ABSTRACT

The elevation of colour printing technology has increased the rate of fake currency note printing on a very large scale. It is the biggest problem faced by many countries including India. The effects that counterfeit money has on society include a reduction in the value of real money. There are machines present at banks and other commercial areas to check the authenticity of the currencies. But a common man does not have access to such systems and hence a need for software to detect fake currency arises, which can be used by common people. Verification of currency note is done by the concepts of image processing and segmentation. To remove such unwanted data in an image, number of the image pre-processing systems is required in order to better perception of the images. The way toward upgrading pixel intensity and image quality additionally are managed after pre handling. In this research, the pre-processing techniques like different types of noise and filters. The noises are speckle, poisson and Gaussian. Different filtering techniques can be adapted for noise declining to improve the visual quality as well as reorganization of images. The filters are Mean, Gaussain and Median filter are used to enhance the clarity of currency images. The purpose of Image segmentation is to partition an image into meaningful regions with respect to a particular application. Image segmentation is a method of separating the image from the background and read the contents. In this research through study has been done on most commonly used edge detection techniques such as Canny-edge detection, Laplacian and Gradient (sobel operator) comparatively reveal and analyze the distinctions from those processed images with those techniques use the peak signal-to-noise ratio (PSNR) for finding the best filter for removing noise from the image.

CHAPTER-1

1. Introduction

1.1General Background

Image processing is the most important part of the machine vision. Machine Vision is becoming more and more important these days because it is being used in manufacturing, inspection of parts, medical applications and robot guiding. Machine vision means making the machines to interact with the environment as human beings do in terms of seeing. But there is much work left to be done. Visual data are most complex and most useful sensory input for humans. Machine vision is concerned with the interpretation of similar visual data. Image Processing is the science of modifying and analyzing pictures. For analysis of images we need to find their edges first. Edges information can be used for segmentation of images or for locating their boundary in formation. Edge detection is important because edges give the compact description of the objects and objects can be reconstructed from the edge information.

Vision begins with transformation of a flux of photons into a set of intensity values at an array of sensors. The first step in visual information processing is to obtain a compact description of the raw intensity values. The primitive elements of the initial description should ideally be complete in the sense of representing the full information contained in the image, and meaningful (that is, capturing significant properties of the three-dimensional surfaces around the viewer). Physical edges are among the most of objects since they correspond to object boundaries or to changes in surface orientation or material properties.

1.2 Motivation

The main motivation behind development of this project was to make a system for easy and quick detection of genuine and fake currency notes. This is a Python based system for segmentation process applied for currency images.

1.3 Objective

The Main Objective of this project is fake currency detection using the segmentation.The Aim is to increasing the accuracy of determining if a note is genuine or counterfeit. There were many methods in existence, this method was designed to overcome the drawbacks of the previous methods. This method gives a faster and more accurate output when compared to the other techniques.

