



International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 11, November 2016

Relative Study of Image Processing Filters with MATLAB, SCILAB and Raspberry Pi

Arti Utikar, Vinita Yerande

Assistant Professor, Dept. of Instrumentation & Control, D. Y. P. C. O. E. Akurdi, Pune, Maharashtra, India

ABSTRACT: This paper serves as an introduction to image processing using MATLAB, SciLab, Raspberry Pi. Now a day's image processing is very emerging trend. Edge is sudden changes of discontinuities in an image. Edge detection is image processing technique for finding the boundaries of objects within images. It is used for image segmentation and data extraction in areas such as image processing, computer vision, and machine vision. For which MATLAB is mostly preferred. But instead of MATLAB, SciLab, Raspberry Pi are the better options, as SciLab is easily available as open source & Raspberry Pi is a basic embedded system having low cost single board using python language. In this paper several methods of edge detection such as Canny, Sobel, Laplacian are implemented & tested on MATLAB, SciLab, Raspberry Pi. The Sobel operator is used to find the approximate absolute gradient magnitude at each point in an input gray-scale image. The Canny operator is to design an optimal edge detector. It shows the positions of tracked intensity discontinuities. Laplacian of an image means taking its double derivative in both directions(x & y).

KEYWORDS: MATLAB, SciLab, Raspberry Pi, Image Processing, edge detection

I. INTRODUCTION

Many softwares can be used for image processing. Three of them are discussed here. Those are MATLAB, SciLab, Raspberry Pi.

Matlab

Matlab (matrix laboratory) is a multi-paradigm numerical computing environment which allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages, including C, C++, C#, Java, Fortran and Python. It is developed by Mathworks.

Although Matlab[7] is intended primarily for numerical computing, an optional toolbox uses the MuPAD symbolic engine, allowing access to symbolic computing abilities. An additional package, Simulink, adds graphical multi-domain simulation and model-based design for dynamic and embedded systems.

In 2004, Matlab had around one million users across industry and academia. Matlab users come from various backgrounds of engineering, science, and economics.

Scilab

Scilab[6] is free and open source software for numerical computation providing a powerful computing environment for engineering and scientific applications. It is a programming language/development environment developed for mathematical programming, and in particular working with matrices. It is basically an open source version of Matlab, a commercial product for the same process. For this reason Scilab is a perfect fit for image processing, as most image processing problems reduce to matrix manipulation. Scilab[4] is also relatively easy to use, and its development environment makes it ideal for prototyping.

Raspberry Pi

The main signal processing chip unit used in Raspberry Pi system is a Broadcom 2835 700MHz Chip in which CPU core is a 32 bit ARM1176JZF-S RISC processor[1] designed by Advanced RISC Machines. This main processing chip connects a camera and display. The Raspberry Pi design does not include a built in hard disk or solid state drive, instead used an SD card for booting and long term storage. This board is intended to run Linux Debian based operating

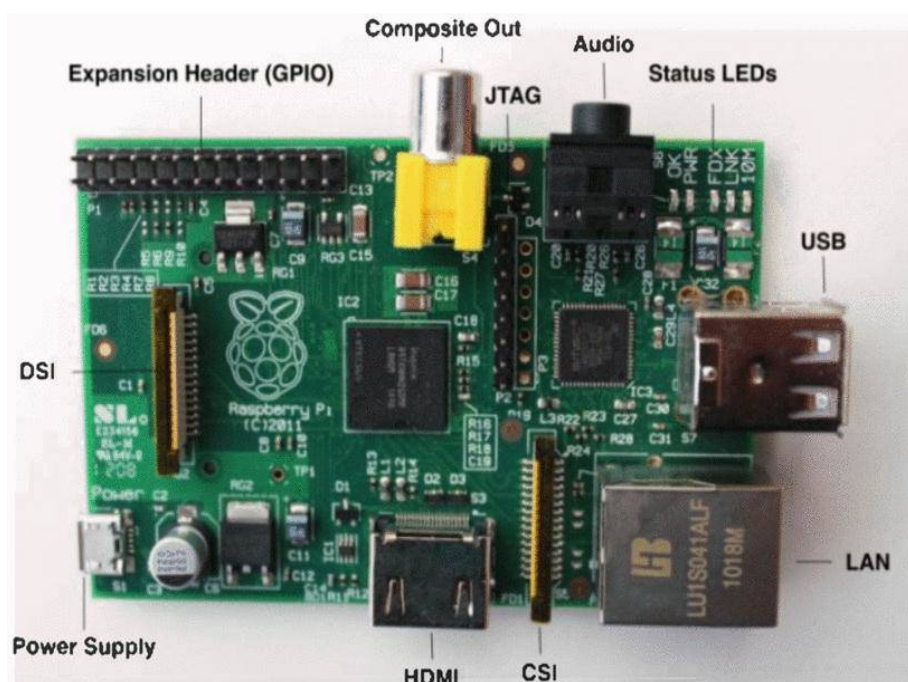
International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 11, November 2016

