

**IMPLEMENTATION OF EDGE DETECTION USING BEAMLET  
TRANSFORM**Mrs.N.Archana<sup>1</sup>, N.Naga Arjun<sup>2</sup><sup>1</sup> Assistant Professor, Department of ECE, GKM College of Engineering and Technology, Chennai.<sup>2</sup> PG Student, M.E Digital Signal Processing, GKM College of Engineering and Technology, Chennai.

**Abstract:-** Among the image processing techniques used today, the most basic and important one is edge detection. This forms the base of other processes such as object recognition, segmentation etc. For this, many new techniques have been proposed recently, to improve the edge detection process. The method proposed is an advanced algorithm by improving the already existing edge detection algorithms to speed up the object tracking and detection process with the simple and efficient edge detector to reject the non-object-like regions and background, hence reducing the false detection rate in an automatic object tracking and detection system in still images. This proposed algorithm is Multiscale Beamlet Transform edge detection. Beamlet Transform is used to extract edges, ridges and curvilinear objects in digital images. It is a new multi scale transform and it has better accuracy, peak signal to noise ratio and provide more complete edges than Canny and other operators.

**Keywords:** Edge detection, Beamlet transform, Thresholding, Parameters, MATLAB GUI.

**I. INTRODUCTION**

In image processing, the edge is a basic feature of an image. Edges define the boundaries (i.e., connected pixels that lie on the boundary) between regions in an image, which helps in segmentation and object recognition. And, edge detection is the process of detecting the edges of an object in an image, which serves to simplify the analysis of images by drastically reducing the amount of data to be processed, while at the same time preserving useful structural information about object boundaries. Edge detection is a region splitting approach, produces an edge map that contains important information about the image. The memory space required for storage is relatively small, and the original image can be restored easily from its edge map. Many methods have been proposed for edge detection in digital images, and among them, here we use various edge detection methods namely, Sobel, Roberts, Prewitt, Canny and Beamlet, among which the Beamlet is defined to give the better speed in tracking and detecting objects in given image.

**II. EDGE DETECTION**

Edge detection is the name for a set of mathematical methods which aim at identifying points in a digital image at which the image brightness changes sharply or, more formally, has discontinuities. The points at which image brightness changes sharply are typically organized into a set of curved line segments termed edges. The same problem of finding discontinuities in 1D signals is known as step detection and the problem of finding signal discontinuities over time is known as change detection. Edge detection is a fundamental tool in image processing, machine vision and computer vision, particularly in the areas of feature detection and feature extraction.

The edges extracted from a two dimensional image of a three dimensional scene can be classified as either viewpoint dependent or viewpoint independent. A viewpoint independent edge typically reflects inherent properties of the three dimensional objects, such as surface markings and surface shape. A viewpoint dependent edge may change as the viewpoint changes, and typically reflects the geometry of the scene, such as objects occluding one another. The purpose of detecting sharp changes in image brightness is to capture important events and changes in properties of the image.

**III. PROPOSED SYSTEM**

The proposed system uses beamlet transform to improve the accuracy, detection rate and peak signal-to-noise ratio which provide complete edges than the existing system and other edge detectors. Combining beamlet transform with steerable filters, a new edge detection method based on line gradient. Based on line segments with a wide range of scales, locations and orientations, beamlet transform can provide optimally sparse representation for line dominated image. Along with the above mentioned parameters object detection process is also done in the proposed system. Edge detection using beamlet transform contains following stages they shown in Figure.1

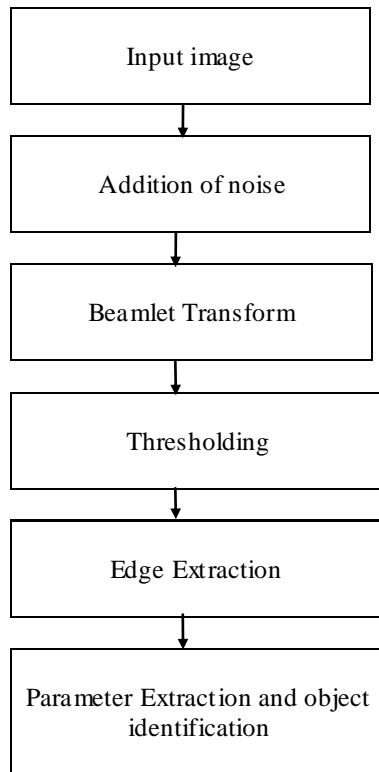


Fig.1. Edge detection using Beamlet Transform

### 3.1. Input image

Here the Lena image is taken for processing with size of 256\*256. The image will be processed to extract the edges present in the image, and to identify the objects present in the image. Instead of Lena image we can use any kind image with different size, elongation, orientation and multiple number of objects

### 3.2. Addition of noise

Gaussian noise is added along the input image for further processing .

