[Sankar, 4(11): November 2017]
DOI- 10.5281/zenodo.1040754

ISSN 2348 – 8034
Impact Factor- 4.022

GLOBAL JOURNAL OF ENGINEERING SCIENCE AND RESEARCHES

CLASSIFICATION OF BLEEDING AND NON-BLEEDING REGIONS IN WIRELESS CAPSULE ENDOSCOPY VIDEOS USING ARTIFICIAL NEURAL NETWORK

Sree Sankar.J*
*Assistant Professor, Dept. of ECE, James College of Engineering and Technology, Kanya Kumari dist, Tamil nadu

ABSTRACT

Wireless Capsule Endoscopy is a technology used to examine and view the gastro intestinal tract. A methodology for the detection of bleeding and non-bleeding regions is proposed here. The edge regions are first detected and then removed before identifying the bleeding regions. The edge and the bleeding regions have the same hue value and also the bleeding and non-bleeding regions have same luminance. The canny edge detection algorithm is used to detect edges since it have the ability to detect more edge pixels and preserves more bleeding regions. After the edge detection the regions are segmented by using super-pixel segmentation. Here Statistical features and Texture features are extracted from Gray Level Co-occurrence Matrix. Finally the bleeding and non-bleeding regions are classified by using the Artificial Neural Networks.

Keywords: Wireless Capsule Endoscopy, Canny edge detection algorithm, Super-pixel segmentation, Artificial Neural Networks, Gray Level Co-occurrence Matrix

I. INTRODUCTION

Bleeding that occurs in the gastrointestinal tract is known as gastrointestinal bleeding or gastrointestinal hemorrhage. The signs and symptoms of the gastrointestinal bleeding can range from small non-visible amounts to massive bleeding. When there exist significant amount of bleeding in the gastrointestinal tract the symptoms includes vomiting black blood, vomiting red blood, black stool and bloody stool. Other symptoms include feeling tired, dizziness, pale skin appearance, shortness of breath and abdominal pain. When there exist small amount of bleeding then no symptoms are shown.

Wireless Capsule Endoscopy (WCE) was introduced by Given Imaging Ltd. in the year 2000. It is a standard imaging technology used for viewing the Gastro Intestinal (GI) tract. The Given Imaging Ltd. developed a suspected blood indicator that is capable of detecting the active bleeding regions in the small intestine and also this software is having insufficient sensitivity and specificity.

The Wireless Capsule Endoscopy technology uses a wireless capsule. The capsule endoscope provides a simple, safe and reliable procedure which avoids sedation, surgery or exposure to radiation. For increasing the speed and performance the computer aided detection technologies are employed. Here the WCE images are captured using SB pill cam. The capsule endoscope is a disposable, small and swallow able device, which is only 26mm x 11mm and weighs 3.7 gram in measurement. It consists of an optical dome, lens holder, lens, illuminating LEDs, CMOS imager, battery, transmitter and Antenna.

II. PROPOSED METHODOLOGY

The detection of abdominal bleeding regions from the Wireless Endoscopy videos requires various image processing techniques. These techniques are described in this section. The figure 2(a) shows the proposed block diagram for the abdominal bleeding classification in Wireless Endoscopy Videos.

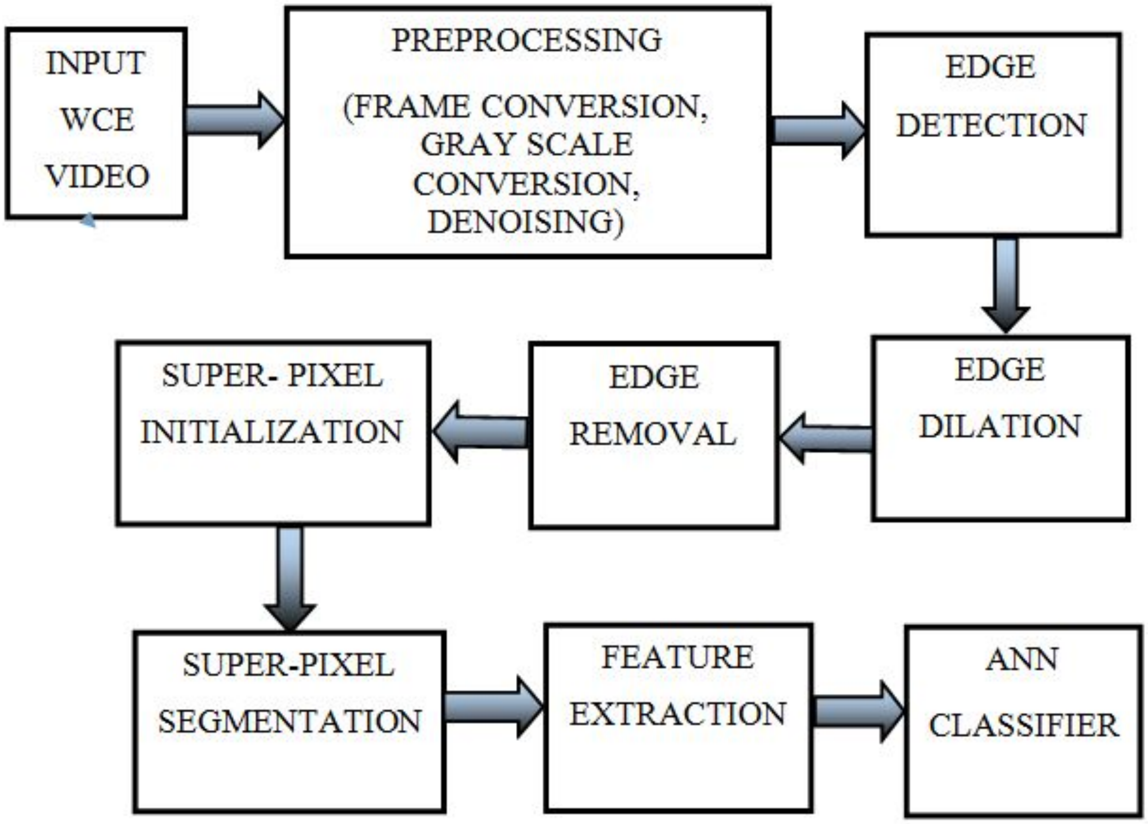

Figure 2 (a) Proposed block diagram for abdominal bleeding detection

(a) Preprocessing

The input video is the Wireless Capsule Endoscopy video that contains the relevant information about the bleeding portions present in the gastrointestinal tract. Preprocessing is firstly performed for the effective extraction of the bleeding regions in the gastrointestinal tract. Preprocessing mainly consist of three processes: Frame conversion, Gray scale conversion and Denoising. The first process in preprocessing is the frame conversion. Here the input video is converted into a number of frames. The number of frames obtained will depend on the input video. The next process in preprocessing is the gray scale conversion of the frames. Gray scale conversion is a necessary procedure for the extraction of features. The third step in the preprocessing is denoising of the WCE frames. The WCE images contain the presence of noise. The process of removal of noises is known as denoising. Here the median filter is used for the removal of noises.