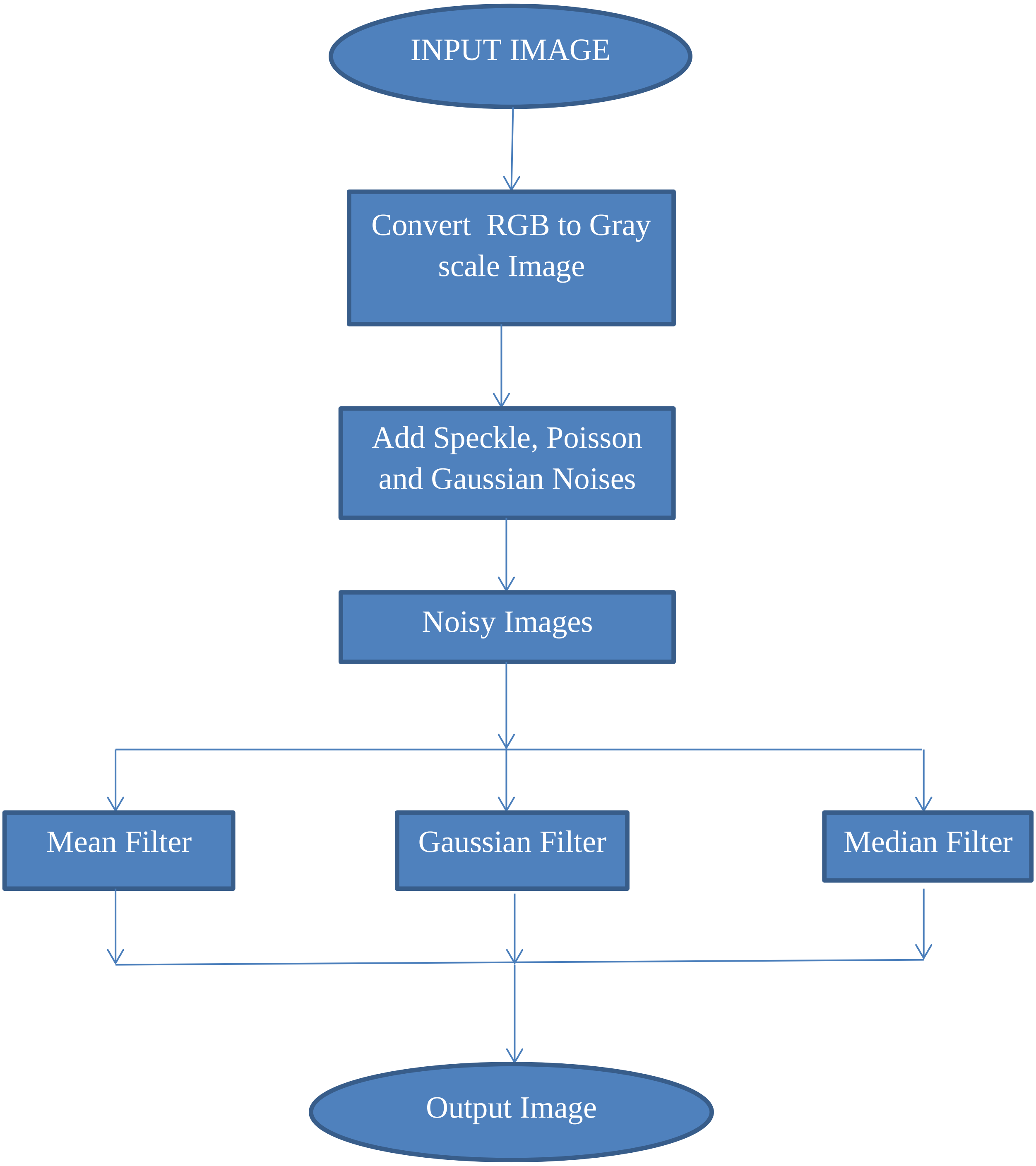
1.4 Edge Detection Challenges

General proposals to apply distinctive edge detection algorithms are a few key features that are increasing the difficulties. They are the data loss due to the image format conversion, noise from the environment, and intrinsic precision error coming from the mathematical convolution within edge detection algorithms. In regular cases, the complexity of implementing the detector is rising along with the mathematical processing of the data. Considering data loss situation and involving noise, more computation resource is definitely to be required to localize the position and intensity of noise background information. That is why sometimes, raw data is highly preferred in this field. Many redundant data would become necessary to recover the objectives edge as real as possible. The common characteristic for both noise data and edge in an image is high-frequency content they carry. Usually, the larger scope of the operator is traded in with accuracy of localization of objective edge so that the detector can average the noise pixel from more samples to eliminates the gradual changes. Since noise causes edge distortion, and it is not equally occurring on the detected edge, the detector should be flexible to fit in the gradual change on edge. Looking at many unpredictable factors on edge detection accuracy is designed to maintain an identical compiling and simulation environment on all algorithms involved in the paper. Besides, the identical size and format of the image are implemented to eliminate the inherited distinction from the raw image data. Segmentation is a process of distinguishing objects from the background. Hence, Image segmentation is distinguishing or partitioning the image from its background. The three main approaches used for image segmentation are: canny-edge techniques, laplacian techniques, gradient techniques. Most widely and important amongest these three techniques is “edge detection”. The level of the subdivision has to stop when the object or image of interest have been partitioned. Picking up an appropriate technique for “good” segmentation is a challenging task. Edge being such an essential part in an image, its study becomes important. Some important features can be extracted from an edge of any image (e.g.: corners, lines, curves). Edge detection is a technique in which the points where image brightness changes sharply or formally are identified. These points are organized under line segments called edges. Edge detection also aims to classify and place discontinuities in an image. Noise and image both have high frequency, hence edge detection becomes difficult.

1.5 Edge Detection Objectives

The main objective of studying various edge detection techniques and analyzing their performance is due to problems such as fake edge detection, noisy images, missing edges etc. Since challenges in applying edge detection on the image involving environmental hazards, the direct purpose of this technology lying on how to effectively retrieve the application-oriented structural edge pixels as highlighted as possible. That is better for delivering more necessary information with a high resolution. For instance, the images shown in figure 2 distinguish edge detection importance in need of a high resolution. An image is bi-directional function f(x,y) in which x and y are spatial co-ordinates, and the magnitudes of f is called as the intensity or gray level of the image. When the x,y and magnitude value of image is finite and discrete in nature then this image is called digital image. These finite elements are called as pixels. Digital image processing is a field in which a digital image is processed by a digital computer to get some wothy information from it. It is a kind of signal processing whose input is an image and provide image as output or characteristics/features associated with that image. Nowadays, it is expanding technologies, researches are continue in this area to explore all engineering aspects. The Edge retrieval methods usually applies in the initial steps of Image processing . Image edge information is essentially one of the most significant information of image, which can describe the object boundary, its relative position within the target area, and other important information. Image edge detection methods drawing out edges from an image by identifying large intensity variations in the pixels. This will provide object outlines and object-background boundaries . Edges can be detected by processing an image in spatial or in frequency domains as well. In spatial domain techniques, all the operation is done on the adjacent pixels of image whereas in frequency domain edge detection image is firstly transformed in frequency domain using discrete fourier transform and than it is processed to get edges of image. The edge detection process serves to simplify the analysis of images by drastically reducing the amount ofdata to be processed, while atthe same time preserving useful structural information about object boundaries.

1.6 Overview of Working Process



1.7 Types of Image Noise

a. Speckle Noise

Speckle noise is one kind of granular noise and the picture quality has been degraded by this speckle noise. The images which are acquired from medical are spoiled by the speckle noise. Generally, speckle noise expands the mean gray near of a native area and causing difficulties in medical because of coherent processing of backscattered signal.

b. Poisson Noise

Poisson noise also called photon noise. It is happening due to some statistical variation in the assessment. The uncertainty associated with this type of noise is the measurement of light and independent of photons . The expected magnitude of the signal is signal dependent and independent of low light conditions.

Reducing noise from the digital image is a test for the specialists in the preprocessing phase. There are different filtering methods that are accessible for various sorts of noise reductions.

c. Gaussian Noise

Gaussian noise is likewise called enhancer noise or random variation impulsive noise. Gaussian noise is created because of (an) electronic circuit noise, (b) sensor noise because of high temperature, (c) sensor noise because of poor brightening. It is a sort of measurable noise where the sufficiency of the noise takes after Gaussian dissemination [10]. Gaussian noise emerges as probability density function of the regular distribution.

1.8 Types of Filters

a. Mean Filter

Mean filtering simplest way to decrease the amount of intensity deviation between one and next pixel for smoothing image.

At this time, g is the ruined image, r and c are the row and column co-ordinates correspondingly within a window size of m×n besides the filtered image. However geometric mean filter is a variation of the arithmetic mean filter.

b. Gaussian Filter

Gaussian filter is a linear smoothing filter, where the weights chosen for the smoothing purpose according to the outline of the function of Gaussian.

A Gaussian Filter is a low pass filter used for **reducing noise (high frequency components) and blurring regions of an image**.

c. Median Filter

Order-statistics filter also known as Median filter, which exchanges the estimation of a pixel by the middle of the gray levels in the region of that pixel. The median is a rank command statistic and in a intelligence the main stream of the pixel values included determines the result.

1.9 Types of Segmentation Filters

a. Canny-Edge

Canny edge detector is one of the most commonly used image processing tools. The Gaussian smoothing in the canny edge detector fulfills two purposes: first it can be used to control the amount of detail that appears in the edge image and second, it can be used to suppress noise.