#### Gaussian noise

Principal sources of Gaussian noise in digital images arise during acquisition e.g. sensor noise caused by poor illumination and or high temperature, and or transmission e.g. electronic circuit noise. In digital image processing Gaussian noise can be reduced using a spatial filter, though when smoothing an image, an undesirable outcome may result in the blurring of fine-scaled image edges and details because they also correspond to blocked high frequencies. Conventional spatial filtering techniques for noise removal include: mean (convolution) filtering, median filtering and Gaussian smoothing.

Gaussian noise is statistical noise having a probability density function (PDF) equal to that of the normal distribution, which is also known as the Gaussian distribution. In other words, the values that the noise can take on are Gaussian-distributed.

### 3.3. Beamlet transform

It is the collection of all line integrals of the image along beamlets in the beamlet dictionary.

$$T(b) = \int_b f(x(l)) dl, b \in B_E$$

where,

$B_E$  -collection of all beamlets

The main idea of beamlet representation is to approximate linear objects in two dimensions by Multiscale, location and orientation segments which are called beamlets. Manipulate the beamlet co-efficients i.e., keep the coefficient where the coefficient is satisfied the threshold.

## **FRAMEWORK**

- Beamlet dictionary
- Beamlet transform
- Beamlet pyramid
- Beamlet graph
- Beamlet algorithm

### **3.3.1. Beamlet Dictionary**

The beamlet dictionary is a dyadically-organized library of line segments at a range of locations, orientations, and scales, which gives a multiscale approximation to the collection of all line segments.

### **3.3.2. Beamlet Transform**

The beamlet transform is the collection of all line integrals of the image along beamlets in the beamlet dictionary.

### **3.3.3. Beamlet Pyramid**

The beamlet pyramid is the collection of all beamlet transform coefficients, arranged in a data structure with a hierarchical multiscale nature.

### **3.3.4. Beamlet Graph**

The beamlet graph is the graph structure in which vertices correspond to pixel corners in the underlying image and the edges correspond to beamlets joining pairs of such pixel corners.

### **3.3.5. Beamlet Algorithm**

Beamlet Algorithms extract data from the beamlet pyramid in a way driven by the structure of the beamlet graph, for example network flow algorithms, or recursive dyadic partitioning algorithms.

## **3.4. Thresholding**

Thresholding is the very simplest method of image segmentation. From a grayscale image, thresholding can be used to create binary images. This operator selects pixels that have a particular value, or are within a specified range. It can be used to find objects within a picture if their brightness level (or range) is known. This implies that the object's brightness must be known as well.

## **3.5. Edge Extraction**

Digital images have uneven backgrounds, excessive noise, artifacts, poor contrast, out-of-focus regions and intensity fluctuations. Edge extraction is the process of extracting the linear features such as edges, lines and curves from the images with noisy backgrounds to detect the object present in input image.

## **3.6. Parameter Extraction and Object Identification**

Parameter Extraction is the process of obtaining appropriate set of values for the given image. These set of values include, Signal to Noise Ratio, peak Signal to Noise Ratio, Mean Square Error, etc.

Object identification is the process of finding and identifying objects in an image or video sequence. Humans recognize a multitude of objects in images with little effort, despite the fact that the image of the objects may vary somewhat in different viewpoints, in many different sizes and scales or even when they are translated or rotated. Objects can even be recognized when they are partially obstructed from view. This task is still a challenge for computer vision systems.

## **IV. EDGE DETECTION OPERATORS**

### **4.1 .Sobel Operator**

The Sobel operator, sometimes called Sobel Filter, is used in image processing and computer vision, particularly within edge detection algorithms, and creates an image which emphasizes edges and transitions.

### **4.2.Robert Operator**

The Roberts operator performs a simple, quick to compute, 2-D spatial gradient measurement on an image. It thus highlights regions of high spatial gradient which often correspond to edges. In its most common usage, the input to the operator is a greyscale image, as is the output.