(b) Edge Detection

For the effective identification of bleeding region the concept of edge pixels are considered. Edges are the region where the intensity varies. The Edge regions are also the boundary regions where the intensity differs. Before the detection of edge regions the input WCE images are converted from RGB to CIELab space. This color space has three components: L, a and b. here L indicates the luminance, brightness or intensity and a and b indicates red / blue and yellow / blue chrominance respectively. Normally in a WCE image the edge pixels and the bleeding pixels share almost similar hue, which indicates the original wavelength of the color. Here the color is RED color. The RED intensities of the edge regions are somewhat similar to the bleeding regions. The traditional algorithms make mistakes often by considering the edge pixels for bleeding pixels. The most distinguishable features between the edge pixels and the non-bleeding pixels are the luminance. The bleeding pixels and the non-bleeding pixels, except the edge pixels, normally have similar luminance and differ in redness. Thus the bleeding pixels cannot be removed.

So the edge regions are detected initially and are dilated using morphological techniques and are subsequently removed through masking. The edge pixels are detected using the Canny edge detection algorithm.

The various steps used in the Canny edge detection algorithm is as follows:
Step 1: In order to reduce the noise, firstly a Gaussian filter is applied to the image.
Step 2: Determine the intensity gradient of the image.

$$G = \sqrt{(Gx^2+Gy^2)} \quad (1)$$

$$\Theta = \text{atan2}(Gy, Gx) \quad (2)$$

Where Gx is the intensity gradient along the horizontal direction and Gy is the intensity gradient along the vertical direction.
Step 3: In order to get rid of the spurious response to the edge detection apply a non-maximum suppression.
Step 4: Finally detect the edges by suppressing all other edges that are weak and are not connected to strong edges.

(c) Edge Dilation

After the edge detection using canny edge detection algorithm, the edge dilation is performed. Here the regions are dilated by using mathematical morphological method. Two set of input is essential for the edge dilation. Consider A is the image to be dilated and B is a set of coordinate points known as structuring element.

$$A \quad B = \{z \mid B z \cap A| = \varphi\} \quad (3)$$

The above mentioned equation (3) is based on the reflection of B about its origin and shifting this reflection by z.

(d) Edge Removal

After edge dilation the edge removal is performed. Here the edges are removed through masking. The edge removal algorithm is given as follows:
Step 1: Conversion of WCE image from RGB to CIELab space for the L channel.
Step 2: Detection of the edge regions using Canny edge detection algorithm.
Step 3: Perform edge dilation using the mathematical morphological method.
Step 4: Finally locate the edge regions through masking. The intensities of the edge pixels are set to zero.

(e) Super-pixel Initialization

Before the super-pixel segmentation procedure super-pixel initialization is carried out. The initialization is a grid in which the super pixels are equally distributed throughout the width and height of the image. Here the larger blocks corresponds to the super-pixel size and the levels with smaller blocks are formed by dividing the larger blocks into 2 x 2 blocks of pixels in a recursive manner until the smaller block level. Basically the super-pixel initialization procedure involves two steps. Firstly the edge removed image is superimposed with the input WCE image. In some cases the edge removed regions contains the bleeding regions and are least visible in nature. In order to get more clearer regions those images are superimposed. Secondly the initialization is done to label those regions.

(f) Super-pixel Segmentation

Super-pixel segmentation means the segmentation of a region into similar pixels. The main advantages of super-pixel segmentation is that it avoids complexity and under segmentation. The super pixel algorithm groups pixels into meaningful atomic regions which can be utilized to replace the rigid structure of the pixel grid. Here Simple Linear Iterative Clustering (SLIC), which adapts K-means clustering, is used to generate super pixels.

(g) Feature Extraction

Basically a feature can be defined as a function of one or more measurements, each of which specifies some quantifiable property of an image. The features are calculated in such a way that it quantifies some important characteristics of that particular image. All the features can be classified as low level features and high level features. The low level features are directly extracted from the original images whereas the High level features are extracted based on the low level features.

A well known statistical approach called Gray Level Co-occurrence Matrix (GLCM) is used here for feature extraction. GLCM is an established tool for characterizing the spatial distribution of gray levels in an image. GLCM is characterized by two parameters; first one is the relative distance which is measured in pixel number and the second one is the orientation, where the directions are 0^0, 45^0, 90^0 and 135^0 along the horizontal, diagonal, vertical and anti-diagonal directions. Here fourteen features are being extracted from the GLCM matrix. The fourteen features include both the statistical features as well as texture features. The eight Statistical features extracted here are mean, variance, skewness, kurtosis, median, mode, moment and correlation. The six Texture features extracted are contrast, energy, entropy, local homogeneity, cluster shade and cluster prominence.

(h) Artificial Neural Network Classifier

Artificial Neural Network (ANN) is used for the detection of bleeding regions and non bleeding regions. ANN classifier is having two phases: Training phase and Testing phase. Here for ANN training Radial Bias Function (RBF) Network is used. The RBF networks are feed forward networks. The usage of RBF networks has several advantages. They usually train much faster than the back propagation networks. The RBF networks are less susceptible to the problems arises with non-stationary inputs. This is due to the behavior of the radial basis functions of the hidden layers. The extracted 14 features are given as input to the RBF network. Here the RBF network consists of 14 features as inputs, 20 hidden layers with proper activator and weight function and a single output layer.

III. EXPIRIMENTAL RESULTS

This section deals with the results obtained. The Bleeding regions from a WCE video are detected using different processes that are mentioned above. The results obtained for those processes are shown below.

