ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 4, Issue 2, February 2015

Customizable object detection using Smartphone for Visually Impaired Users

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Abstract: The visually impaired face various kinds of problems that normally sighted people don't. Here a significant help is offered by android application for smartphone equipped with speech synthesizers. In this paper we have mentioned various problems faced by them and currently available solutions. We have used HSV model for more accurate processing of image. For training and recognizing image ANN algorithm is used. ANN facilitates faster training and detection of objects. To separate foreground and background from image sobel edge detection is used.

Keywords: HSV model, ANN and Sobel edge detection

I. INTRODUCTION

The visually impaired face various kinds of problems that normally sighted people don't. They face difficulties in safe and independent travelling depriving them of normal professional and social life. Then the other problems are communication and access to information. Here a significant help is offered by software application for touch screen devices equipped with speech synthesizers that enable detection of various objects and give output in speech format.

The common problems faced by visually impaired are:

1. Personal care: e.g. monitoring and use of medicines
2. Timekeeping, alarm, alerting: e.g. controlling household appliances.
3. Money and finance: e.g. detection of currency.

In this work we focus our attention on the group of daily tasks, in particular, systems that enable the visually impaired to identify objects, e.g. books, fruits.

II. WHY ANDROID?

Cell phones have become a very common platform for computing and communication and personal use. Communication along with many features like multimedia and applications makes it more efficient and effective. Android is a development platform for the application and it is becoming the most widely used platform among the mobile technologies. Detecting objects in a given image is the first step in image processing applications. The information to be associated with the image is tagged to the detected object. Thus user can get the information as and when required. So far object detection is done by various methods for desktop applications. Identification of objects in an image on android platform is not fully developed. The present study is focused on detecting objects in an image which later can be used for various other purposes. Objects once detected can be saved and is available for further use. In the present study image processing

III. LITERATURE SURVEY

The paper is structured as follows. In section III we review software applications for mobile devices that are especially devoted to visually impaired users. In section IV image processing algorithms which will be applied in the application are described.

A. Currently Available Solutions

Currently available solution can be grouped into two major groups:

1. Low-tech labelling system in which labels are attached to objects, e.g. with tactile signs or text messages in Braille
2. High-tech systems that employ 1-D and 2-D barcodes, talking labels or RFID.

Both systems however require attaching special tags or visual signs to the objects. Consequently, they can be costly, since such system need to be regularly maintained to keep them up to date. In this paper we provide a solution aimed at helping the visually impaired in detection and recognition of objects. The system is based on a dedicated image recognition application running on an android system smartphone. Image recognition results re communicated to the blind user by means of pre-recorded verbal messages.

B. Smartphones

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

C. Existing Applications

Currently there are several similar applications for mobile devices available on the market. One of them is software termed Recognizer developed by LookTel. It is a

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 4, Issue 2, February 2015

commercial application dedicated for Iphones that is supposed to recognize an object within the camera field of view that was previously stored in a local database of object's images. The application is intended to help visually impaired people to recognize household objects. For the best results, objects 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 Eye Ring project. This is a finger-worn device that communicates with an android mobile phone. The Eye Ring comprises a VGA mini-camera, a 16 MHz 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 bank notes, recognition of colours
And distance calculation which is supposed to work as a "virtual walking cane". This solution, however, is costly and requires an additional device to be worn by a blind user.

IV.METHODOLOGY

Image recognition algorithm, the goal was to design an application which would allow recognizing objects from images recorded by the camera of a mobile device. The object recognition algorithm should be insensitive to image registration parameters, i.e. scale, rotation and lighting conditions. Moreover, the recognized object should be robustly detected and localized in the image context.