It is a better method because it extracts the features in an image without disturbing its features. There are certain criteria to improve current methods of edge detection. The first and most obvious is low error rate. It is important that edges occurring in images should not be missed. The second criterion is that the edge points be well localized i.e. the distance between the edge pixels as found by the detector and the actual edge should be minimum. A third criterion is to have only one response to a single edge.

b. Laplacian

In laplacian based methods, edges are recognized by searching zero crossings in a 2nd derivative of the image. A pre-processing step is taken that is smoothing usually Guassian smoothing of image. In smoothing, firstly convolution is performed between image and Guassian filter to minimize noise. Thereafter isolated noise pixels and small structures are filtered out. Laplacian of gaussian is also known as Marr-Hildreth Edge Detector.

The Laplacian edge detector uses only one mask. It can compute second order derivatives in a one pass.

c. Gradient

The edge is the area where image grey value changes abruptly, using gradient operator edges are detected by perfoming first order derivative. It detect edges by computing the magnitude of gradient, and then going for local directional maxima of it by using an estimation of the local orientation of the edges, normally the gradient’s direction. For an image function f(x, y), the derivative of ‘f’ at coordinates (x, y) is denoted as the two directional column vector.

Sobel Operator: It is 3x3 convolution kernels. One kernel is simply the other rotated by 900. It is a row-edge detector.

The kernel can be applied separately to input image for obtaining gradient component in each orientation i.e. GX and GY.

1.10 Problem Statement

The Existing System, doesn’t scanned the rear part of the currency note it only scans the front end part of the currency note. The existing system doesn’t give efficient results and it’s accuracy rate is low. Image processing and pattern recognition area is the base area for feature extraction. Existing system is a time consuming process for detection. There are some techniques which are specifically from the application area of Image processing and pattern recognition and using those techniques the researchers achieved the accuracy rate low.

CHAPTER 2

LITERATURE SURVEY

1. **Meo Vincent Caya, Dionis Padilla, Gilbert Ombay, Arnold Janssen Hernandez. Detection and Counting of Red Blood Cells in Human Blood using Canny Edge Detection and Circle Hough Transform Algorithms[C]. 2019 IEEE 11th International Conference on Humanoid, Nanotechnology, Information Technology, Communication and Control, Environment, and Management (HNICEM). 2019,12.**

Description:

Edge detection is an important part of image segmentation, in this paper, the edge detection algorithm based on traditional Canny operator for medical images is studied. The Canny operator is improved using Otsu algorithm and double-gate limit detection method, and the ability of Canny operator edge detection is strengthened. The simulation of the algorithm is realized on the computer platform by MATLAB, and the experimental results are analyzed from two image objective evaluation indexes of information entropy and mean square error. The experimental results show that compared with the traditional Canny algorithm, the improved adaptive double threshold Canny algorithm has better edge detection effect, richer image details, better noise suppression and less false edges.

Disadvantages :

- The primary disadvantage of using Canny edge detector is that it consumes a lot of time due to its complex computation.

Advantages:

- It gives a good localization, response and is immune to a noisy environment.

2. M. Defferrard, X. Bresson, and P. Vandergheynst, “Convolutional neural networks on graphs with fast localized spectral filtering”, in Proc. Adv. Neural Inf. Process. Syst., vol. 29, 2016, pp. 3844-3852.

Description:

In generalizing convolutional neural networks (CNNs) from low-dimensional regular grids, where image, video and speech are represented, to high-dimensional irregular domains, such as social networks, brain connect or words’embedding, represented by graphs. We present a formulation of CNNs in the context of spectral graph theory, which provides the necessary mathematical background and efficient numerical schemes to design fast localized convolutional filters on graphs. Importantly, the proposed technique offers the same linear computational complexity and constant learning complexity as classical CNNs, while being universal to any graph structure. Experiments on MNIST and 20NEWS demonstrate the ability of this novel deep learning system to learn local, stationary, and compositional features on graphs.

Disadvantages:

- For fake notes recognition , need to focus on the key frames and joint information, and too much redundant will lead to a decrease in fake notes recognition.

Advantages:

- Skeleton based fake notes recognition has attracted extensive attention due to the robustness of the fake notes skeleton data in the field of computer vision.

3. Akash Pandey,S. K. Shrivastava.A Survey Paper on Calcaneus Bone Tumor Detection Using different Improved Canny Edge Detector[C]. 2018 IEEE International Conference on System, Computation, Automation and Networking (ICSCA),2018,7.

Description:

Edge detection is an important part of image segmentation, in this paper, the edge detection algorithm based on traditional Canny operator for medical images is studied. The Canny operator is improved using Otsu algorithm and double-gate limit detection method, and the ability of Canny operator edge detection is strengthened. The simulation of the algorithm is realized on the computer platform by MATLAB, and the experimental results are analyzed from two image objective evaluation indexes of information entropy and mean square error. The experimental results show that compared with the traditional Canny algorithm, the improved adaptive double threshold Canny algorithm has better edge detection effect, richer image details, better noise suppression and less false edges.

Disadvantages:

- It is difficult to implement to reach the real-time response.

Advantages:

- The signal can be enhanced with respect to the noise ratio by non-maxima suppression method which results in one pixel wide ridges as the output.

4. Naresh Kumar Ravichandran,Hoseong Cho,Jaeyul Lee,et al. An Averaged Intensity Difference Detection Algorithm for Identification of Human Gingival Sulcus in Optical Coherence Tomography Images [J]. IEEE Access,2019,(7), pp: 73076-73084.

Description:

In the past decade, there has been an increase in the development of sensitive, high-resolution, non-invasive diagnostic methods for periodontic diseases. Optical coherence tomography (OCT) has attracted considerable attention in clinical settings. In this study, a reliable, robust algorithm for the detection of gingival sulcus in 2D OCT cross-sectional images is proposed. Previously, the measurement of gingival sulcus in OCT images has been performed by manual identification using two-dimensional (2D) cross-sectional images. The automated detection of gingival sulcus continuity in 2D OCT images may help medical practitioners to assess important features of gingival tissues. The Sobel and canny operators have mainly been used for boundary and edge detection in OCT images. The images were processed using three algorithms: canny, Sobel and averaged intensity difference.

Disadvantages:

- The main disadvantage of Canny edge detector is that it is time consuming, due to its complex computation noise.

Advantages:

- The presence of Gaussian filter allows removing of any noise in an image.
- The effectiveness can be adjusted by using parameters.