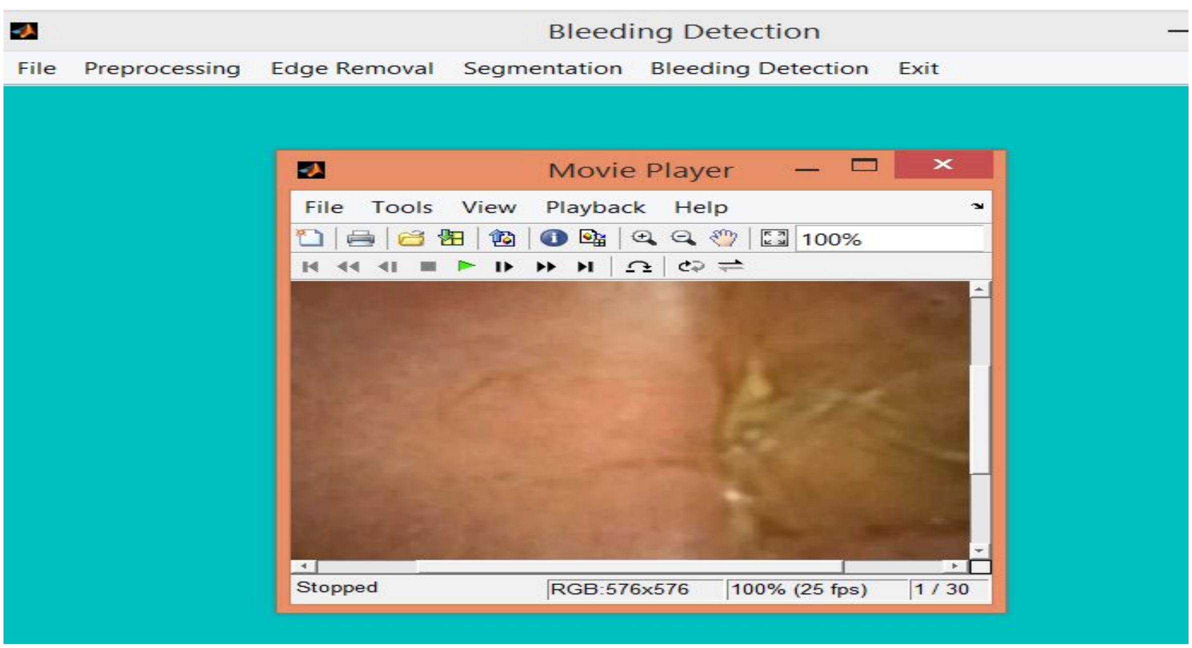

Figure 3 (a) WCE Input Video file

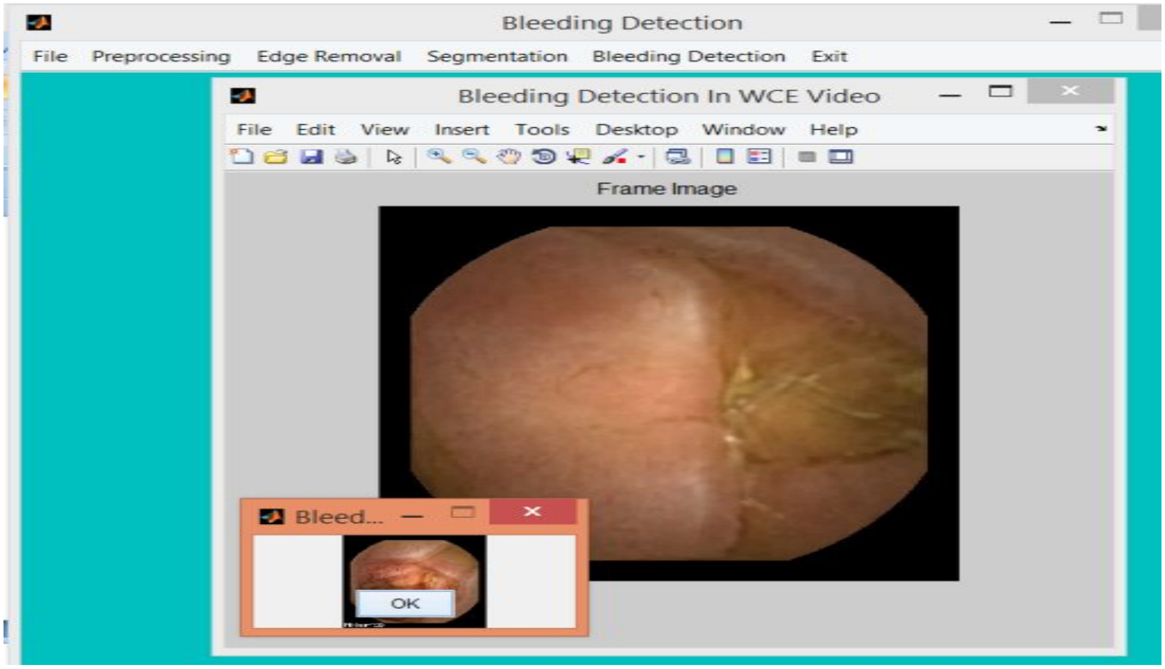

Figure 3(b) Frame Image

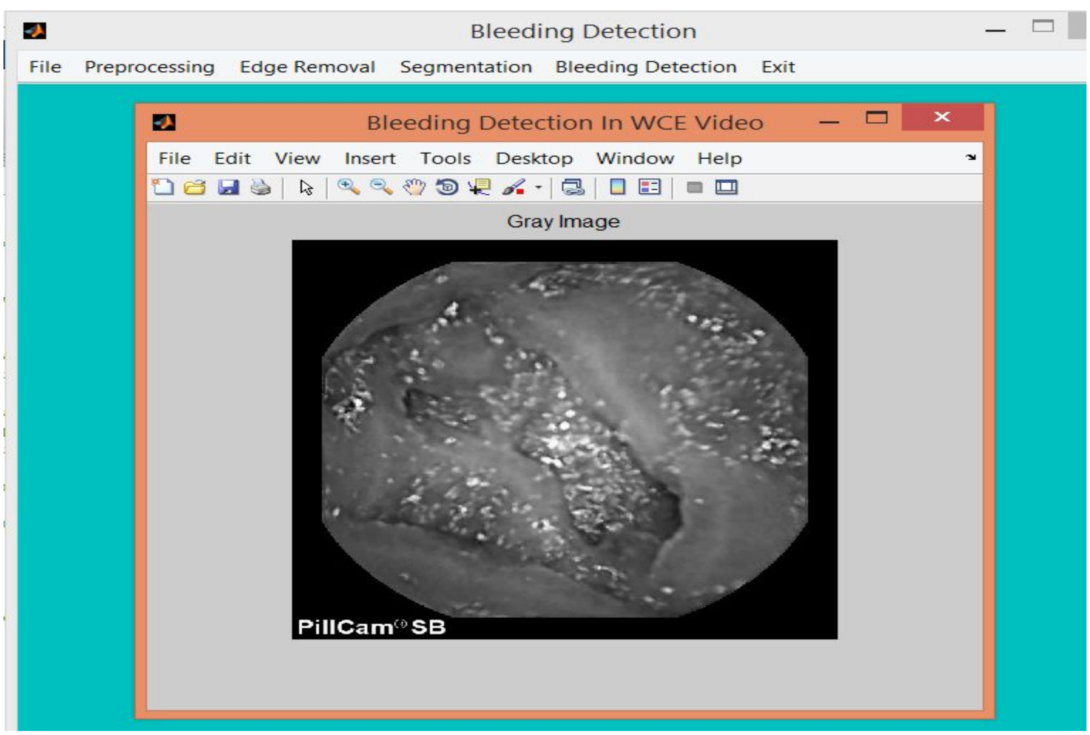

Figure 3 (c) Gray Scale Image

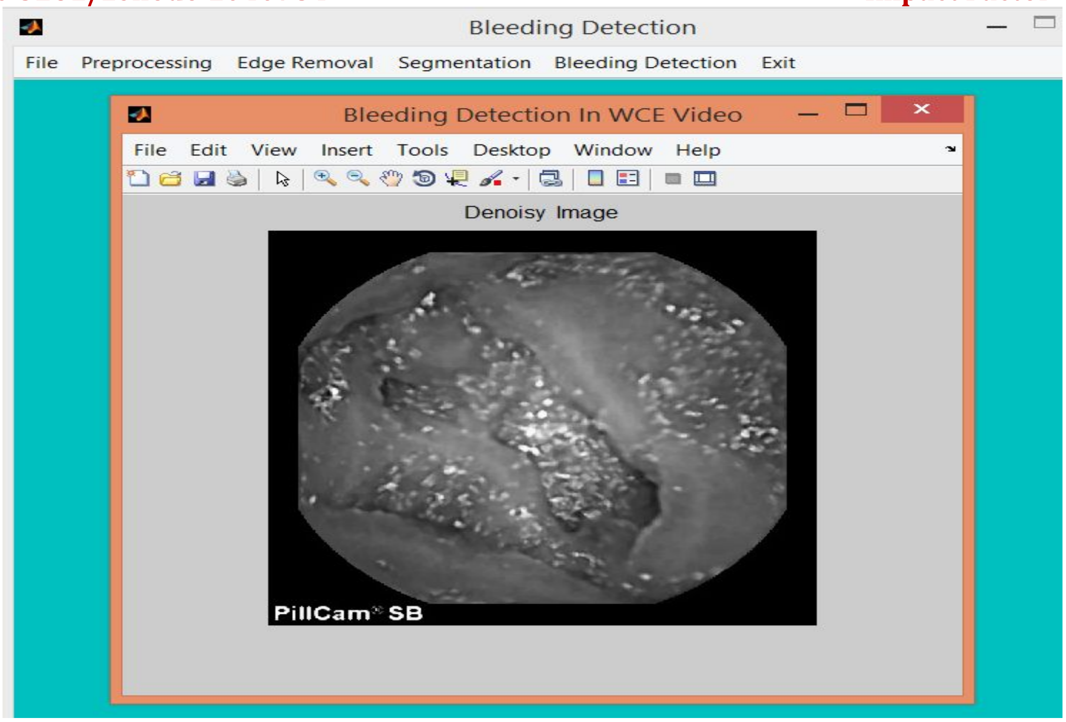

Figure 3(d) Denoised Image