systems. This Raspberry Pi[2] module has a Samsung class 4 micro SD card preloaded with the Raspberry Pi NOOBS (New Out of Box Software) package, and a printed Micro SD card adaptor

The Raspberry Pi platform originally intended for educational purposes has become famous immediately after its introduction in 2012. The next-generation Raspberry Pi 2 (RPi2 hereinafter)[2] was released in 2015 when almost six million Raspberry Pi of the first generation have been already sold. The second generation is based on the Broadcom BCM2836 system on a chip with a quad-core ARM Cortex-A7 processor and a Video Core IV dual-core GPU with 1 GB of RAM.



II RELATED WORK

In [1] authors showcased the attempt to realize the algorithms based on image processing for different applications. The work is developed in Raspberry pi development board with python 2.7.3 and Open CV 2.3.1 platform. The result shows for the fully automated without any user intervention. The prime focus is on python image library (PIL) in addition to numpy, scipy, and matplotlib form a powerful platform for scientific computing. In [2] authors considered an ARM processor-based small open-source computer that is rapidly gaining popularity among hobbyists and researchers alike for its ease of use, versatile capabilities, and surprisingly low cost in spite of good build and support quality. In [3] the authors proposes solution capable to process aerial images from UAVs to identify failures in plantations and makes a comparison of the system running on light sized computers and low power computing platforms. An algorithm was developed based on watersheds using Open CV library. In [4] the objective of this book is to provide a tutorial for the use of Scilab/Scicos with a special emphasis on modelling and simulation tools. While it will provide useful information to experienced users, it is designed to be accessible to beginning users from a variety of disciplines. In [5] this paper the important problem is to understand the fundamental concepts of various filters and apply these filters in identifying a shark fish type which is taken as a case study. In this paper the edge detection techniques are taken for consideration. The software is implemented using MATLAB. In [6], the goal of authors is to present the core of skills necessary to start with Scilab. In the first part, authors present how to get and install this software on our computer. They also present how to get some help with the provided in-line documentation and also thanks to web resources and forums. In the remaining sections, they present the Scilab language, especially its structured programming features. They present an important feature of Scilab, that is the management of real matrices and overview the linear algebra library. This book [7] teaches MATLAB as a technical programming language,



International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 11, November 2016

showing students how to write clean, efficient, and documented programs. It makes no pretence at being a complete description of all of MATLAB's hundreds of functions. Instead, it teaches the student how to use MATLAB as a computer language and how to locate any desired function with MATLAB's extensive on-line help facilities. In [8] discuss the mathematical theorems and algorithms used in image processing. Digital Image Processing is the use of computer algorithms to perform image processing on digital images. Since the use of complex algorithms are allowed, digital image processing can order both more sophisticated performance at simple tasks, and the implementation of methods which would be impossible by analog means. The paper [9] gives the introduction of the edge-detection technique for image segmentation and its purpose also provides basics of edge-detection method & includes various steps of edge-detection method, with description of different approaches to implement edge-detection. In this paper, [10] 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. In this paper [11] authors discuss about the extraction of a digital image edge using different digital image processing techniques. Edge detection is the most common technique for detecting discontinuities in intensity values. The input image or actual image have some noise that may cause the of quality of the digital image. In this paper [12] after a brief introduction, overview of different edge detection techniques like differential operator method such as sobel operator, prewitt's technique, Canny technique and morphological edge detection technique are given.