5. Isabel Rodrigues, Joao Sanches, “Denoising of medical images corrupted by Poisson noise”, 15th IEEE International Conference on Image Processing 2020

Description:

Medical images are often noisy owing to the physical mechanisms of the acquisition process. The great majority of the denoising algorithms assume additive white Gaussian noise. However, some of the most popular medical image modalities are degraded by some type of non-Gaussian noise. Among these types, we refer the Poisson noise, which is particularly suitable for modeling the counting processes associated to many imaging modalities such as PET, SPECT, and fluorescent confocal microscopy imaging. The aim of this work is to compare the effectiveness of several denoising algorithms in the presence of Poisson noise. We consider algorithms specifically designed for Poisson noise (wavelets, Platelets, and minimum descritpion length) and algorithms designed for Gaussian noise (edge preserving bilateral filtering, total variation, and non-local means). These algorithms are applied to piecewise smooth simulated and real data. Somehow unexpectedly, we conclude that total variation, designed for Gaussian noise, outperforms more elaborated state-of-the-art methods specifically designed for Poisson noise.

Disadvantages:

- Lose fine image detail and contrast.

Advantages:

- Easy to implement.

6. Meenakshi Sharma and Himanshu Aggarwal, "Methodologies of legacy clinical decision support system - A review" International Conference on Recent Innovations in Computer Science and Information Technology.2017 May.

Description:

Information technology playing a prominent role in the field of medical by in corporating the clinical decision support system (CDSS) in their routine practices. CDSS is a computer based interactive program to assist the physician to make the right decision at right time. Nowadays, clinical decision support systems are a dynamic research area in the field of computers, but the lack of understanding, as well as functions of the system, make adoption slow by physicians and patients. The literature review of this article focuses on the overview of legacy CDSS, the kind of methodologies and classifiers employed to prepare such a decision support system using a non-technical approach to the physician and the strategy-makers. This article provides understanding of the clinical decision support along with the gateway to physician, and to policy-makers to develop and deploy decision support systems as a healthcare service to make the quick, agile and right decision.

Disadvantages:

- Detection of edges is inaccurate at times. Thus less reliable.
- These are more sensitive to noise.

Advantages:

- Simple, easy and quick to compute.
- Edges are detected along with their orientation.

7. Gajanand Gupta, “Algorithm for Image Processing Using Improved Median Filter and Comparison of Mean and Improved Median Filter” (IJSCE) ISSN: 2231-2307, Volume-1, Issue-5, November 2021.

Description:

Noise reduction in medical images is a perplexing undertaking for the researchers in digital image processing. Noise generates maximum critical disturbances as well as touches the medical images quality, ultrasound images in the field of biomedical imaging. The image is normally considered as gathering of data and existence of noises degradation the image quality. It ought to be vital to re-establish the original image noises for accomplishing maximum data from images. Medical images are debased through noise through its transmission and procurement. Image with noise reduce the image contrast and resolution, thereby decreasing the diagnostic values of the medical image. This paper mainly focuses on Gaussian noise, Pepper noise, Uniform noise, Salt and Speckle noise. Different filtering techniques can be adapted for noise declining to improve the visual quality as well as reorganization of images. Here four types of noises have been undertaken and applied on medical images.

Disadvantages:

- Very sensitive to noise.
- Less accurate in finding Orientation of edges.

Advantages:

- Orientation is possible.
- Fixed characteristic in all Direction.

8. Y.Ramadevi, T.Sridevi, B.Poornima, B.Kalyani “Segmentation and object recognition using edge detection techniques” International Journal of Computer Science & Information Technology (IJCSIT), Vol 2, No 6, December 2020

Description:

Image segmentation is to partition an image into meaningful regions with respect to a particular application. Object recognition is the task of finding a given object in an image or video sequence. In this paper, interaction between image segmentation (using different edge detection methods) and object recognition are discussed. Edge detection methods such as Sobel, Prewitt, Roberts, Canny, Laplacian of Guassian (LoG) are used for segmenting the image. Expectation-Maximization (EM) algorithm, OSTU and Genetic algorithms were used to demonstrate the synergy between the segmented images and object recognition.

Disadvantages:

- Discontinuity in edges.
- Sensitive to noise.
- Can’t meet real time Requirement.

Advantages:

- Easy to implement.
- Orientation is possible.

9. Sunanda Gupta, Charu Gupta & S.K.Chakarvarty “Image edge detection :A review” international journal of advance reaserach in computer science and technology (IJARCET) Volume 2, Issue 7, July 2021.

Description:

Edges are the set of curved line segments where brightness level of image changes sharply. It is one of the most important information of an image which can helps to detect object boundary, its relative position within target area and many other useful information. In edge detection process, edges are retrieved from an image by spotting high intensity variations of the pixels. Edge detection of an image minimizes the amount of processed data effectively and discards information that is less important, keeping the important structural properties of an image. This paper presents a different approach to apply Gradient and LoG operator to get more continuous edges than the conventional one using MATLAB. Their results are compared using peak signal to noise ratio (PSNR). Two images in rainy weather are taken by my camera for case study. It can be used in many applications such as in object tracking, in data compression, in image analysis and medical imaging.

Disadvantages:

- Complex computation.
- Low operational speed.

Advantages:

- Better performance in case of Noise.
- Reduce computation time Effectively.

10. G.T.Shrivakshan & Dr.C.Chandrasekar, "A comparison of various edge detection techniques used in image processing" IJCSI International Journal of Computer Science Issues, Vol. 9, Issue 5, No 1, September 2012.

Description:

Authentication and Identification is one of the key features of Biometric Application. In such applications before generating the templates, a feature is extracted from the input image captured by a sensor after pre-processing. In pre-processing steps, the goal is to enhance the visual appearance of the image by noise removal, dilation, erosion, segmentation etc. In feature extraction, the edge is detected where there is an abrupt change in the intensity values of the image. This paper is aimed to analyse various edge detection techniques like Prewitt, Sobel, Roberts, Canny, LoG, Zero crossing etc. and proposing the best suitable method of edge detection for biometric application. The comparison of biometric image edge detection is based on the comparison parameter Mean Square Error (MSE), Root Mean Square Error (RMSE), Peek Signal to Noise Ratio (PSNR) using MATLAB software.

Disadvantages:

- Complex and time consuming computations.
- False zero crossing.
- It is difficult to give a generic threshold that works well on all image.

Advantages:

- Better detection in noise conditions.
- Retains texture of original image.
- Less computation time.