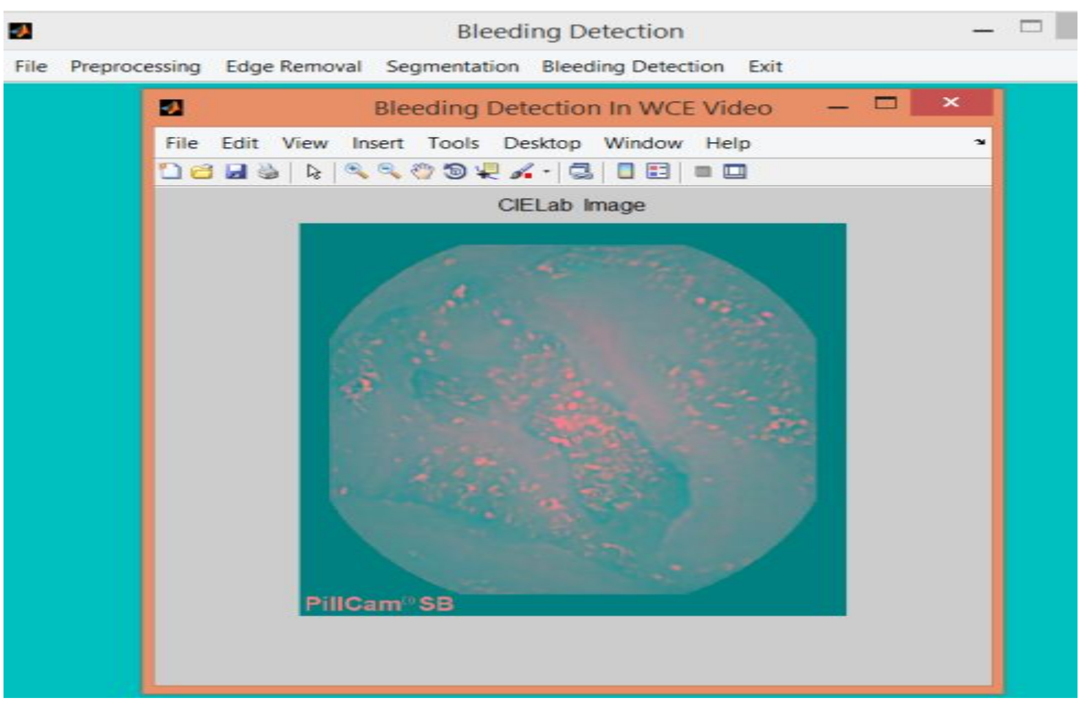

Figure 3 (e) CIE Lab space

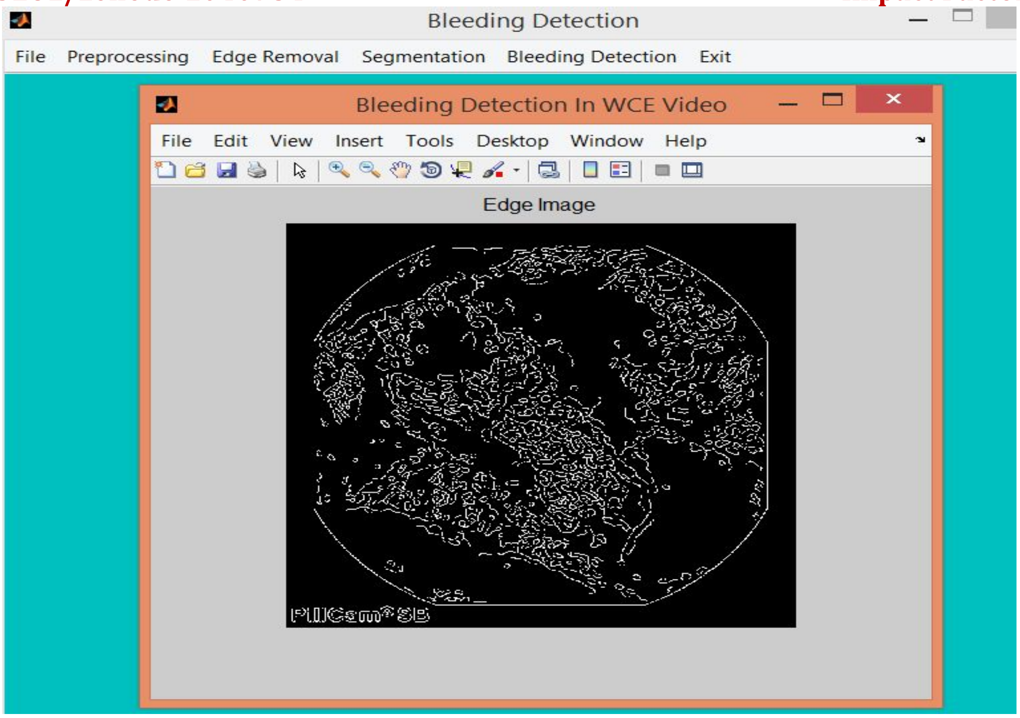

Figure 3 (f) Canny Edge Image

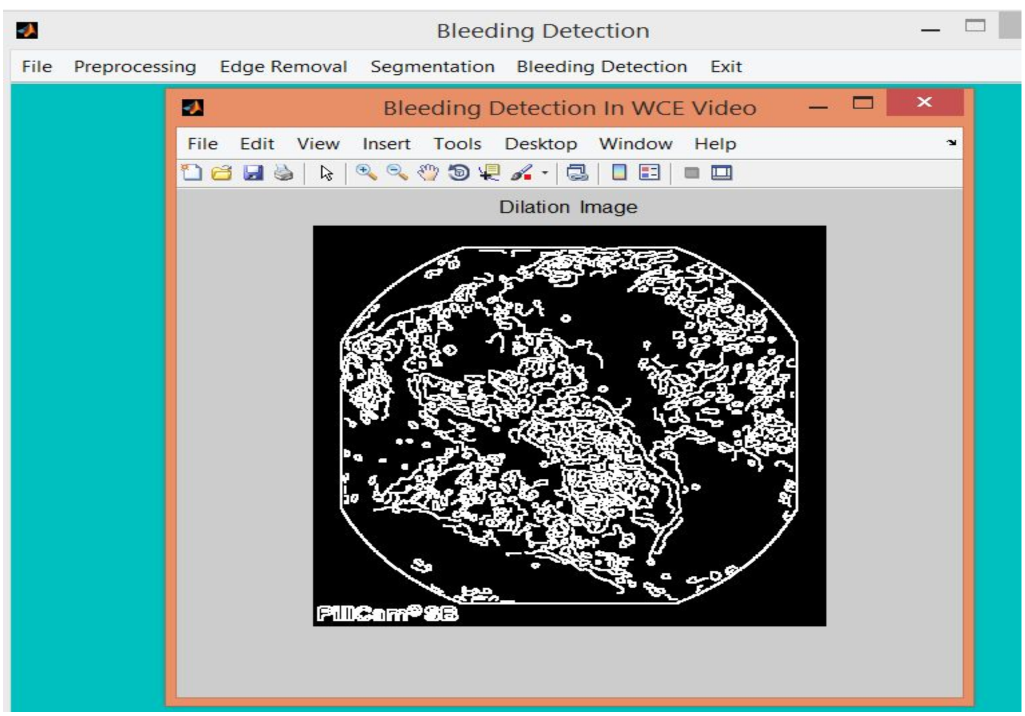

Figure 3 (g) Edge Dilation

ISSN 2348 – 8034
Impact Factor- 4.022

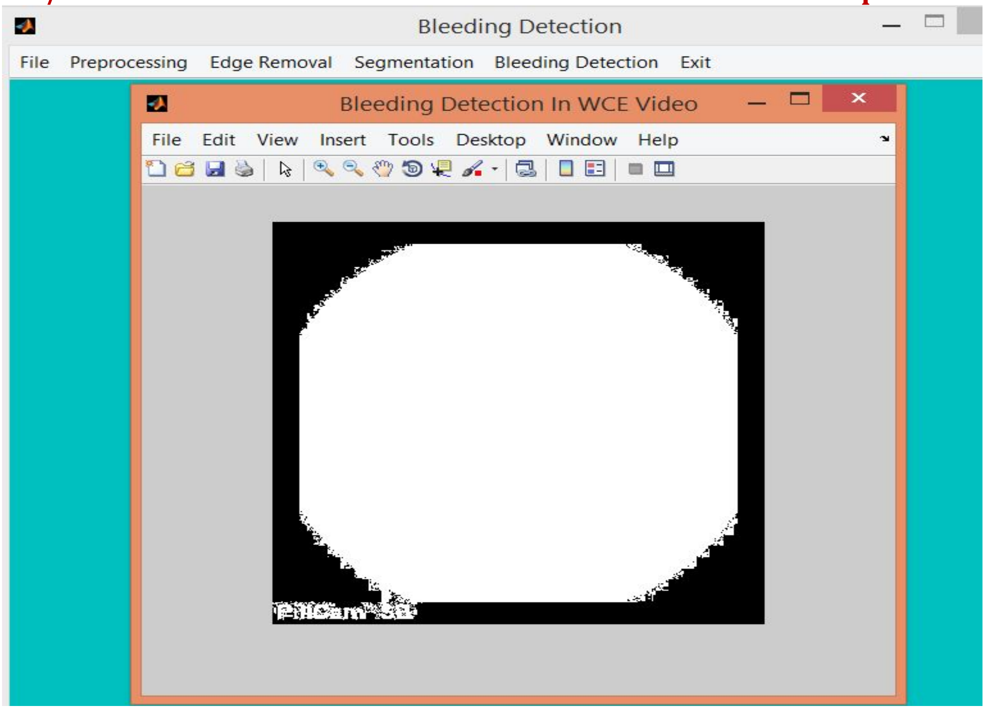

