ISSN: 2278 – 7798
International Journal of Science, Engineering and Technology Research (IJSETR)
Volume 5, Issue 6, June 2016

Vocal Vision Android Application for Visually Impaired Person

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***Abstract*— The blind and the visually impaired person face various kinds of life challenges that normally sighted people take for granted. The main aim is to develop software application based on Android Smartphone for the visually impaired person. The main module is to recognize and match scanned objects stored in file of mobile application using Image Processing and Artificial Neural Network algorithm. For edge detection, Sobel edge detection and for training Back Propagation Neural Network algorithm is used. Recognized object in image is communicated to blind user by text to speech synthesizers. Accuracy for color feature object, shape feature object and Both is 94%, 67 and 90% Respectively. In Future, it can be trained by using various Image Processing and Artificial Neural Network algorithms.**

***Index Terms*— ANN, BPNN, Object Detection, Sobel Edge Detection, Smartphone.**

I. INTRODUCTION

There are millions who suffer from vision impairment in one or other way. Vision is one of the very essential human senses and it plays important role in human perception. People who suffer with blindness or in other words visual impairment face quite difficulties while moving around the surrounding. This condition leads the concerned person to be handicapped and need guidance or assistance for every action. It is depriving them from their normal, professional and social life [1]. Human vision abilities are extraordinary to realized images with the imbibed images in the brain. But these are having some limitation like being tired, slow, and not accurate because of some retinal diseases [2]. These limitations can be resolved by using the principle of computer vision system which definitely improves the blind life quality.

The object detection and recognition technology is used for object tracking, recognition and prediction of moving object as it is one of the major research area in computer vision. Object detection technology recognizes objects from input image through the learning process it relies on objects features such as edge, shape and intensity. In general, the input image is analyzed in three stages for object detection. First, features are examined based on local image information. Second, classification is done based on extracted features from image. Finally, objects in the image are recognized based on training process [3]. Artificial neural network algorithm is used for detecting objects in the image.

For our image processing application we have decided to choose the Android platform, because of wide popularity of the Android based devices. According to Gartner's analysis in the end of 2012 the mobile platform has gained 70% share of the Smartphone market [4]. Moreover it is equipped with speech synthesis and accessibility software.

In this communication we have reported a solution aimed at aiding the visually impaired in detection of objects. The system is based on a dedicated android application for visually impaired person using android mobile phone. The detected objects are communicated to blind person using text to speech synthesizers.

The paper is constructed as follows. In section II review of software applications for mobile phone that are specially devoted to blind users. In section III image processing algorithms and artificial neural network (ANN) algorithms were applied in developed application. Finally we have shortly reported results of preliminary test of the android application aided for visually impaired person.

II. RELATED WORK

Application for android mobile phone dedicated to visually impaired person

A. Choosing Target Device

Mobile phones are nowadays popular, also among blind and visually impaired users. A few years ago the Symbian based phones equipped with special applications like Talks or Mobile Speak were the most popular among the blind users. These types of programs are called screen readers because they read all the content displayed in the phone screen by using a synthesized voice [5]. The currently observed trend is that phones with a physical keyboard are less and less popular. This tendency has initially posed a new usability barrier for the blind that had to go through difficulties in handling small touch-screen devices. However, new user interfaces based on the so called touch gestures has significantly improved user-friendliness of the touch-screen devices for the blind users.

Android based devices can be one of the affordable choices [6]. The non-operating system phones are not commonly used

by blind users. As it do not offer any special tools aiding for this group of users. The Android system is similarly well adapted to the needs of the blind as the iOS system. It is

equipped with the talkback accessibility service. This tool allows to verbally comment and read GUI (Graphical User Interface) components. Choosing a modern smartphone has also another advantage as they are equipped with good quality inbuilt application likes digital cameras, GPS receivers, audio recorders etc. These applications can be used in dedicated software which can be used by the blind user. On the other hand, there are numerous dedicated devices available for the blind such as navigation devices, colour detector readers etc. However, it has the two main disadvantages. Firstly, they are expensive (their cost is much higher than that of mobile applications). Second, the blind user is forced to carry several devices, each for a specific application, e.g. a navigation device. We have employed an Android based smartphone as the platform for an image processing and object recognition applications which work on images captured by inbuilt camera.