### **4.3.Prewitt Operator**

The Prewitt operator is used in **image processing**, particularly within **edge detection** algorithms. Technically, it is a **discrete differentiation operator**, computing an approximation of the **gradient** of the image intensity function.

#### 4.4. Canny Edge Detection

The Canny edge detector is an edge detection operator that uses a multi-stage algorithm to detect a wide range of edges in images. It was formulated with three main objectives:

- optimal detection with no spurious responses
- good localization with minimal distance between detected and true edge position
- single response to eliminate multiple responses to a single edge.

#### 4.5. Beamlet Analysis

The Beamlet analysis was first introduced by Donoho and Huo as a tool for multiscale image analysis. The concept of beamlet analysis deals with the approximation of the linear objects by line segments, as depicted in Figure .2.

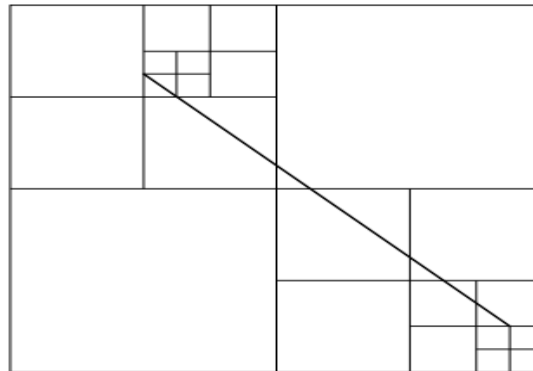


Fig.2. Approximating a Line Segment by Beamlets

Beamlet is a framework for multiscale image analysis in which line segments play a role analogous to the role played by points in wavelet analysis. Beamlet transforms are proven to be insensitive to noise, computationally efficient, and able to detect features with high accuracy. beamlets are a simple dyadically organized collection of all line segments at different locations, orientations, and scales. The beamlet transform is the collection of line integrals along the set of all beamlets.

The beamlet transform is performed in the dyadically partitioned squares of an image. Images are viewed as the continuum square  $[0, 1]^2$  and the pixels as an array of  $1/n$  by  $1/n$  squares arranged in a grid in  $[0, 1]^2$ . The collection of beamlets is a multiscale collection of line segments occurring at a full range of orientations, positions, and scales, as illustrated in Figure 3. It is generated as follows:

##### 4.5.1. Dyadic Subdivision

We form all dyadic sub squares of  $[0, 1]^2$  in the obvious way; to begin we divide the unit square into four sub squares of side length  $1/2$ . Each sub square is then divided into four smaller sub squares, and so on. Figure shows some sub squares after 0, 1, 2 or 3 steps of subdivision.

##### 4.5.2. Vertex Labelling

For deniteness, think of as  $1/n$ , although in certain applications should be far smaller. Traversing the boundary of each subsquare, we mark out equally spaced vertices at spacing .

##### 4.5.3. Connect the Dots

In each subsquare, form the collection of all line segments connecting any pair of vertices. Any such line segment is called a beamlet.

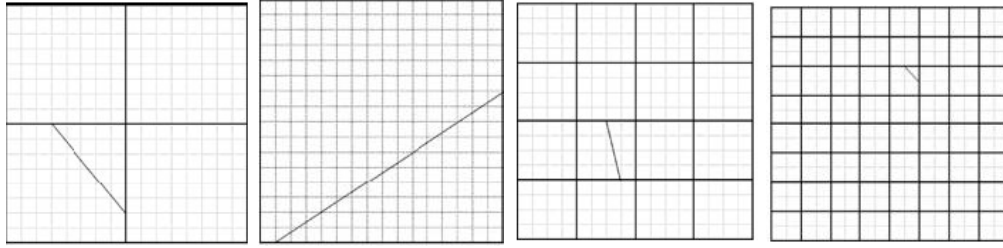


Fig.3. Four Beamlets at various scales, location and orientation.

## V. PARAMETER REQUIREMENTS

### 5.1. Structural Similarity index

The structural similarity (SSIM) index is a method for measuring the similarity between two images. The SSIM index is a full reference metric; in other words, the measuring of image quality based on an initial uncompressed or distortion-free image as reference. SSIM is designed to improve on traditional methods like peak signal-to-noise ratio (PSNR) and mean squared error (MSE).

The difference with respect to other techniques mentioned previously such as MSE or PSNR is that these approaches estimate perceived errors, on the other hand, SSIM considers image degradation as perceived change in structural information. Structural information is the idea that the pixels have strong inter-dependencies especially when they are spatially close. These dependencies carry important information about the structure of the objects in the visual scene.