Figure 3 (h) Edge Removed Image

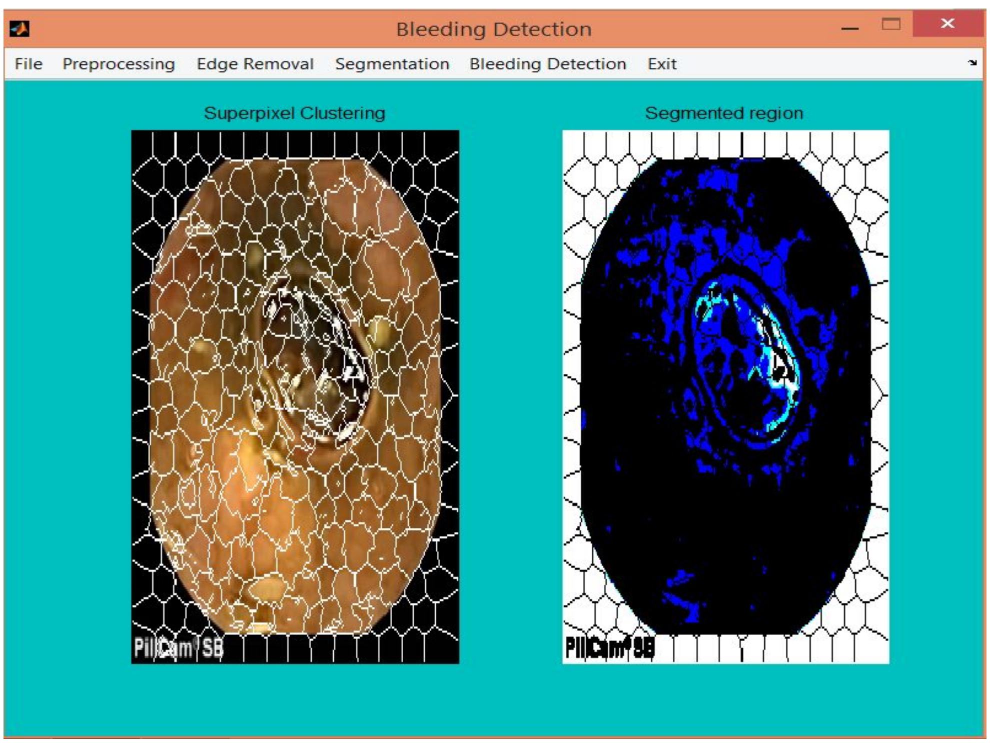

Figure 3(i) Super-pixel Segmentation

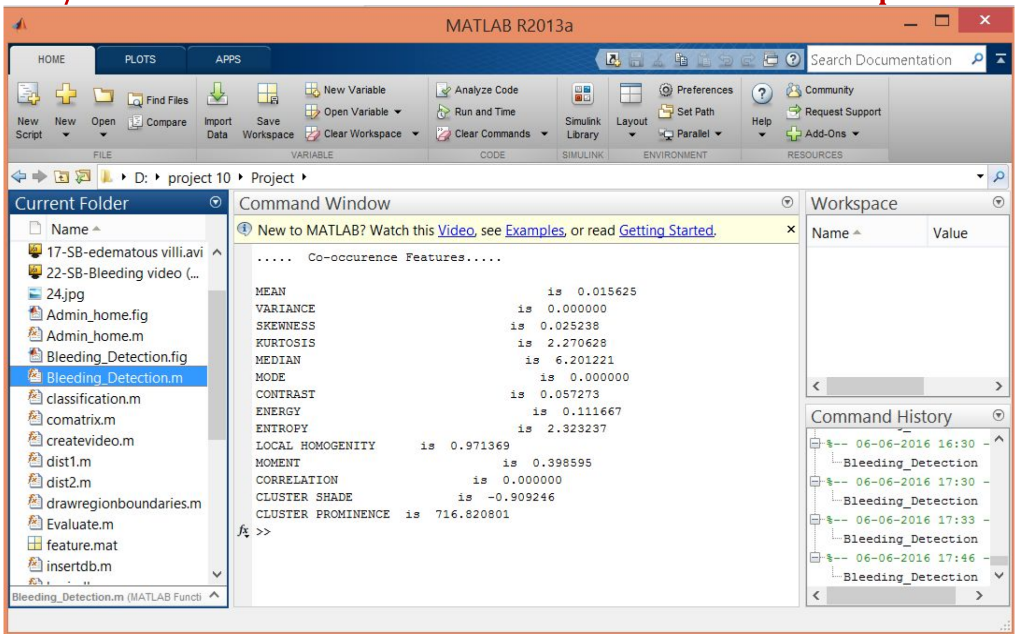

Figure 3 (j) Features Extracted

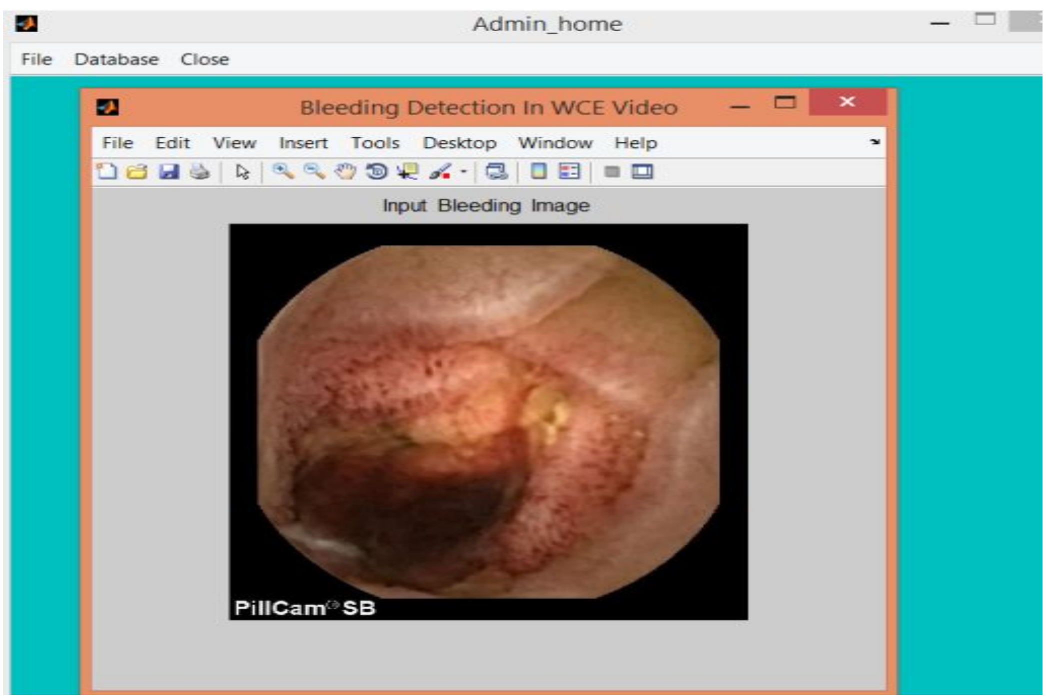

Figure 3 (k) Input Training Image

