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VOCAL VISION For VISUALLY IMPAIRED

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Abstract

This project is a vision substitute system designed to assist blind people for autonomous navigation. Its working concept is based on 'image to sound' conversion. The vision sensor captures the image in front of blind user. This image is then fed to MATLAB for processing. Processing unit processes the captured image and enhances the significant vision data. This processed image is then compared with the database kept in microcontroller. The processed information is then presented as a structured form of acoustic signal and it is conveyed to the blind user using a set of earphones. Colour information from the interested object is evaluated to determine the colour of the object. The colour output is informed to the blind user through headphones.

Keyword: *object identification,visually impaired,colour detection,edge detection*

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I. INTRODUCTION

World Health Organization (WHO) reported that there are currently about 45 million blind people worldwide and every year this number is increases by 1 to 2 million. Blind people's navigation is restricted because they do not receive enough information about the objects or obstacles in their environment. Blind and visual impaired face many problems during their daily activities with navigation and finding objects. When processing an image to determine the color of an object within, it is necessary to extract the object from the image, thus removing the background. If the background remains in the image when it is processed it will distort the analysis of the image and produce inaccurate results. To extract the object from its background we first have to determine where the object is or more specifically, which region of the image belongs to the object.

Image of the scene in front of blind user is captured using video camera and it is transformed into sound pattern. The intensity of the pixel of the image is transformed into loudness. In real world scene, background fills more area than the objects. It is also noted that most of the background is of light intensity and the sound produced on it will be of high amplitude compared to the objects in the scene. As a result, the sound produced from the unprocessed image may contain more information of the background rather than object. This may be the reason for the blind user's difficulties to distinguish the object and the background of the environment. This proposed design incorporates the interfacing of the vision sensor with ARM processor to capture the image of the object which is present in front of the visually impaired person. This processing results out in the identification of the object as well as to recognize its color in the captured image. The extra feature which is included in this design is to measure the distance of the object from the person which facilitates them to know the exact distance of the object.

II. LITERATURE SURVEY:

Blind and visual impaired face many problems during their daily activities with navigation and finding objects.Many technologies supports blind, visual impaired and people with other kinds physical challenges. For example, scanners for the blind, facsimile devices for the deaf and remote controllers for the physical challenged. Some of the early developments relating to independent navigation of visually impaired have been well covered in historical publications by P Heckbert (1982), C. L. Novak, and S. A. Shafer (1987),P.B.L. Meijer. (1992) and, more recently, in IEEE by R. Nagarajan,(2001). However, it is quite recently that individual navigation for visually impaired have appeared that are capable of delivering believable sensory stimuli at a reasonable cost using different technologies of a practical size.

Existing technologies and devices includes:
1. Electronic Travel Aids (ETA).
2. Augmented Reality (AR) technology.
3. Navigation Assistance for Visually Impaired (NAVI)

1. ETA:

This technology propose a new system for blind navigation using RFID tags to set up a location tagging infrastructure within buildings such that the blind can use an RFID equipped ETA (such as a cell phone) to determine their location as well as software that can utilize this localization data to generate vocal directions to reach a destination. Electronic Travel Aids (ETAs) are electronic devices designed to improve autonomous navigation of blind people. ETAs design varies from the sizes, the type of sensor used in the system, the method of conveying information and also the method of usage. Image of the scene in front of blind user is captured using video camera and it is transformed into sound pattern. The intensity of the pixel of the image is transformed into loudness

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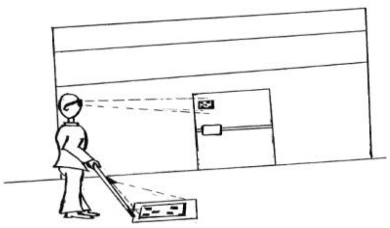
2 . AR Technology:

Augmented Reality (AR) technologies have the potential to support some of the activities for the blind people. This paper presents a design for how a walking cane can be augmented with a camera to detect Semacodes and a Braille device to deliver information. Based on the design they have developed a prototype and described its characteristics, limitations, and lessons learned.Augmented Reality (AR) technologies make the daily life easier for people with disabilities. Smaller and smaller computers enable these people to wear powerful information devices that can help navigating and recognizing objects. Otherwise impossible tasks could be doable by introducing AR concepts and special designed tools. This outlines three strategies in the field of augmented reality:

1) Augmenting the user,
2) Augmenting physical objects and
3) Augmenting the environment



3. NAVI:

This technology proposes a new object identification and color recognition module for blind people. Image processing techniques are proposed to identify objects in the captured image and then the processed image is transformed into stereo sound patterns. Color information from the interested object is evaluated to determine the color of the object.NAVI system consists of tiny vision sensor attached on a sunglass, a stereo earphones and a Single Board Processing System (SBPS) interconnected. SPBS selected for this system is PCM-9550F with Embedded Intellow power PentiumMMX 266 MHz processor, 128 MB SDRAM, 2.5” light weight hard disk, two Universal serial bus and RTL 8139 sound device chipset assembled in Micro box PC-300 chassis. The weight of SBPS is 0.7 Kg. Constant 5V and 12 V supply for SBPS is provided from the batteries. Vision sensor selected for this application is a digital video camera, Zion PN615CMOS. Figure shows the processing equipment of NAVI system.

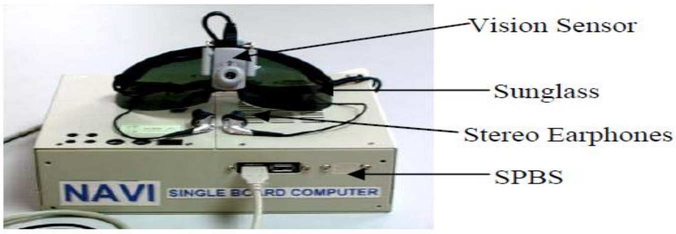


Figure: NAVI System

4. PROBLEM DEFINITION

Vocal Vision is an application made for visually impaired people. From long years ago till the date it is seen that blind people face many problems in doing their activities. They are dependent on others for doing everything. This motivated us to design the system called "VOCAL VISION". This is a small approach to make the blind people independent.

5. BLOCK DIAGRAM

III. Description:

- A webcam or a vision sensor mounted at the center of goggle is used to capture the image of the object in the surrounding.
- This captured image is given as the input to PC for MATLAB processing. MATLAB processing includes edge detection, edge linking, noise elimination, object enhancement etc.
- The processed image is then given to ARM7. So for communication between PC and ARM7 it is necessary to use a USB to TTL converter. This converter converts the signal from the serial port to the signal suitable for use in TTL compatible digital logic circuit.
- ARM7 will contain a database of various objects and their color.
- MATLAB processed image will then be compared with the database. The matched object name with its color will be audible to the respective person through headphones.

IV. IMAGE PROCESSING MODEL

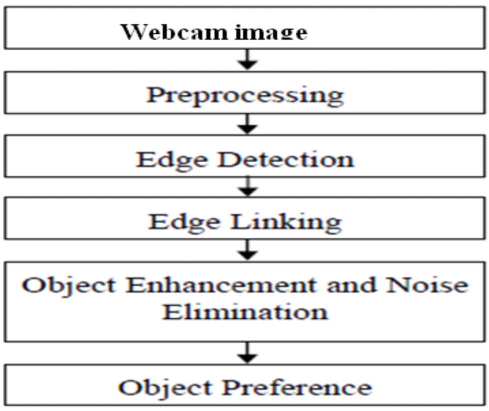


Figure: Flow Diagram for Image Processing

V. OBJECT IDENTIFICATION ALGORITHMS

Once an image of the scan plate has been obtained it is necessary to extract the object from its background so that the object alone is analysed. If the background is included, it will distort the results of the three functions of Colour Naming, Colour Matching and Object Naming. The next five describe the different methods attempted in order to achieve this task and the methods used in the final implementation

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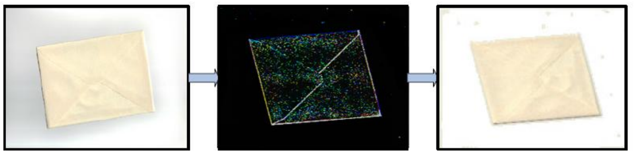
The three methods tried were:

• **Image (background) subtraction** simply compares two images to see how they differ. Regions of similar pixels are 'subtracted' leaving the pixels that are different between the two images. This can be used with the webcam by first taking a picture of the 'background', placing the object to be analysed in front of the webcam and then taking a second picture. The subtracted image should contain only the pixels that differ between the first and second image resulting in an image of only the object.