The SSIM metric is calculated on various windows of an image. The measure between two windows  $x$  and  $y$  of common size  $N \times N$  is:

$$SSIM(x, y) = \frac{(2\mu_x\mu_y + c_1)(2\sigma_{xy} + c_2)}{(\mu_x^2 + \mu_y^2 + c_1)(\sigma_x^2 + \sigma_y^2 + c_2)}$$

with

$\mu_x$  the average of  $x$ ;

$\mu_y$  the average of  $y$ ;

$\sigma_x^2$  the variance of  $x$ ;

$\sigma_y^2$  the variance of  $y$ ;

$\sigma_{xy}$  the covariance of  $x$  and  $y$ ;

$c_1 = (k_1 L)^2$ ,  $c_2 = (k_2 L)^2$  two variables to stabilize the division with weak denominator

### 5.2. Signal to Noise Ratio

Signal-to-noise ratio is defined as the power ratio between a signal (meaningful information) and the background noise (unwanted signal):

$$SNR = \frac{P_{signal}}{P_{noise}}$$

where

$P$  is average power.

SNRs are often expressed using the logarithmic decibel scale. In decibels, the SNR is defined as

$$SNR = 10 \log_{10} \left( \frac{P_{signal}}{P_{noise}} \right) = P_{signal\text{dB}} - P_{noise\text{dB}}$$

### 5.3. Mean Squared Error

The mean squared error (MSE) of an estimator measures the average of the squares of the “errors”, that is, the difference between the estimator and what is estimated. MSE is a risk function, corresponding to the expected value of the squared error loss or quadratic loss. MSE is defined as,

$$MSE = \frac{1}{mn} \sum_{i=0}^{m-1} \sum_{j=0}^{n-1} [I(i, j) - K(i, j)]^2$$

Where,

$I(i,j)$  - Noise free image

$K(i,j)$  - Noisy image

#### 5.4. Peak Signal to Noise Ratio

Peak signal-to-noise ratio, it is defined as the ratio between the maximum possible power of a signal and the power of corrupting noise that affects the fidelity of its representation.

The PSNR (in dB) is defined as:

$$PSNR = 10 \log_{10} \left( \frac{MAX_I^2}{MSE} \right)$$

Here,  $MAX_I$  is the maximum possible pixel value of the image.

## VI. RESULTS

The Beamlet transform and other Image edge detection algorithms are implemented by using MATLAB GUI.

#### Graphical User Interface

A graphical user interface (GUI) is a graphical display in one or more windows containing controls, called components, that enable a user to perform interactive tasks. The user of the GUI does not have to create a script or type commands at the command line to accomplish the tasks. Unlike coding programs to accomplish tasks, the user of a GUI need not understand the details of how the tasks are performed. GUI components can include menus, toolbars, push buttons, radio buttons, list boxes, and sliders, just to name a few. GUIs created using MATLAB tools can also perform any type of computation, read and write data files, communicate with other GUIs, and display data as tables or as plots.