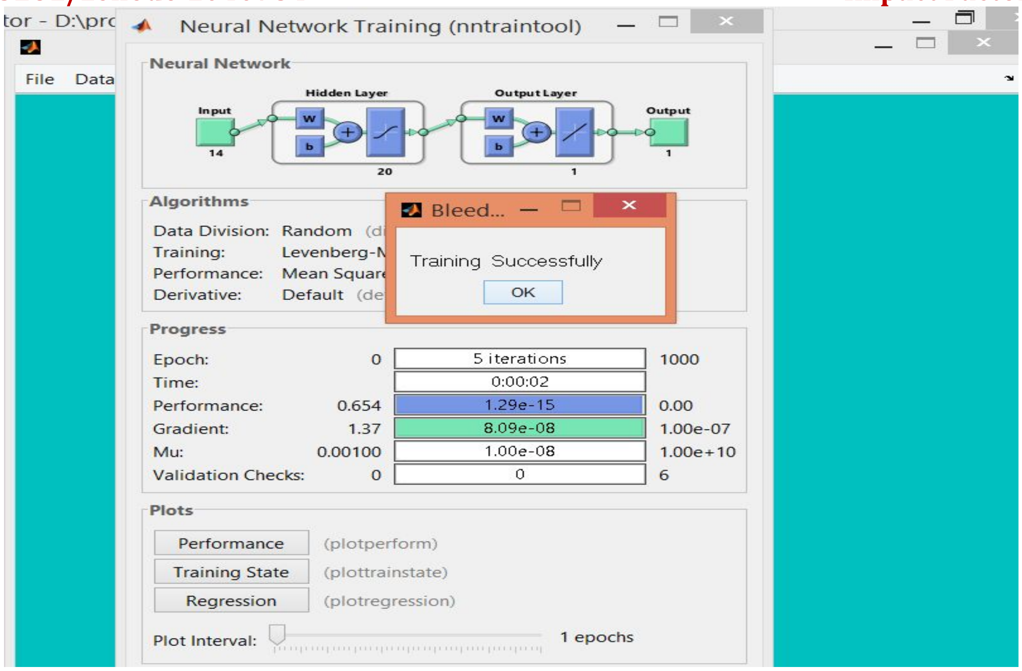

Figure 3(l) RBF Training Network

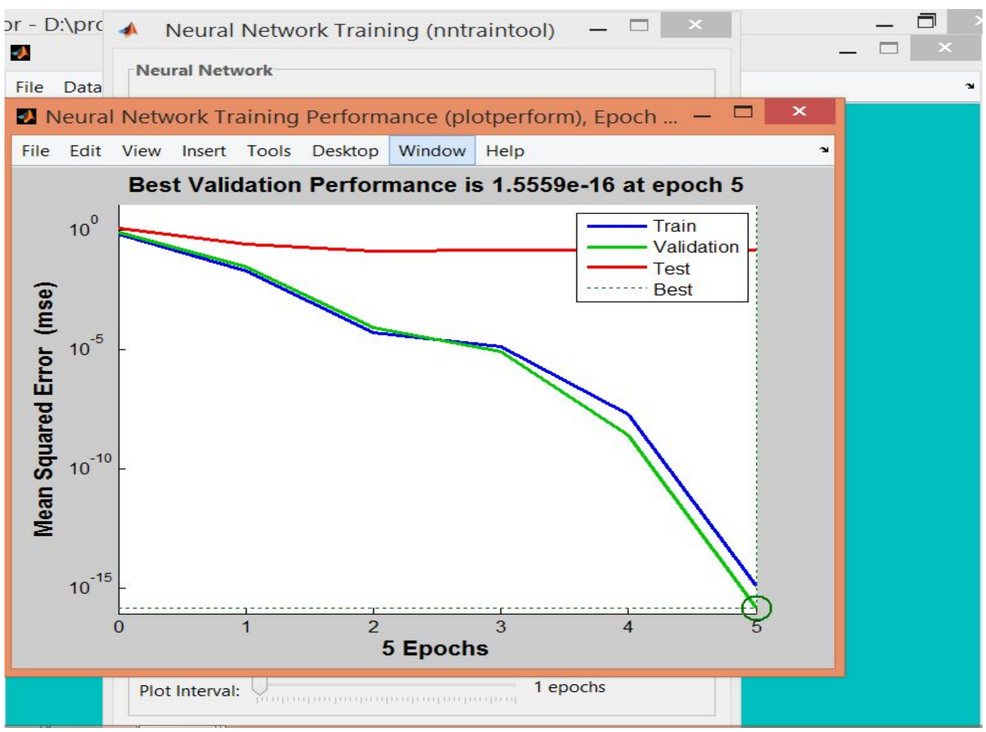

Figure 3 (m) Neural Network Training Performance Graph

RESEARCHERID
THOMSON REUTERS
[Sankar, 4(11): November 2017]
DOI- 10.5281/zenodo.1040754
ISSN 2348 – 8034
Impact Factor- 4.022