III. BASIC CONCEPT

Image Processing:

In imaging science, Image Processing is processing of images using mathematical operations in matrix form by using any form of signal processing for which the input is an image, a series of images, or a video, such as a photograph or video frame; the output of image processing may be either an image or a set of characteristics or parameters related to the image. Most image-processing techniques involve treating the image as a two-dimensional signal and applying standard signal-processing techniques to it. Images are also processed as three-dimensional signals where the third-dimension being time or the z-axis.

Image processing [3] usually refers to digital image processing, but optical and analog image processing also are possible. This article is about general techniques that apply to all of them. The acquisition of images (producing the input image in the first place) also describing features, intensity values, pixel values is referred as imaging.

Closely related to image processing are computer graphics and computer vision. In computer graphics, images are manually made from physical models of objects, environments, and lighting, instead of being acquired (via imaging devices such as cameras) from natural scenes, as in most animated movies. Computer vision, on the other hand, is often considered high-level image processing out of which a machine/computer/software intends to decipher the physical contents of an image or a sequence of images (e.g., videos or 3D full-body magnetic resonance scans).

Also in biomedical field it is required to get exact location & dimension of cancer cells or any other abnormality through images.

IV. METHODOLOGY OF EDGE DETECTION

Edges characterize boundaries and are therefore a problem of fundamental importance in image processing [3]. Image Edge detection significantly reduces the amount of data and filters out useless information, while preserving the important structural properties in an image. Since edge detection is in the forefront of image processing for object detection, it is crucial to have a good understanding of edge detection algorithms.

Edge detection [5] refers to the process of identifying and locating sharp discontinuities in an image. The discontinuities are abrupt changes in pixel intensity which characterize boundaries of objects in a scene. Classical methods of edge detection involve convolving the image with an operator (a 2-D filter) [12], which is constructed to be sensitive to large gradients in the image while returning values of zero in uniform regions. There are an extremely large number of edge detection operators available, each designed to be sensitive to certain types of edges. Variables



International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 11, November 2016

involved in the selection of an edge detection operator include Edge orientation, Noise environment and Edge structure. The geometry of the operator determines a characteristic direction in which it is most sensitive to edges. Operators can be optimized to look for horizontal, vertical, or diagonal edges. Edge detection is difficult in noisy images, since both the noise and the edges contain high frequency content. Attempts to reduce the noise result in blurred and distorted edges. Operators used on noisy images are typically larger in scope, so they can average enough data to discount localized noisy pixels. This results in less accurate localization of the detected edges. Not all edges involve a step change in intensity. Effects such as refraction or poor focus can result in objects with boundaries defined by a gradual change in intensity. The operator needs to be chosen to be responsive to such a gradual change in those cases. So, there are problems of false edge detection, missing true edges, edge localization [11], high computational time and problems due to noise etc. Therefore, the objective is to do the comparison of various edge detection techniques and analyze the performance of the various techniques in different conditions. There are many ways to perform edge detection. However, the majority of different methods may be grouped into two categories: Gradient based Edge Detection: The gradient [5] method detects the edges by looking for the maximum and minimum in the first derivative of the image.

1. Sobel Operator

The operator consists of a pair of 3×3 convolution kernels [10]. One kernel is simply the other rotated by 90° . 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 G_x and G_y). 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: $G = \sqrt{G_x^2 + G_y^2}$ Typically, an approximate magnitude is computed using: $G = |G_x| + |G_y|$ 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: $\theta = \arctan(G_y / G_x)$.

2. Canny Filter

The Canny edge detection algorithm [5] is known to many as the optimal edge detector. The first and most obvious is low error rate. It is important that edges occurring in images should not be missed and that there be no responses to non-edges. The second criterion is that the edge points be well localized. In other words, the distance between the edge pixels as found by the detector and the actual edge is to be at a minimum. A third criterion is to have only one response to a single edge. This was implemented because the first two were not substantial enough to completely eliminate the possibility of multiple responses to an edge. Based on these criteria, the canny edge detector first smooths the image to eliminate noise. It then finds the image gradient to highlight regions with high spatial derivatives. The algorithm then tracks along these regions and suppresses any pixel that is not at the maximum (non maximum suppression). The gradient array is now further reduced by hysteresis. Hysteresis [9] is used to track along the remaining pixels that have not been suppressed. Hysteresis uses two thresholds and if the magnitude is below the first threshold, it is set to zero (made a non edge). If the magnitude is above the high threshold, it is made an edge. And if the magnitude is between the 2 thresholds, then it is set to zero unless there is a path from this pixel to a pixel with a gradient above T_2 .