CHAPTER 3

MODULES

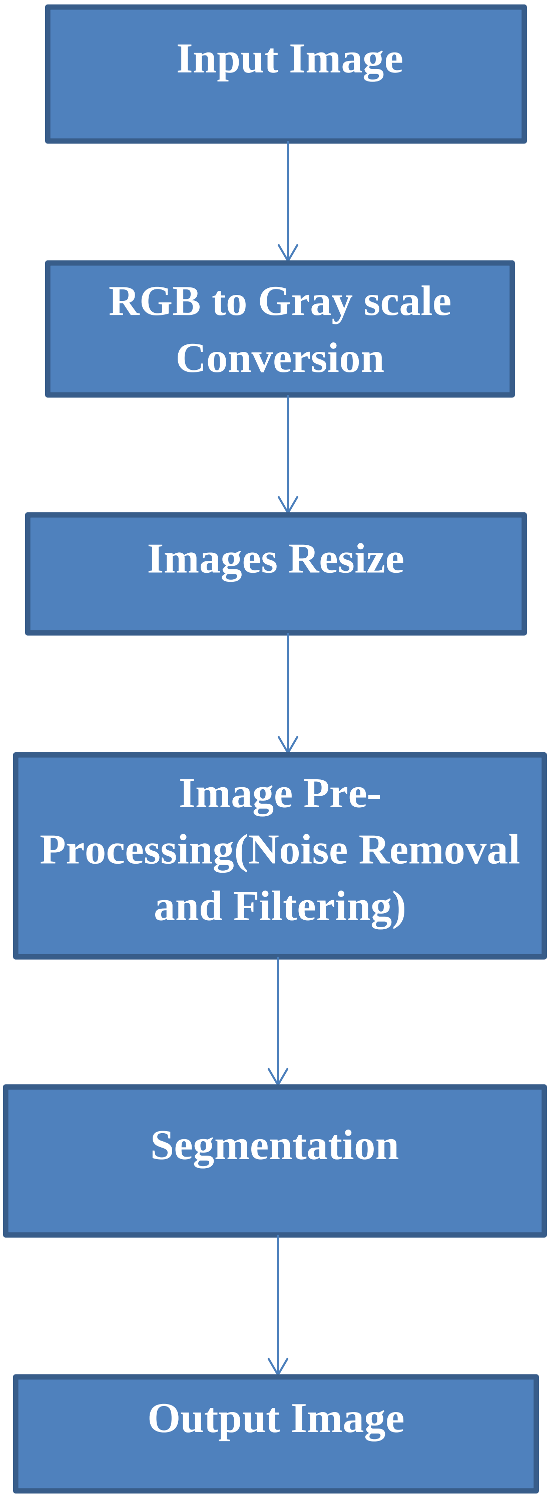
1.Preprocessing

The aim of preprocessing is an improvement of an image data that suppresses unwanted distortions or enhances some image features important for further processing. The pre preparing associated with transformation, picture resize, noise removing and improves the quality and produces an image where in details can be perceived precisely. To remove such unwanted data in an image, number of the image pre-processing systems is required in order to better perception of the images. The way toward upgrading pixel intensity and image quality additionally are managed after pre handling. In this research, the pre-processing techniques like different types of noise and filters. The noises are speckle, poisson and Gaussian. Different filtering techniques can be adapted for noise declining to improve the visual quality as well as reorganization of images. The filters are Mean, Gaussain and Median filter are used to enhance the clarity of currency images.

2.Segmentation

Image segmentation is the process of partitioning a digital image into multiple image segments, also known as image regions or image objects (sets of pixels). By dividing an image into segments, the process only the important segments of the image instead of processing the entire image. The purpose of Image segmentation is to partition an image into meaningful regions with respect to a particular application. Image segmentation is a method of separating the image from the background and read the contents. In this research through study has been done on most commonly used edge detection techniques such as Canny-edge detection, Laplacian and Gradient (sobel operator).

METHODOLOGY



A. Pre-Processing

Gray Scale Conversion:

The filtering strategies like Gaussian and median channel are balanced for noise removal method. it is easy to remove the noise by using conversion of colours images to gray scale images. The image acquired is in RGB color. It is converted into gray scale because it carries only the intensity information which is easy to process instead of processing three components R (Red), G(Green), B(Blue).

Image resizes:

Picture resizing is a critical job in picture taking care of strategy, to create and decrease the given picture size in pixel position. picture contribution can be divided into two distinct ways, they are picture down-testing and up-examining which is important while resizing the data for organizing either the specific correspondence channel or the output display. While it is more efficient to transmit low resolution forms to the client an estimation of the first high resolution might be required for introducing the last visual data. An exact resizing of picture data is a fundamental advance in numerous applications, extending from a few buyer things to essential limits inside the clinical security and defence segments. The speed of resizing can be resolved with the usage of strategy experiences the way that the subsequent picture frequently contains block artefacts, which are not outwardly noticeable but rather regularly additionally can definitely contrarily influence, error calculations wont to compare methods

Noise Removal:

Image noise is described considering the way that the irregular variety of brightness or shading data in pictures conveyed by currency devices or scanners. Picture noise is commonly seen as a undesirable result during picture obtaining. Noise is generally characterized because the uncertainity during a signal. There are numerous explanations behind these variances. Each currency picture contain some visual noise. The presence of noise gives a picture a mottled, grainy, completed, or covered appearance. A couple of sorts of noise exist in currency pictures.

Speckle Noise:

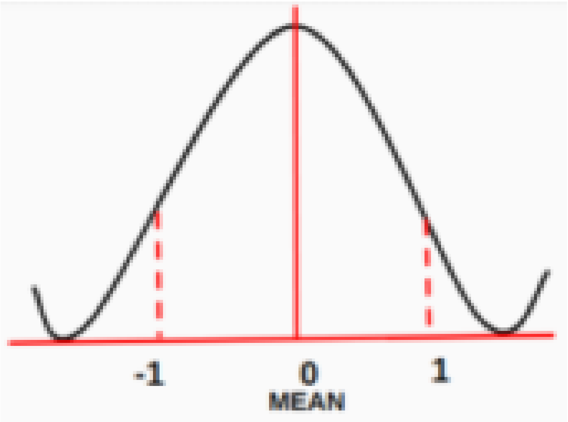
Speckle noise is one kind of granular noise and the picture quality has been degraded by this speckle noise. The images which are acquired from medical are spoiled by the speckle noise. Generally, speckle noise expands the mean gray near of a native area and causing difficulties in medical because of coherent processing of backscattered signal. Speckle noise Pulse generator picture standard is mostly reduced due to speckle noise. Speckle noise is a typical marvel in all intelligent imaging frameworks like a laser, acoustic and SAR symbolism. The source of this sort of commotion is caused because of arbitrary obstruction between the coherent returns given from such huge numbers of disperses present on an earth surface, on the size of a wavelength of the incident radar wave.