B. Existing Solutions

Currently there are several similar image analysis applications for mobile devices available on the market.One of them are software termed Recognizer developed by LookTel [7]. It is a commercial application dedicated for iPhones. Which is supposed to recognize an object within the camera field of view that was previously stored in a local database of objects' images. The application is intended to help visually impaired people to recognize household objects. For the best results, object templates stored in the database should be captured by a sighted person in a predefined orientation. Another application intended for the blind users is the EyeRing project [8]. This is a finger-worn device that communicates with an Android mobile phone. The EyeRing comprises a VGA mini-camera, a 16MHz AVR microcontroller, a Bluetooth connection module and control buttons. The task of the mobile device is running speech processing algorithms and all computer vision algorithms. The currently implemented functionality of the device is detection of banknotes, recognition of colours and distance calculation which is supposed to work as a "virtual walking cane". However, this solution is costly and requires an additional device to be worn by a blind user.

Object detection using image processing algorithms and artificial neural network (ANN) on android phone is an emerging concept. Hence only few published literature were available. However, the available literatures mainly concentrated on desktop application.

Kanghun Jeong and Hyeonjoon Moon designed object detection application using Feature Accelerated Segment Test (FAST) algorithm based on Smartphone to describe environment, navigation and interaction [9]. FAST corner detector provides faster feature computation by extracting only corner information. Further normalization is applied to extracted features. Based on normalized extracted features information SVM and BPNN training is performed for efficient recognition of objects. K.Matusiak, P.Skulimowski and P.Strumillo designed object recognition application using Scale Invariant Feature Tranform (SIFT) transform to detect and localize object in image robustly. It is insensitive to image restriction parameters i.e. scale, rotation and lighting condition [10]. Further, for classification and training matching keypoints technique was used.

Savitha G, Venugopal P S, Dr. Sarojdevi and Dr. Niranjan Chiplunkar designed object detection approach on android mobile phone using morphological opening and closing filters are used in sequence for object detection [11]. Contour based learning techniques are adopted for drawing contours of object detected. Open CV functions are used to implement these algorithms on android mobile phone.

Ruxandra tapu, Bogdan Mocanu, Andrei Bursuc and Titus Zaharia designed obstacle detection and classification system using multiscale Lucas-Kanade algorithm for extracting interested points. Through homographic transform camera and background motion is estimated [12]. For objects in motion Agglomerative clustering technique is used. Interested points are refining using k- nearest neighbors (K-NN) algorithm. Further, object classification in video stream HOG descriptor into bag of visual words (BoVW) retrieval framework is combined. For training SVM algorithm is used.

III. PROPOSED WORK

In proposed work, object detection system is designed for visually impaired person using android Smartphone. The goal is to design an application which will allow detecting objects from images captured by camera of a mobile device.

1. Object Training and Detection Mode for Color Feature

The proposed object training and detection for color feature system implies Sobel edge detection for feature extraction. For object image training and detection ANN classifier i.e. (BPNN Algorithm) [13] is used. The block diagram of object training and detection for color feature is shown in figure 1. In the proposed, object training and detection for color feature system, input image given to system contains noise in image. Further to remove the noise from the image. The image is blurred by using color blur technique. The RGB image is converted to gray scale to get each pixel value same in overall image. And also RGB image is converted into HSV image for further use. While plotting the histogram of extracted features it will require HSV values.

Edge detection is a basic tool used in image processing, basically for feature detection and extraction. The aim is to identify points in a digital image where brightness of image changes sharply and find discontinuities [14]. The purpose of edge detection is reducing the amount of data in an image and preserves the structural properties for further image processing. In a grey level image, the edge is a local feature, within a neighborhood. It separates each region, where the gray level is more or less uniform with the different values on the two sides of the edge. For a noisy image, it is difficult to detect edges as both edge and noise contains high frequency contents which results into blurred and distorted result. Edge

detection is done to extract corner information and remove the noise over edges. The corner information is extracted the input image using the Sobel edge detector [15].

Thresholding is the simplest method of image segmentation. From a grayscale image, Thresholding can be used to create binary images i.e. image with only black or white colors. Blob detection technique is used to refer visual modules that are aimed at detecting points, regions, or blobs in the image. It differs in properties like brightness or color compared to the surrounding. Blob detection is done extract object from image. Further cropping is done to extract the blob detected earlier and are cropped into blocks and these blocks are having feature values which are saved. Now these extracted feature values are further used for plotting histogram using original HSV values. The extracted features histogram is plotted. Histogram is a simple graph that displays where all of the brightness levels contained in the image from the darkest to the brightest [16]. Histogram normalization is a process that changes the range of from

pixel intensity values. Normalization is sometimes called contrast stretching or histogram stretching. It is also called as dynamic range of expansion in digital signal processing. Further there are two modes object training and recognition. In training mode, image data is given to ANN classifier i.e Back Propogation Neural Network (BPNN) algorithm is used for training[17]. After training extract object features are is saved to database. In recognition mode, the complete procedure it follows from input image to ANN. The obtained feature values of object are given to ANN[18] and it is compared to object features saved in database.