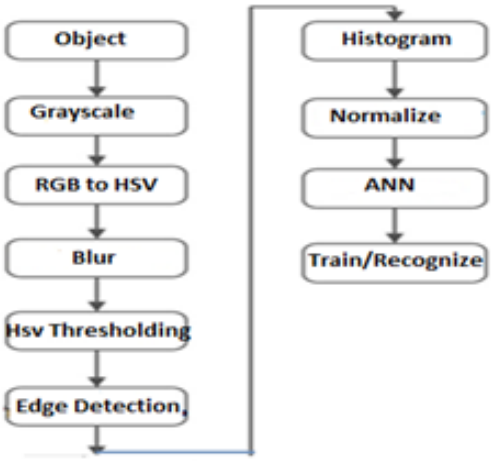

Fig. 1 Flow of the system

A. Image

An image is a 2D array of pixels. An image is an array, or a matrix, of square pixels arranged in columns and rows. A pixel is the smallest visual element on video display screen. Pixels are stored as integers. The integers can be 8-bit, 24-bit or 32-bit depending on image type. Most popular are 24-bit colour images where 8-bits each for red, green and blue. 8-bit images are gray scale images whereas 32-bit images have an additional transparency channel.

B. Gray scale Conversion

1. Traverse through entire input image array.
2. Read individual pixel colour value (24-bit).
3. Split the colour value into individual R, G, and B 8-bit values.

R = col & 0xff;
G = (col>>8) & 0xff;
B = (col>>16) & 0xff;

4. Calculate the gray scale component (8-bit) for given R, G and B pixel using a conversion formula.

GS = (R + G + B)/3

5. Assign R = G = B = GS;
6. Compose a 24-bit pixel value from 8-bit gray scale value.
7. Store the new value at same location in output image.

C. RGB TO HSV

H(hue)-specify the position of pure colour on wheel. S(saturation)-describes how white the colour is. E.g. pure red is fully saturated; tints of red have saturation less than one. V(value)-called as lightness of colour, describes intensity of colour

C.1. Advantages Of HSV Over RGB

1. Offers more intuitive representation of relationship between colours.
2. HSV selects more specific colour.
3. In HSV model value of H and S remains constants if the value of V changes but value of RGB changes with change in V.

C.2. Conversion of RGB To HSV

1. Load image.
2. Read each pixel from image.
3. Separate RGB colour for each pixel.
4. Find min and max value from R,G,B.
5. Assign max to value.
6. If value equals to 0 assign H = S = 0
7. Else S = 255*(max-min)/value.
8. If S = 0 then assign H = 0,setpixel.
9. End if
10. Else If max equals to R then H = 0+43*(G-B)/(max-min)
11. End if
12. Else If max equals to G then H = 85+43*(B-R)/(max-min)
13. End if
14. Else If max equals to B then H = 171+43*(B-R)/(max-min)
15. End if
16. If H < 0 then H = H + 255
17. End if
18. End if
19. Set each pixel again on image.
20. End.

D. Blur

In image terms blurring means that each pixel in the source image gets spread over and mixed into surrounding pixels. Another way to look at this is that each pixel in the

DOI 10.17148/IJARCCE.2015.4276

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering
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destination image is made up out of a mixture of surrounding pixels from the source image. Blurring an image reduces the sharpening effect, this makes the detection more accurate. There are two types of blurring an image.

1. Grayscale blur.
2. Colour blur.

D.1. Algorithm

1. Traverse through entire input image array.
2. Read individual pixel colour values.
3. Split the colour value into individual RGB values.
4. Calculate the RGB average of surrounding pixels and assign this average value to it.
5. Repeat the above step for each pixel.
6. Store the new value at same location in output image.

E. Thresholding

Thresholding is simplest method of image segmentation. From a gray scale image, thresholding can be used to create binary images i.e. image with only black and white colour. It is usually used for feature extraction where required features of images are converted to white and everything else to black (or vice-versa).

E.1. Algorithm

1. Traverse through entire input image array.
2. Read individual pixel colour values and convert it into gray scale.
3. Calculate the binary output pixel values based on current threshold.
4. Store the new values at same location in output image.

F. Edge Detection Techniques

In image processing, an edge is the boundary between an object and its background. They represent the frontier for single objects. Therefore, if the edges of image's object can be identified with precision, all the objects can be located and their properties such as area, perimeter, shape etc. can be calculated. Edge detection is an essential tool for machine vision and image processing. Fig. 2. Illustrates an edge detection process. There are three overlapping objects in the original (Figure 2a), with uniform gray background. After the application of edge detection technique, the objects have been isolated, and only the boundaries between the regions are identified (Figure 2b).