Poisson Noise:

Poisson noise also called photon noise. It is happening due to some statistical variation in the assessment. The uncertainty associated with this type of noise is the measurement of light and independent of photons . The expected magnitude of the signal is signal dependent and independent of low light conditions. Reducing noise from the digital image is a test for the specialists in the pre-processing phase. There are different filtering methods that are accessible for various sorts of noise reductions.

Gaussian Noise:

Gaussian noise is measurable noise that includes a likelihood thickness work (PDF) of the ordinary distribution, also referred to as regular assignment. In Gaussian noise, each pixel inside the picture will be changed from its unique value by a (normally) bit. It is also called as electronic noise because it arises in amplifiers or detectors. Source: thermal vibration of atoms and discrete nature of radiation of warm objects.



The side image is a bell shaped probability distribution function which have mean 0 and standard deviation (sigma) 1.

Filtering Methods:

Filtering technique for improving a picture , in filtering are essentially wont to cover either the high frequencies inside the image, for instance smoothing the image, or the low frequencies, i.e., improving or perceiving edges inside the image. For instance, you will filter a picture to pressure certain feature or evacuate different highlights. Number of techniques are available and thusly as well as can be expected depends on the picture and the manner in which it will be utilized. Picture filtering is important for a few applications, including smoothing, sharpening, expelling noise, and edge acknowledgment. filtering methods Input pictures are influenced by various noise either Gaussian channel, Median channel, etc. so noise picture process is managed to improve the image quality utilizing the filtering strategy respectively. The detail of each noise described below.

Mean Filter:

The simplest of these algorithms is the Mean Filter. The Mean Filter is a linear filter which uses a mask over each pixel in the signal. Each of the components of the pixels which fall under the mask are averaged together to form a single pixel. This new pixel is then used to replace the pixel in the signal studied. The Mean Filter is poor at maintaining edges within the image. It is often used to reduce noise in images.

$\frac{1}{9}$	$\frac{1}{9}$	$\frac{1}{9}$
$\frac{1}{9}$	$\frac{1}{9}$	$\frac{1}{9}$
$\frac{1}{9}$	$\frac{1}{9}$	$\frac{1}{9}$

3×3 averaging kernel often used in mean filtering

Computing the straightforward convolution of an image with this kernel carries out the mean filtering process. 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.

An arithmetic mean filter operation on an image removes short tailed noise such as uniform and Gaussian type noise from the image at the cost of blurring the image. The arithmetic mean filter is defined as the average of all pixels within a local region of an image.

Mean filtering simplest way to decrease the amount of intensity deviation between one and next pixel for smoothing image. Arithmetic mean filter can be expressed by,

$$\hat{f}(x, y) = \frac{1}{mn} \sum_{(s,t)\in S_{xy}} g(s, t)$$

At this time, g is the ruined image, r and c are the row and column co-ordinates correspondingly within a window size of m×n besides the filtered image is f'. However geometric mean filter is a variation of the arithmetic mean filter, which calculated appearance can be known as follows,

$$\hat{f}(x, y) = \left[\prod_{(s,t)\in S_{xy}} g(s, t) \right]^{\frac{1}{mn}}.$$

This has the effect of eliminating pixel values which are unrepresentative of their surroundings. Mean filtering is usually thought of as a convolution filter. Like other convolutions it is based around a kernel, which represents the shape and size of the neighborhood to be sampled when calculating the mean.

Algorithm:

Step 1: Place a window over element.

Step2: Take an average — sum up elements and divide the sum by the number of elements.

Gaussian Filter:

Gaussian filter is a linear smoothing filter, where the weights chosen for the smoothing purpose according to the outline of the function of Gaussian. Gaussian filter in the nonstop space and can be defined by the resulting equation,

In 1D:

$$g_\sigma(x) = \frac{1}{\sqrt{2\pi}\sigma} \exp\left(-\frac{x^2}{2\sigma^2}\right)$$

In 2D:

$$G_\sigma(x, y) = \frac{1}{2\pi\sigma^2} \exp\left(-\frac{x^2 + y^2}{2\sigma^2}\right)$$

A Gaussian Filter is a low pass filter used for **reducing noise (high frequency components) and blurring regions of an image**. The kernel is not hard towards drastic color changed (edges) due to it the pixels towards the center of the kernel having more weightage towards the final value then the periphery. A Gaussian Filter could be considered as an approximation of the Gaussian Function (mathematics).

A further way to compute a Gaussian smoothing with a large standard deviation is to convolve an image several times with a smaller Gaussian. While this is computationally complex, it can have applicability if the processing is carried out using a hardware pipeline.

Using the above function a gaussian kernel of any size can be calculated, by providing it with appropriate values. A 3×3 Gaussian Kernel Approximation(two dimensional) with Standard Deviation = 1, appears as follows

$$\frac{1}{16}\begin{bmatrix} 1 & 2 & 1 \\ 2 & 4 & 2 \\ 1 & 2 & 1 \end{bmatrix}$$

Median Filter:

The median filter is the filtering technique used for noise removal from images and signals. Median filter is very crucial in the image processing field as it is well known for the **preservation of edges during noise removal.** Order-statistics filter also known as Median filter, which exchanges the estimation of a pixel by the middle of the gray levels in the region of that pixel. The median is a rank command statistic and in a intelligence the main stream of the pixel values included determines the result. The expression of Median filter,

FORMULA:

$$\hat{f}(x,y) = \max_{(s,t)\in S_{xy}} \{g(s,t)\}$$

The first estimation of the pixel is incorporated into the calculation of the median. Median filters are extremely standard for assured sorts of arbitrary noise. They give astonishing noise diminish capacities, with stunningly less clouding than a linear smoothing filter of comparative size. The median is figured by first sorting all the pixel values from the window in numerical order. A while later supplanting the pixel being considered with the inside (middle) pixel value. Median filters are viable for the bipolar and unipolar impulse noise. Median filters are mainly reasonable within the sight of both unipolar and bipolar impulse noise.