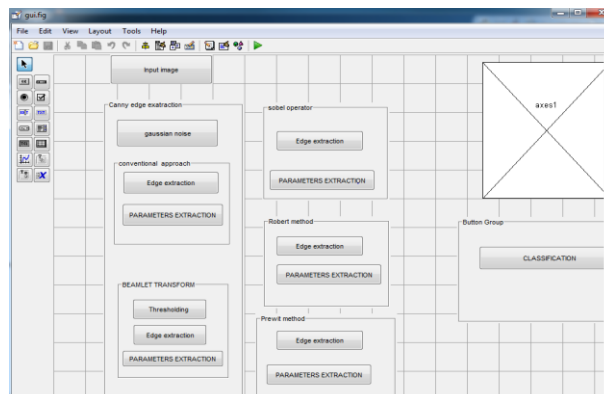


Fig.4. GUI View



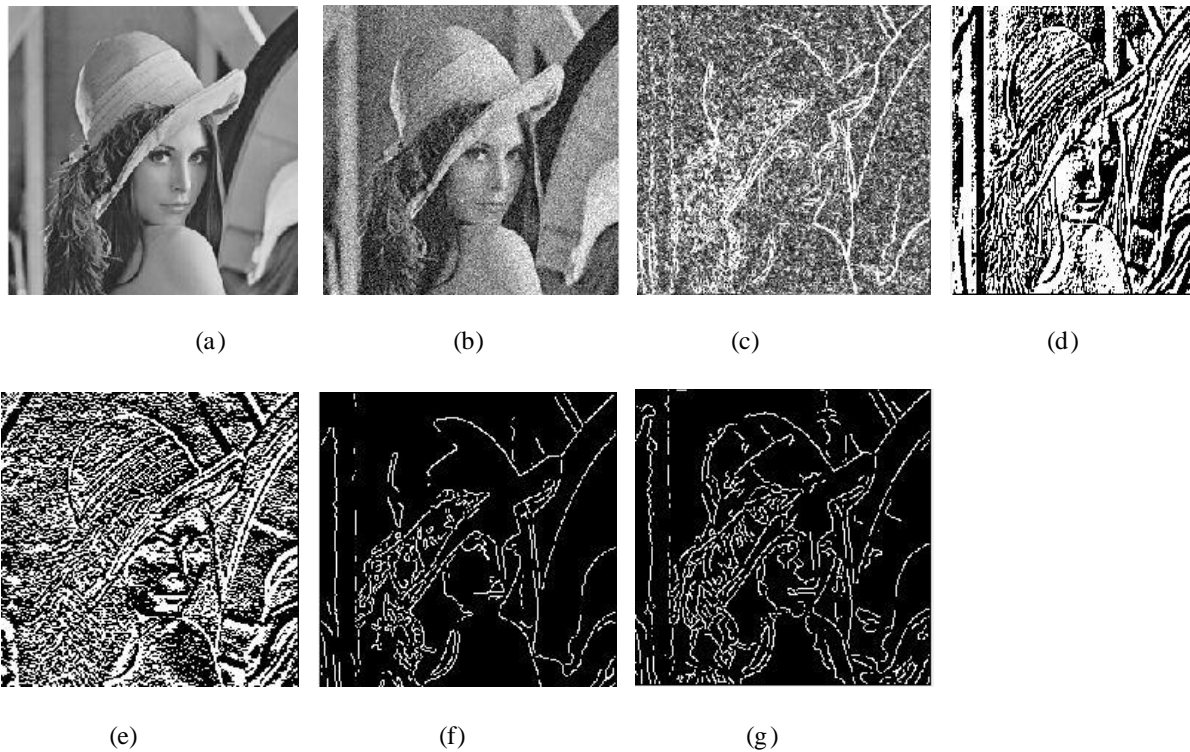


Fig.5. (a)Input image (b)Noisy image (c)Edge Extraction by sobel operator (d) Edge Extraction by prewitt operator (e)Edge Extraction by Robert operator (f) Edge Extraction by Canny operator (g) Edge Extraction by Beamlet Transform

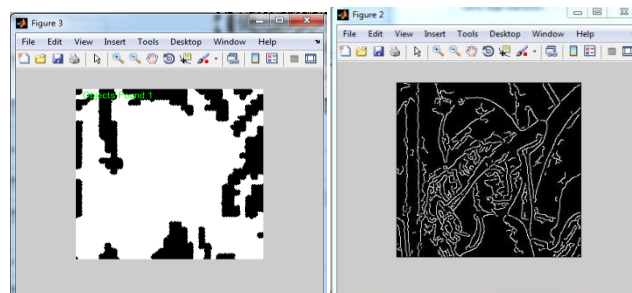


Fig.6. Object identification

**TABLE I: COMPARISON OF DIFFERENT EDGE DETECTION PARAMETER**

Edge Operator	Elapsed time	MSE	SNR	PSNR	SSIM
Sobel	2.760	0.291	26.862	33.489	0.963
Robert	0.191	0.286	28.932	39.559	0.935
Prewitt	0.162	0.292	37.849	43.476	0.912
Canny	5.427	0.308	53.101	67.728	0.099
Beamlet	0.038	0.271	68.176	79.797	0.971

## **VII. CONCLUSION AND FUTURE WORK**

Based on line segments with a wide range of scales, locations and orientations, beamlet transform can provide optimally sparse representation for line dominated image. This project proposes a new approach for edge detection combining beamlet transform with steerable filters, which achieves more speed, higher signal to noise ratio and position accuracy etc, when compared with other edge detectors.

These all the parameter results of beamlet transform and other edge detection will be loaded in the Digital Signal Processing Starter kit in the future and the experiment results can prove that edge detection of beamlet transform could be achieved in a more efficient way.

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