If object feature matches from saved database then Object name is given in text form and text is verbalised using text to speech synthesizers [19]. If it does not match then it is verbalised as unknown object. Further it will ask for training objects once again.

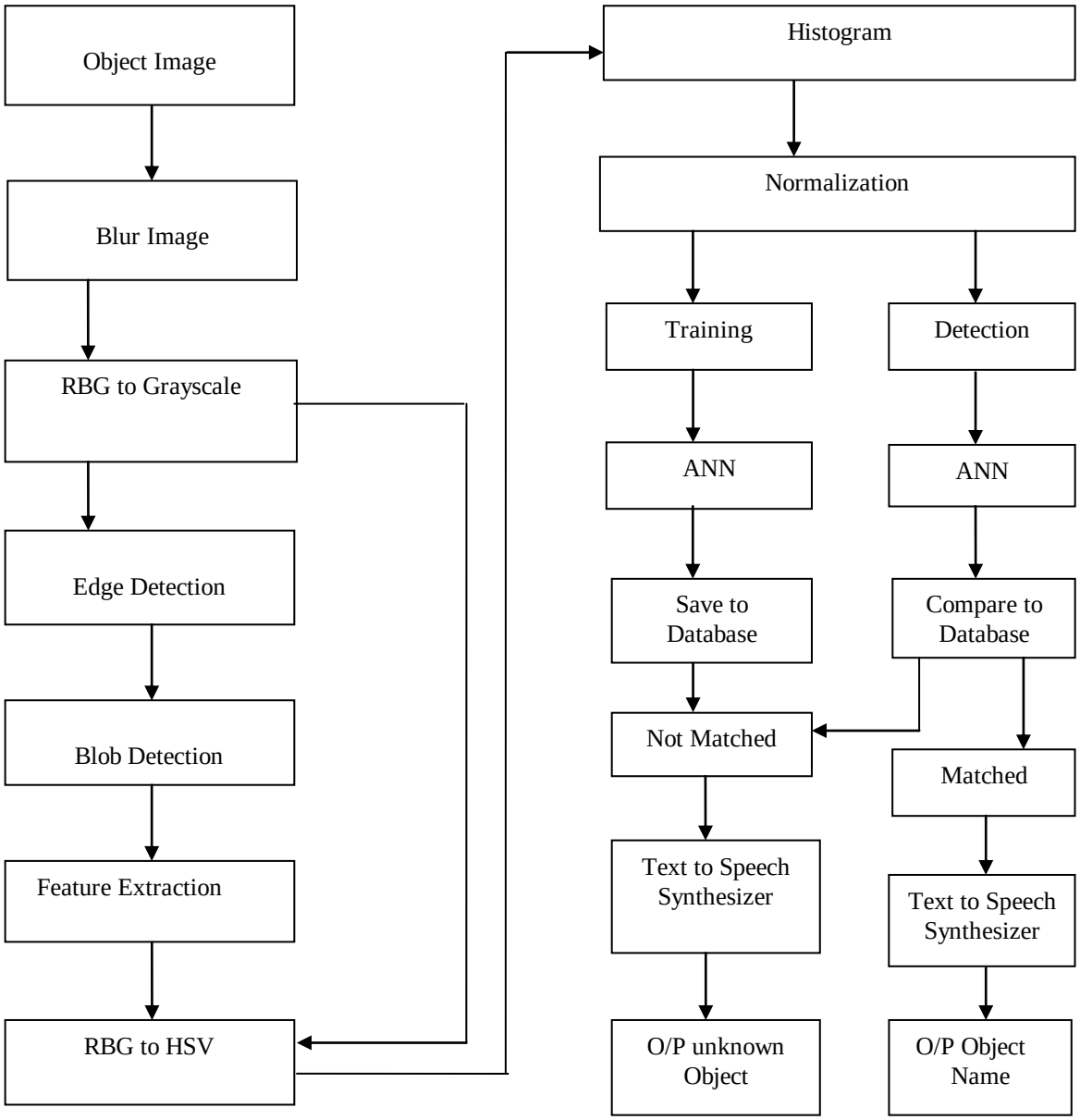

Figure 1:- Block Diagram of Object Training and Detection for color parameter

2. Object Training and Detection Mode for Shape Feature

The proposed object training and detection for shape feature system implies Sobel edge detection for feature extraction.For object image training and detection ANN classifier i.e.(BPNN Algorithm) [13] is used. The block diagram of object training and detection for shape feature is shown in figure 2. In the proposed, object training and detection for shape feature system, input image given to system on that Blob detection technique is used. Blob detection technique is used to refer visual modules that are aimed at detecting points or regions in the image. It differs in properties like brightness or color compared to surrounding blob detection is done.To extract object in image. The image obtained after blob detection is resize to fixed scale size i.e. 256*256 pixel value for further easy processing.The RGB image is converted to gray scale to get each pixel value same in overall image. Edge detection is a basic tool used in image processing, basically for feature detection and extraction.