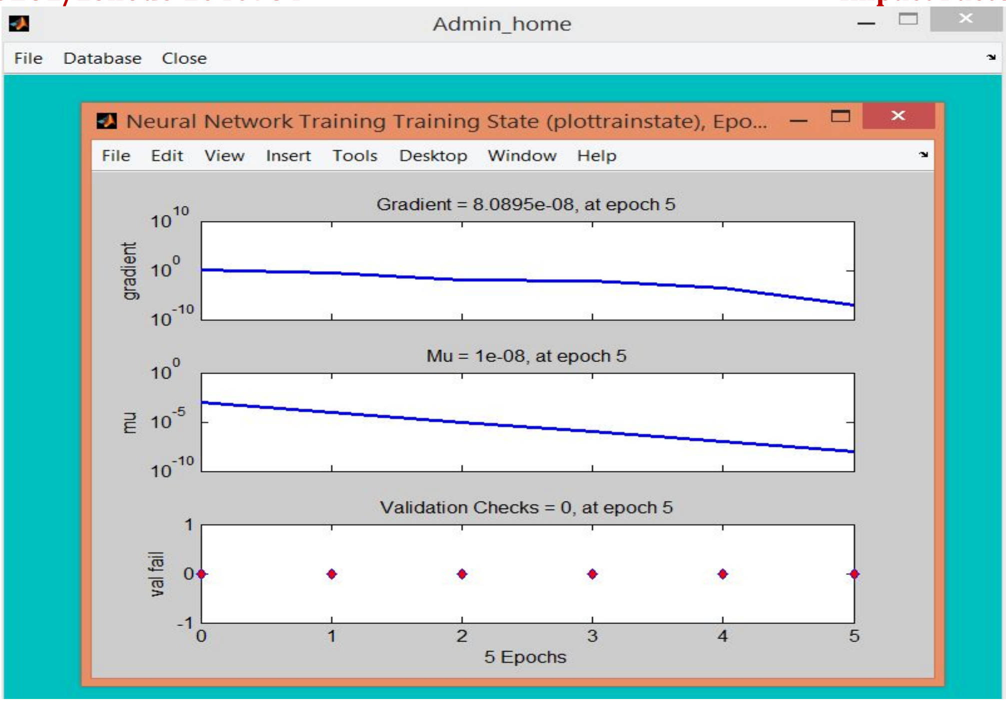

Figure 3(n) Neural Network Training state

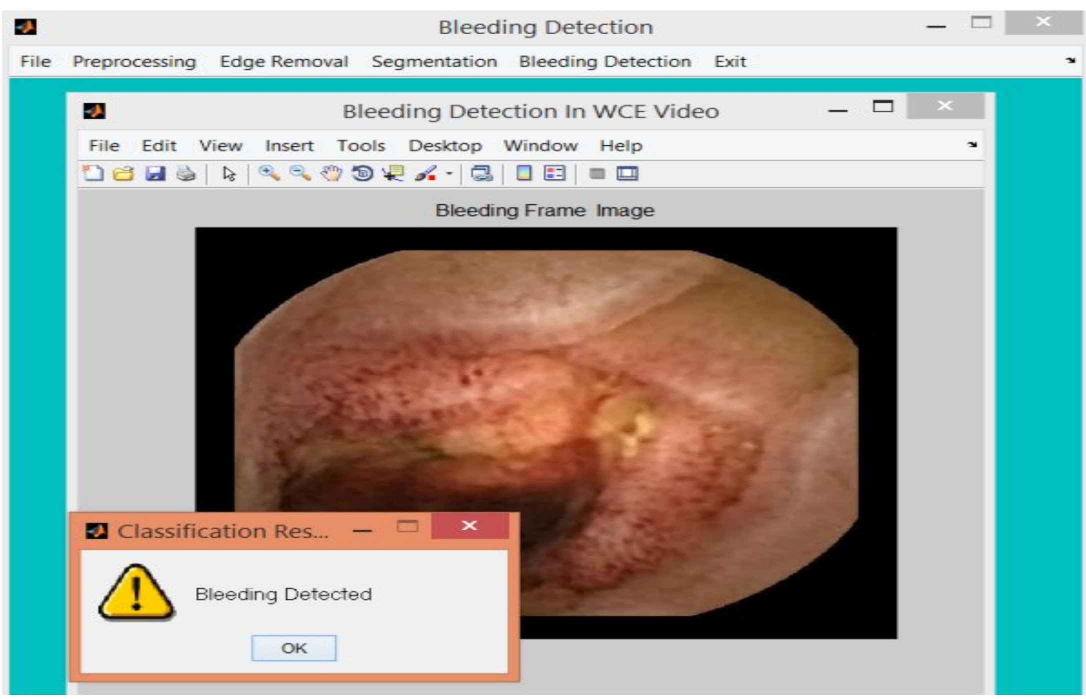

Figure 3(o) Bleeding Detected as classified result

ISSN 2348 – 8034
Impact Factor- 4.022

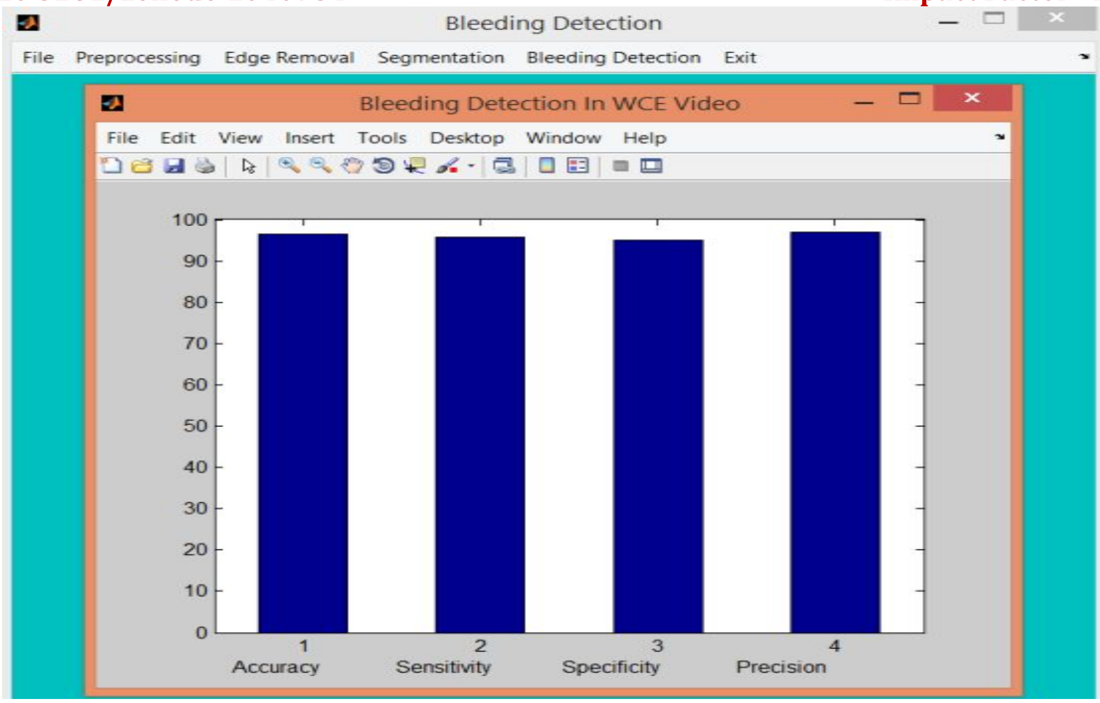

Figure 3 (p) Performance Evaluation Graph

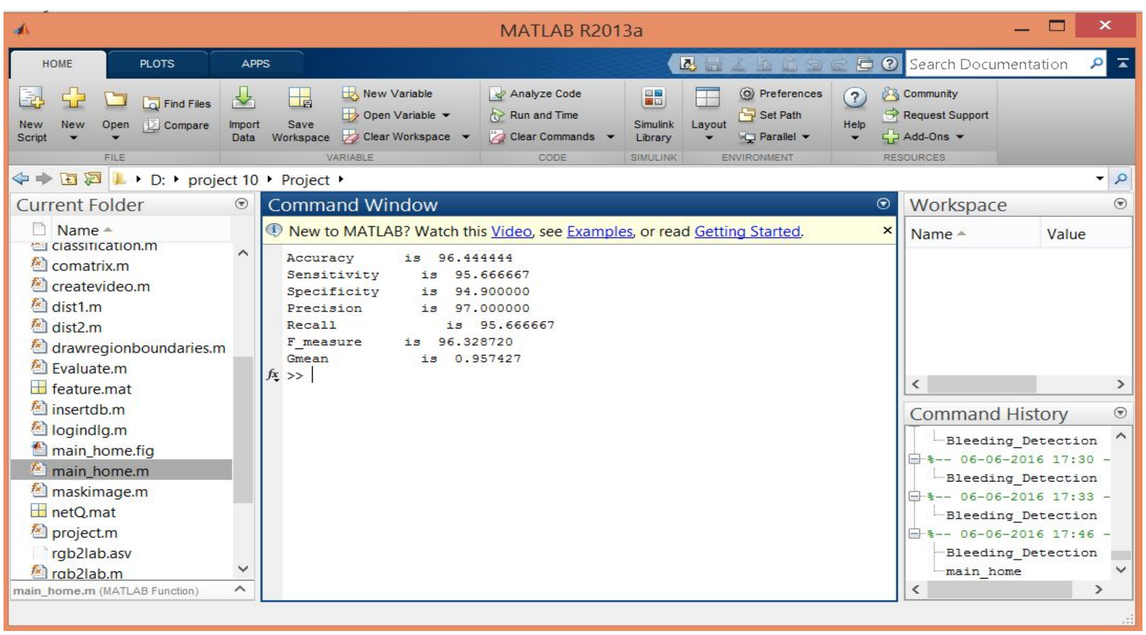

Figure 3(q) Performance Evaluation Result Obtained

IV. CONCLUSION

The proposed method is very effective for the detection of the bleeding regions from WCE videos. A performance evaluation was done on the proposed method for bleeding detection. The performance was measured using the parameters such as sensitivity, specificity, accuracy and precision. The proposed method has shown 96.44 % of accuracy, 95.66 % of sensitivity, 94.9 % of specificity and 97 % of precision.

REFERENCES

1. Alexandros Karargyris and Nikolaos Bourbakis,(2010).”A survey on various methodologies”,IEEE Engineering in Medicine and Biology Magazine.
2. Balathasan Giritharan, Xiaohui Yuan and Jianguo Liu,(2008).“Bleeding Detection from Capsule Endoscopy Videos”, 30th Annual International IEEE EMBS Conference Vancouver, British Columbia, Canada.
3. B. Li and M. Meng,(2009) “Computer-aided detection of bleeding regions for capsule endoscopy images” ,IEEE Trans. Biomed. Eng., vol. 56, no. 4,pp. 1032–1039.
4. B. Penna, T. Tillo, M. Grangetto, E. Magli, and G. Olmo,(2009). “A technique for blood detection in wireless capsule endoscopy images”,in Proc. 17th Eur. Signal Process. Conf., Glasgow, Scotland, 2009, pp. 1864–1868.