Algorithm for the improved median filter

To remove salt and pepper noise from the corrupted image the below described algorithm is used.

Step 1: A two dimensional window (denoted by 3×3 W) of size 3x3 is selected and centered around the processed pixel p(x, y) in the corrupted image.

Step 2: Sort the pixels in the selected window according to the ascending order and find the median pixel value denoted by Pmed), maximum pixel value (Pmax) and minimum pixel value (Pmin) of the sorted vector V0. Now the first and last elements of the vector V0 is the Pmin and Pmax respectively and the middle element of the vector is the Pmed.

Step 3: If the processed pixel is within the range Pmin < P(x, y) < Pmax , Pmin > 0 and Pmax < 255,it is classified as uncorrupted pixel and it is left unchanged. Otherwise p(x, y) is classified as corrupted pixel.

Step 4: If p(x, y) is corrupted pixel, then we have the following two cases:

Case 1: If Pmin < Pmed < Pmax and 0 < Pmed < 255, replace the corrupted pixel p(x, y) with Pmed.

Case 2: If the condition in case 1 is not satisfied then Pmed is a noisy pixel. In this case compute the difference between each pair of adjacent pixel across the sorted vector V0 and obtain the difference vector VD .Then find the maximum difference in the VD and mark its corresponding pixel in the V0 to the processed pixel.

Step 5: Step 1 to step 4 are repeated until the processing is completed for the entire image.

B. Segmentation Methods:

Image Segmentation is the process of partitioning a digital image into multiple regions or sets of pixels. Essentially, in image partitions are different objects which have the same texture or color. The image segmentation results are a set of regions that cover the entire image together and a set of contours extracted from the image. All of the pixels in a region are similar with respect to some characteristics such as color, intensity, or texture. Adjacent regions are considerably different with respect to the same individuality. The different approaches are,

(i) by finding boundaries between regions based on discontinuities in intensity levels,

(ii) thresholds based on the distribution of pixel properties, such as intensity values, and

(iii) based on finding the regions directly.

Thus the choice of image segmentation technique is depends on the problem being considered.

Steps in Edge detection:

A. Filtration: Every image is associated with some intensity values, random change in these values can result in noise. Some common noise is: salt and pepper noise, impulse noise etc. Noise can result in difficulties in effective edge detection; hence image has to be filtered in order to reduce the noise content that leads to loss of edge strength . It is also termed as Smoothening.

B. Enhancement: Improving the quality of image is termed as enhancement. It aims to produce an image which is better and more suitable than original. A filter is applied in order to enhance the quality of edge in image.

C. Detection: Several methods are adopted to determine which points are edge points and which a edge pixels should be discarded as noise.

Edge detection is the problem of fundamental importance in image analysis. Edge detection techniques are generally used for finding discontinuities in gray level images. To detect consequential discontinuities in the gray level image is the important common approach in edge detection. Image segmentation methods for detecting discontinuities are boundary based methods.

Canny-Edge Detection:

The Canny edge detection technique is one of the standard edge detection techniques. It was first created by John Canny for his Master's thesis at MIT in 1983, and still outperforms many of the newer algorithms that have been developed. To find edges by separating noise from the image before find edges of image the Canny is a very important method. Canny method is a better method without disturbing the features of the edges in the image. It is a better method because it extracts the features in an image without disturbing its features. There are certain criteria to improve current methods of edge detection. The first and most obvious is low error rate. It is important that edges occurring in images should not be missed. The second criterion is that the edge points be well localized i.e. the distance between the edge pixels as found by the detector and the actual edge should be minimum. A third criterion is to have only one response to a single edge.

Importance of Canny

Despite of number of edge detection techniques available canny algorithm is considered because it contains a number of adjustable parameters which can affect the computation time and effectiveness of the algorithm.

a) The size of the Gaussian filter: The smoothing filter used in the first stage directly affects the results of the detection of small, sharp lines. A larger filter causes more blurring, smearing out the value of an given pixel over a larger area of image.

b) The use of two thresholds with hysteresis allows more flexibility than in a single-threshold. A threshold set too high can miss important information. On the other hand, a threshold set too low will falsely identify irrelevant information (such as noise) as important.

The edge detection in this technique is optimized with regard to the following criteria.

a) Maximizing the signal-to-noise ratio of the gradient.

b) Edge localization for ensuring the accuracy of edge.

c) Minimizing multiple responses to a single edge.

The algorithmic steps are as follows:

Step 1: Convolve image f(r, c) with a Gaussian function to get smooth image

f^(r, c). f^(r, c)=f(r,c)*G(r,c,6)