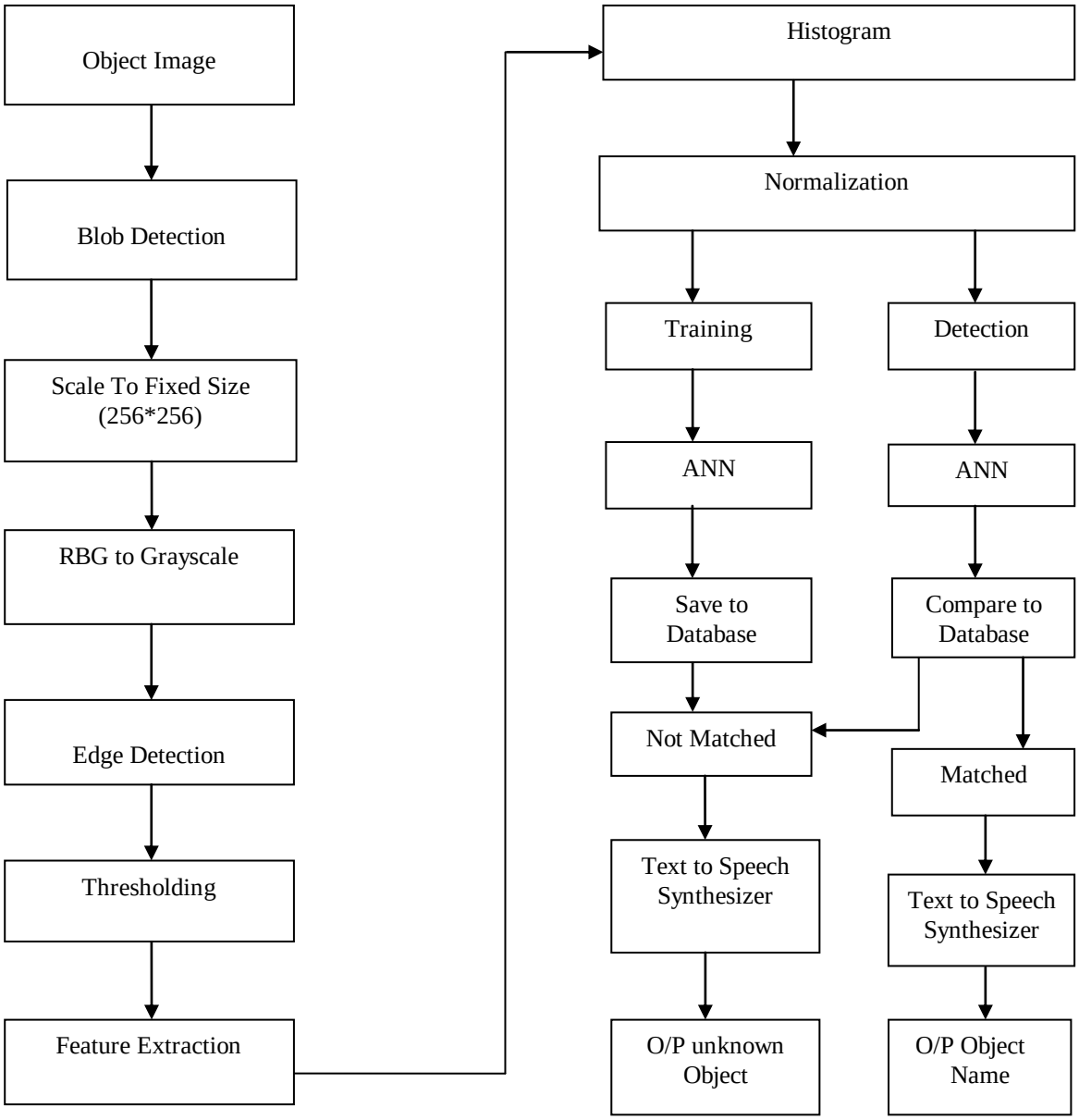

Figure 2:- Block Diagram of Object Training and Detection for shape parameter

The aim is to identify points in a digital image where brightness of image changes sharply and find discontinuities [14]. The purpose of edge detection is reducing the amount of data in an image and preserves the structural properties for further image processing. In a grey level image, the edge is a local feature, within a neighborhood. It separates each region, where the gray level is more or less uniform with the different values on the two sides of the edge. For a noisy image, it is difficult to detect edges as both edge and noise contains high frequency contents which results into blurred

and distorted result. Edge detection is done to extract corner information and remove the noise over edges. The corner information is extracted from the input image using the Sobel edge detector[15].