5. B. Li and M. Meng,(2012) “Tumor recognition in wireless capsule endoscopy images using textural features and SVM-based feature selection” ,IEEE Trans. Inform. Technol. Biomed., vol. 16, no. 3, pp. 323–329.
6. B. Li and M. Q.-H. Meng,(2012). “Ulcer detection in capsule endoscopy images”, Imag. Vis. Comput., vol. 27, no. 9, pp. 1336–1342.
7. J. Canny.(1986.). “A computational approach to edge detection”, IEEE Trans. Patt. Anal. Mach. Intell., vol. 8, no. 6, pp. 679–698,
8. Jie Li, Jinwen Ma and Tamman Tillo,(2012).”A Training Based Support Vector Machine Technique For Blood Detection In Wireless Capsule Endoscopy Images”, IEEE EMBS International Conference on Biomedical Engineering.
9. M. Liedlgruber and A. Uhl,(2011). “Computer-aided decision support systems for endoscopy in the gastrointestinal tract: A review”, IEEE Rev. Biomed. Eng., vol. 4, pp. 73–88.
10. Poh Chee Khun, Zhang Zhuo, Liang Zi Yang, Li Liyuan, and Liu Jiang, (2009).“Feature Selection and Classification For Wireless Capsule Endoscopic Frames”, Institute for Infocomm Research (I2R) Agency for Science, Technology and Research (A*STAR), IEEE.
11. Tonmoy Ghosh and Khan Arif Wahid,(2014).”An Automatic Bleeding Detection in Wireless Capsule Endoscopy based on RGB pixel intensity ratio”, International Conference on Electrical Engineering and Information & Communication Technology (ICEEICT).
12. T.Ghosh, S.K.Bashar,S.A Fattah,(2014)”An Automatic Bleeding Detection Scheme in Wireless Capsule Endoscopy based on Statistical Features in hue space”,17th International Conference on Computer and Information Technology (ICCIT).