected to the write memory and the output is connected with read memory. Operator unit perform the edge detection methods for the image segmentation processing. Operator performs the algorithms for the edge detection for the segmentation.

5. Experimental Results:

The experimental results for the x-ray image segmentation for edge detection in MAT LAB is shown in fig 5. (a) is the input images and the fig 5(b) shows the output images and the simulation waveform for the modules is also shown in the fig 6.

![Figure 5: (a) Original image](image)

![Figure 5: (b) Sobel edge detection](image)

**Figure 5: Edge detection in mat lab**

Here another fig which is shown below of the simulation waveform for image segmentation using sobel edge operator fig 6(a) image segmentation 6(b) image segmentation using edge operators waveform.
Figure 6: (a) segmentation

Figure 6: (b) simulation segmentation using sobel edge operator
6. Conclusion:

This paper analyzed the applicability of five different edge detection algorithms for detecting the edges of X-ray images. These algorithms were selected because of their popularity in image analysis systems. Various experiments proved that the Sobel edge detection algorithm is fast and efficient in identifying the edges. It gives an algorithm which is a combination of detection and evaluation of the edge detectors of the segmentation. The results show that the edge detection in the mat lab and the simulation waveform implemented in the model sim. The fpga based architecture is good and stable techniques for the edge detection.
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