Thresholding is the simplest method of image segmentation. From a grayscale image, thresholding can be used to create binary images i.e. image with only black and white colors. Further cropping is done to extract the features using black count of pixels of image and white count of pixels of image. These black and white count pixels values are given to ann for training and detection modes. Further, in training mode, image shape features is given to ANN classifier i.e BPNN algorithm. After training, object shape features are saved to database [11]. In recognition mode, shape feature data is given to ANN and it is compared to database saved. If object image matches from saved database then Object name is given in text form and text is verbalised using text to speech synthesizers. If it does not match then it is verbalised as null object or shape not recognized.

3. Object Training and Detection Mode for Color and Shape Combined Feature

In this object recognition system, color features are obtained while performing training. This colors feature is saved in database. Similarly, shape features are obtained while training is performed[19s]. This shape feature is saved in database. These both features are combined to produce single output using programming logic.

The color feature output is in range 0.1 - 0.9 whereas shape output is in range 100-1000.As output should be in same range so to normalized it in shape output is divided by 500 and color output is multiplied by 1000 then both values are added. The added value is saved in myval and then average of both is taken. Similarly for all inputs same procedure is done in for loop. Now the average output is compared with all outputs. The maximum output value is given in index value to generate object number accordingly it gives object name in text form and parallel it is verbalized.

IV. RESULTS

The application was implemented using android programming language for Android OS using ADT-Bundle-windows-x86 software. The object recognition algorithm was tested in terms of performance and quality of results. We have used Samsung Galaxy Grand and Sony Xperia M smartphones because of their good quality camera and computational capabilities. For the test purposes, images of 5 indoor premises photos was taken. Each photo contains a front side view and was taken at daylight conditions. A result of the preliminary tests of the object recognition algorithms is tested on Sony Xperia M and Samsung Galaxy Grand Smartphone.

Recognized object in image is communicated to blind user by text to speech synthesizers. Accuracy for color feature object, shape feature object and Both is 94%, 67 and 90% respectively.

The formula to calculate Accuracy

$$Accuracy=(TP+TN)/(TP+TN+FP+FN)$$

Object List	Total Iteration	Time required (min)	True positive (TP)	True negative (TN)	False positive (FP)	False negative (FN)
Coffeemug	20	1ms	18	1	0	1
Bag	20	2ms	19	0	1	0
Laptop	20	2ms	18	1	1	0
Container	20	3ms	17	1	1	1
Moovspray	20	2ms	18	1	1	0
Total	100	12ms	90	4	4	2

Table I: - Confusion Matrix result shows accuracy for color feature objects.

Object List	Total Iteration	Time required (min)	True positive (TP)	True negative (TN)	False positive (FP)	False negative (FN)
Coffeemug	20	5ms	11	3	4	2
Bag	20	3ms	10	3	4	3
Laptop	20	6ms	9	3	4	4
Container	20	4ms	11	4	2	3
Moovspray	20	3ms	9	4	5	2
Total	100	21ms	50	17	19	14

Table II: - Confusion Matrix result shows accuracy for shape feature objects.

Object List	Total Iteration	Time required (min)	True positive (TP)	True negative (TN)	False positive (FP)	False negative (FN)
Coffeemug	20	1ms	18	1	0	1
Bag	20	2ms	17	1	1	1
Laptop	20	2ms	16	1	1	2
Container	20	3ms	17	0	2	1
Moovspray	20	2ms	18	1	1	0
Total	100	12ms	86	4	5	5

Table III: - Confusion Matrix result shows accuracy for color and shape feature objects.

V. Conclusion

The developed software application is implemented with help of image processing and recognition algorithms dedicated for blind users. The application is tested on the smartphones equipped with a digital camera i.e. Samsung galaxy grand and Sony Xperia M . Performance of these algorithms depends on the quality of the inbuilt camera and image acquisition lighting conditions. Accuracy for color feature object, shape feature object and For both is 94%, 67 and 90% Respectively The application is tested among a number of blind users. The object detection application is designed only for indoor premises. In future system can be redesigned using various other image processing algorithms. For further work we plan to extend the system and improve it with a advanced alerting functionalities. In this respect, we want to make use of bond induction headphones which allow the users to hear the both the sounds from the device and the environment sounds.

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