3. Laplacian of Gaussian

The Laplacian method searches for zero crossings in the second derivative of the image to find edges. An edge has the one-dimensional shape of a ramp and calculating the derivative of the image can highlight its location. Suppose we have the following signal, with an edge [5] shown by the jump in intensity below: Suppose we have the following signal, with an edge shown by the jump in intensity below: If we take the gradient of this signal (which, in one dimension, is just the first derivative with respect to t) we get the following: Clearly, the derivative shows a maximum located at the center of the edge in the original signal. This method of locating an edge is characteristic of the "gradient filter" family of edge detection filters and includes the Sobel [8] method. A pixel location is declared an edge location if the value of the gradient exceeds some threshold. As mentioned before, edges will have higher pixel intensity values than those surrounding it. So once a threshold is set, you can compare the gradient value to the threshold value and detect an edge whenever the threshold is exceeded. Furthermore, when the first derivative is at a maximum, the second derivative is zero.

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 11, November 2016

V. RESULT

One sample image is processed for Sobel, Canny, Laplacian filters through Matlab, Scilab, Raspberry Pi. Results are obtained after application of algorithms through all 3 filters.

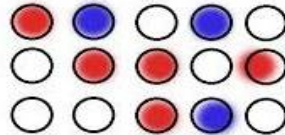


Fig:- Sample Image

Images of Matlab:

When the sample image is processed with Matlab, the output is drawn as shown in figure below

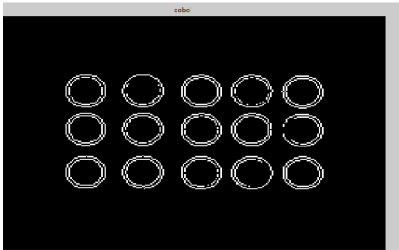


Fig:- Sobel

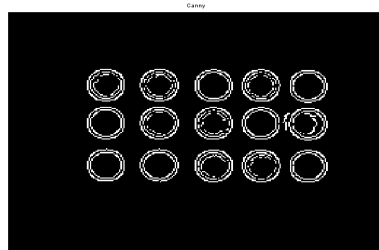


Fig:- Canny

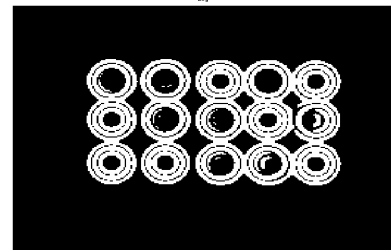


Fig:- Laplacian

Images of scilab:

When the sample image is fed to Scilab, the output carried out is as below:

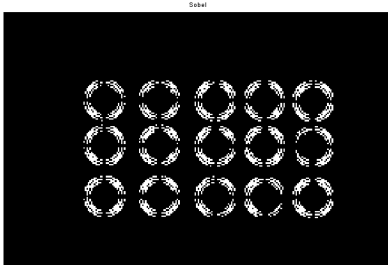


Fig:- Sobel

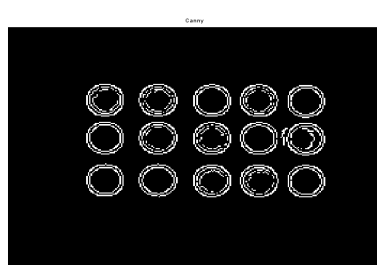


Fig:- Canny

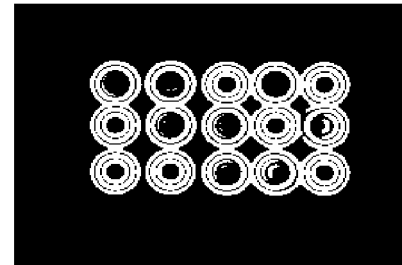


Fig:- Laplacian

Images of Raspberry Pi:

When the sample image is given to Raspberry Pi processor, the output carried out is as below:

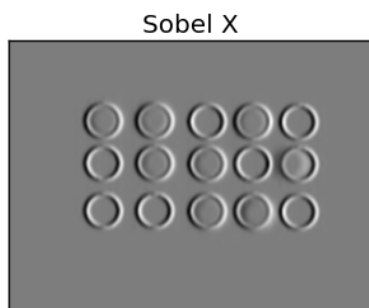


Fig:- Sobel

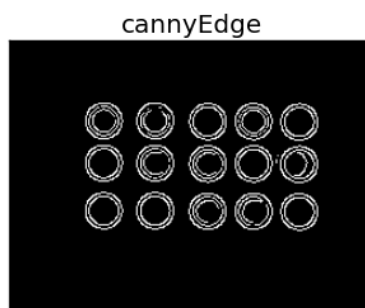


Fig:- Canny

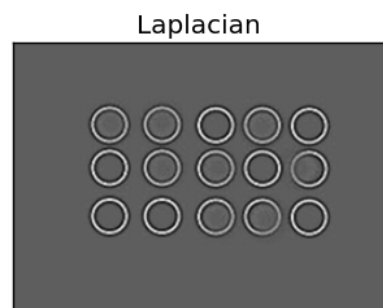


Fig:- Laplacian



International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 11, November 2016

VI. CONCLUSION

From all above resultant images, it can be concluded that there will be no loss of information from image if we use Scilab or Raspberry Pi instead of Matlab. As Matlab is not open source, it is costly & complicated to handle compared with Scilab and Raspberry pi. Scilab is open source and easy to handle with all tools (SIV, SIVP, IPD). Raspberry Pi is Compact in size, low cost, linux operated, and user friendly processor. Image capturing tools like camera can be installed easily. It is effective for real time application. Raspberry Pi gives portable instrument. Thus Scilab & Raspberry pi can be used instead of Matlab.

REFERENCES

- 1) Mrutyunjaya Sahani and Mihir Narayan Mohanty, "Realization of Different Algorithms Using Raspberry Pi for Real-Time Image Processing Application", Springer India 2015, L.C. Jain et al. (eds.), Intelligent Computing, Communication and Devices, Advances in Intelligent Systems and Computing 309, DOI 10.1007/978-81-322-2009-1_53
- 2) Samarth Brahmabhatt, "Embedded Computer Vision: Running Open CV Programs on the Raspberry Pi", Book, Springer
- 3) Jonas Fernandes da Silva, Alisson V. Brito, José Antônio Gomes de Lima, Helder Nogueira de Moura Reintegris, "An Embedded System for Aerial Image Processing from Unmanned Aerial Vehicles", 2015 Brazilian Symposium on Computing Systems Engineering
- 4) Stephen L. Campbell, Jean-Philippe Chancelier and Ramine Nikoukhah "Modeling and Simulation in Scilab/Scicos", 2006 Springer Science + Business Media, Inc.
- 5) 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
- 6) Maichel Baudin, "Introduction To Scilab", www.Scilab.org
- 7) Stephen J. Chapman "MATLAB Programming for Engineers" November 1st 2007 by Thomson Learning
- 8) Debosmit Ray, "Edge Detection in Digital Image Processing", June 06, 2013.
- 9) Sonam Saluja , Aradhana Kumari Singh , Sonu Agrawal, "A Study of Edge-Detection Methods", International Journal of Advanced Research in Computer and Communication Engineering Vol. 2, Issue 1, January 2013
- 10) 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 2010
- 11) M. Kalpana, G. Kishorebabu, K.Sujatha, "Extraction of Edge Detection Using Digital Image Processing Techniques", International Journal Of Computational Engineering Research (ijceronline.com) Vol. 2 Issue.5
- 12) Pooja Sharma,Gurpreet Singh, Amandeep Kaur, "Different Techniques Of Edge Detection In Digital Image Processing", International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 , Vol. 3, Issue 3, May-Jun 2013, pp.458-461

BIOGRAPHY

Arti Utikar currently works as an assistant professor at D. Y. Patil College of Engg., Akurdi. She had completed her ME (Biomedical Instrumentation) from Pune University.

Vinita Yerande currently works as an assistant professor at D. Y. Patil College of Engg., Akurdi. She had completed her MTech(Process Instrumentation) from SRTMU University.