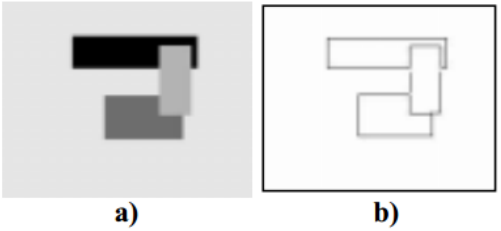

Fig. 2.Example of edge detection a) Original overlapping rectangle's image. b) Edge-enhanced image showing only the boundaries.

G. Histogram

An image histogram is a type of histogram that acts as a graphical representation of the tonal distribution in a digital image. It plots the number of pixels for each tonal value. By looking at the histogram for a specific image a viewer will be able to judge the entire tonal distribution at a glance. Image histograms are present on many modern digital cameras. Photographers can use them as an aid to show the distribution of tones captured, and whether image detail has been lost to blown-out highlights or blacked-out shadows.

The horizontal axis of the graph represents the tonal variations, while the vertical axis represents the number of pixels in that particular tone. The left side of horizontal axis represents the black and dark areas, the middle represents medium gray and right hand side represents light and pure white areas. The vertical axis represents the size of the area that is captured in each one of the zones. Thus, the histogram for a very dark image will have the majority of its data points on the left side and center of the graph. Conversely, the histogram for a very bright image with few dark areas and /or shadows will have most of its data points on the right side and center of the graph.

H. ANN

An artificial neural network (ANN), usually neural network (NN), is a mathematical model or computational model that is inspired by the structure and/or functional aspects of biological neural networks. A neural network consists of an interconnected group of artificial neurons, and it processes information using a connectionist approach to computation. In most cases an ANN is an adaptive system that changes its structure based on external or internal information that flows through the network during the learning phase. Modern neural networks are nonlinear statistical data modelling tools. They are usually used to model complex relationships between inputs and outputs or to find patterns in data.

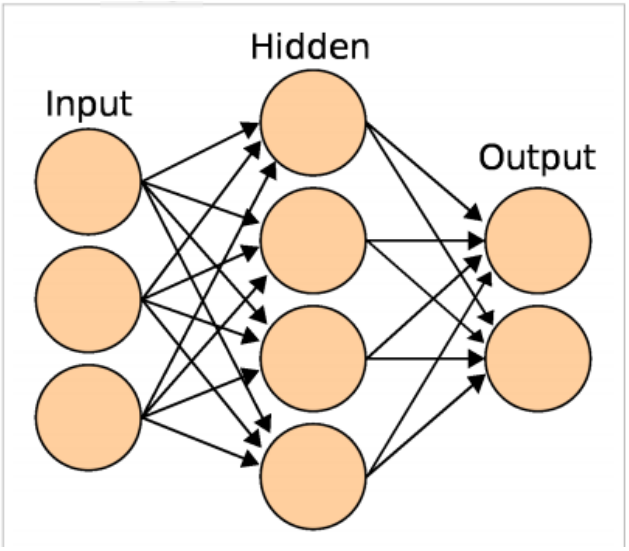

Fig. 3. An artificial neural network

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering
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H.1. Employing Artificial Neural Networks

Perhaps the greatest advantage of ANN is their ability to be used as an arbitrary function approximation mechanism that learns from observed data. However, using them is not so straight forward and a relatively a good understanding of the underlying theory is essential.

- Choice of model: This will depend on the data representation and the application. Overly complex models tend to lead to problems with learning.
- Learning algorithm: There are numerous trade-offs between learning algorithm. Almost any algorithm will work well with the correct hyper parameters for training on a particular fixed data set. However selecting and tuning an algorithms for training on unseen data requires a significant amount of experimentation.
- Robustness: If the model, cost function and learning algorithm are selected appropriately the resulting ANN can be extremely robust.

With the correct implementation, ANN can be used naturally in online learning and large data set application. Their simple implementation and the existence of mostly local dependencies exhibited in the structure allows for fast, parallel implementation in hardware.

V. CONCLUSION

Object detection is achieved using java language and implemented on android device by using image processing algorithms. Larger objects get detected and indicated by marking their boundary. System is trained to recognize different objects using ANN algorithm, the trained objects are stored in vectors which can be used for further processing.

Memory utilization increases with the presence of more number of objects in an image. Also time consumed to process increases with presence of smaller objects in an image.

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