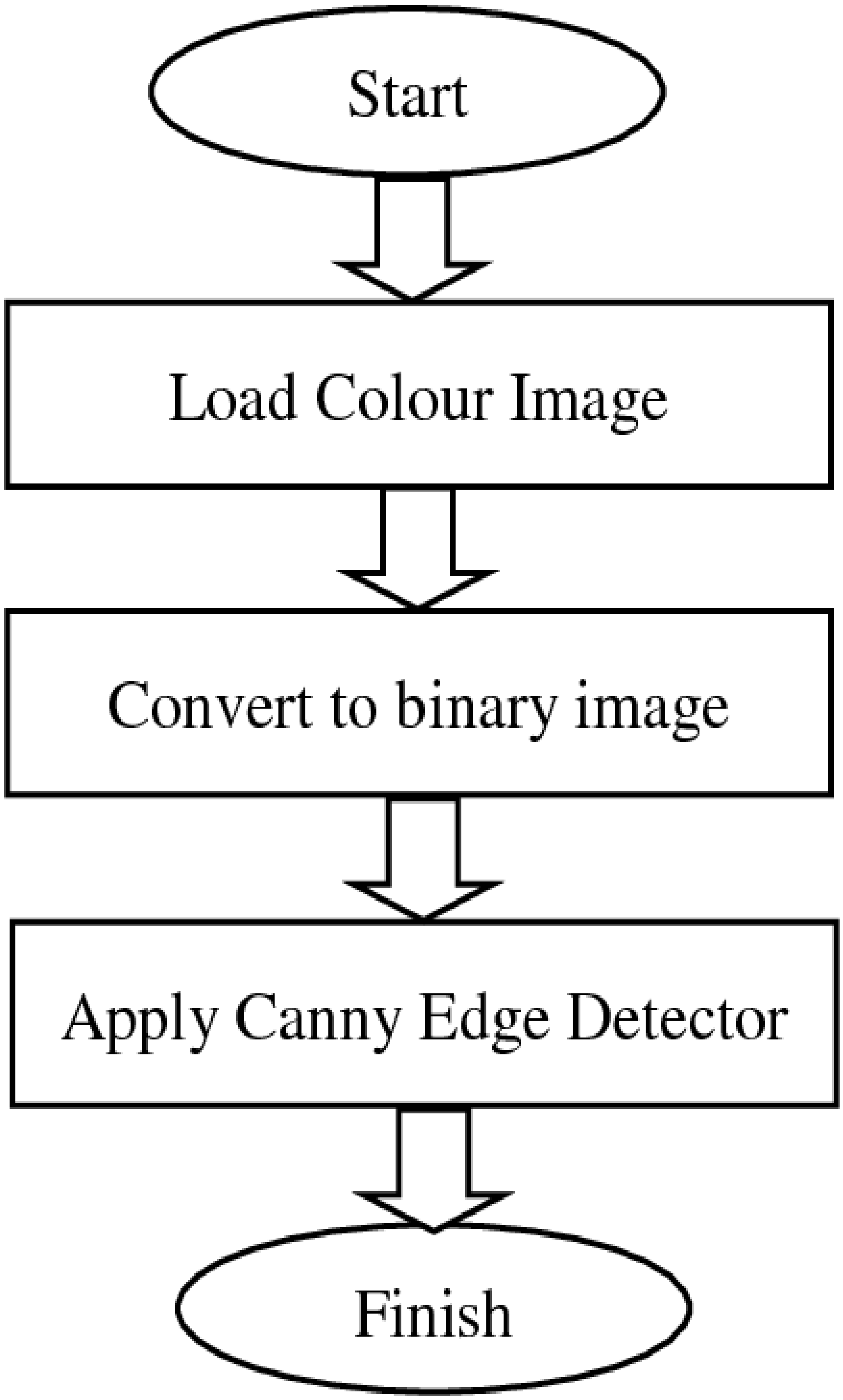
Step 2: Apply first difference gradient operator to compute edge strength then edge magnitude and direction are obtain as before.

Step 3: Apply non-maximal or critical suppression to the gradient magnitude.

Step 4: Apply threshold to the non-maximal suppression image.

The canny-edge detection flow chart are given below,

Flow chart



Laplacian

The Laplacian edge detection algorithm usually referred to Log detection algorithm. Also known as Laplacian filtering operator, it is a direction-free, isotropic operator directly take the 2nd order spatial derivative of an image. The distinction of this method is that the log operator only focuses on the rapid discontinuity of the pixel intensity within a certain area. That could run into trouble if images are raw and high-frequency noise hasn't been smoothed before this step. As a result, a smooth process is usually pre-requisite for this algorithm. Typically, Log is taking a grayscale image no matter what the type of the gray image is, and produce another one in grayscale. It first smoothes the image and then computes the Laplacian. This yields in double edge image; hence for finding the edge the zero crossing between the double edges is taken. The Laplacian of an image with the pixel intensity value L(x,y) is given by:

$$\nabla^2 f = \frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2}$$

$$\frac{\partial^2 f}{\partial x^2} = f(x+1, y) + f(x-1, y) - 2f(x, y)$$

In laplacian based methods, edges are recognized by searching zero crossings in a 2nd derivative of the image. A pre-processing step is taken that is smoothing usually Guassian smoothing of image. In smoothing, firstly convolution is performed between image and Guassian filter to minimize noise. There after isolated noise pixels and small structures are filtered out.

The commonly used discrete approximations to Laplacian filter are:

0	1	0
1	−4	1
0	1	0

(a)

1	1	1
1	−8	1
1	1	1

(b)

The Gaussian filtering is combined with Laplacian to break down the image where the intensity varies to detect the edges effectively.

<u>Steps:</u>

- Read the image
- If the image is colored then convert it into RGB format.
- Define the Laplacian filter.
- Convolve the image with the filter.
- Display the binary edge-detected image.

Gradient:

Sobel Operator: It is 3x3 convolution kernels. One kernel is simply the other rotated by 900. It is a row edge detector.

-1	0	+1
-2	0	+2
-1	0	+1

Gx

+1	+2	+1
0	0	0
-1	-2	-1

Gy

GX and GY are the common masks used in Sobel Operator.

This figure shows the masks used by Sobel operator. The kernel can be applied separately to input image for obtaining gradient component in each orientation i.e. GX and GY.

These kernels are designed to respond maximally to edges running vertically and horizontally relative to the pixel grid, one kernel for each of the two perpendicular orientations. The kernels can be applied separately to the input image, to produce separate measurements of the gradient component in each orientation (call these *Gx* and *Gy*). These can then be combined together to find the absolute magnitude of the gradient at each point and the orientation of that gradient. The gradient magnitude is given by:

$$|G| = \sqrt{Gx^2 + Gy^2}$$

And its approximation is done by:

$$|G| = |Gx| + |Gy|$$

which is much faster to compute.

The angle of orientation of the edge (relative to the pixel grid) giving rise to the spatial gradient is given by:

$$\theta = \arctan(Gy/Gx)$$

In this case, orientation 0 is taken to mean that the direction of maximum contrast from black to white runs from left to right on the image, and other angles are measured anti-clockwise from this.

Often, this absolute magnitude is the only output the user sees --- the two components of the gradient are conveniently computed and added in a single pass over the input image using the pseudo-convolution operator shown in Fig.

P_1	P_2	P_3
P_4	P_5	P_6
P_7	P_8	P_9

Pseudo-convolution kernels used to quickly compute approximate gradient magnitude

Using this kernel the approximate magnitude is given by:

$$|G| = |(P_1 + 2 \times P_2 + P_3) - (P_7 + 2 \times P_8 + P_9)| + |(P_3 + 2 \times P_6 + P_9) - (P_1 + 2 \times P_4 + P_7)|$$

The algorithm works with two kernels

1. A kernel to approximate intensity change in the x-direction (horizontal).

2. A kernel to approximate intensity change at a pixel in the y-direction (vertical).