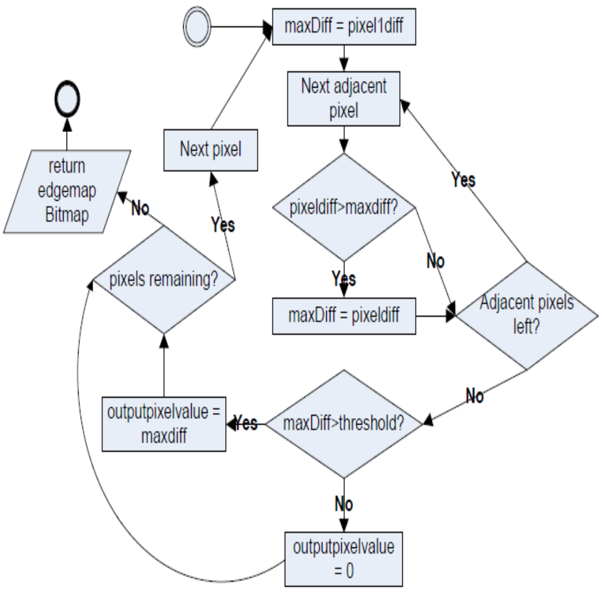
• **Edge detection** is a method that works in two stages. First of all the edges in the image are found by analysing variations in colour amongst adjacent pixels. Secondly, assuming that the object is in the centre of the image, the pixels are made transparent from the edges of the image, moving towards the centre until and edge is reached. This leaves an image with the object in the centre and a transparent background.

• **Pixel clustering** involves searching through the pixels in an image and comparing them to adjacent pixels. If the pixels are similar by a certain factor (in this case colour) then they are put into the same group. In the experiments an output image was produced containing only the pixels in the largest set. Some of the methods are better suited to the scanner than the webcam.

The technique used in proposed model is Edge detection. Following figure shows its working:



the algorithm used has flowchart as shown in following figure:



5.1 Fuzzy Rules Based Object Preference

Preference is assigned based on properties such as occurrence in iris area and sizes. Object in the centre is more important for collision free thisgation. In industrial vision system, the object of interest is found by known feature of object in the scene. But in THIS, object is undefined, uncertain and time varying. This is due to the constant shifting of the headgear-mounted orientation by the blind people. To resolve this uncertainty, fuzzy logic is applied. The features to be extracted are described as follows:

a)Size of object - The size of object is the total number of pixels in an object. The size of object, is given as in equation

$$P_1 = \sum_{i=1}^{32} \sum_{j=1}^{32} O(i, j)$$

b) Object's pixel distribution in Iris Area - the central (8 x 8) of image pixel area is called as iris area. The object's pixel distribution in iris area is expressed as in equation 2:

$$P_2 = \sum_{i=13}^{20} \sum_{j=13}^{20} O(i, j)$$

Object's pixel distribution in Outer Area - The object's pixel distribution in outer area is given as:

$$P_3 = \sum_{i=1}^{32} \sum_{j=1}^{32} O(i, j) - \sum_{i=13}^{20} \sum_{j=13}^{20} O(i, j)$$

These features are used as input to fuzzy logic algorithm. Each feature is expressed using three membership functions namely small (S), medium (M) and big (B). Membership functions such as small and big is expressed using trapezoidal curve. For medium membership, a triangular curve is used. The output is the object preference, which has three triangular curve memberships; low (L), medium (M) and high (H). The defuzzification is performed using centroid method. 27 rules are formed based on the human visual consideration stated earlier and some of the rules are given as follows:

• If P_1 is S and P_3 is S and P_2 is S, then O is L
• If P_1 is S and P_3 is S and P_2 is B, then O is H
• If P_1 is M and P_3 is S and P_2 is M, then O is M

The designed fuzzy system produces three outputs, which are low, medium and high preferences. These outputs are referred for assigning the objects with different grey intensity. Dark grey intensity with value of 77 is assigned for low preference object. A medium preference object is shaded to light grey intensity (179) and high preference object to white intensity (255). The processed image I_1 is then presented in structural stereo sound pattern.

VI. Colour Identification

Colour plays a vital role in human daily life for communication as well as for recognition. Blind people are expected to be interested in the colour of their cloths, the colour of toys and the colour of pictures [13]. The development of colour object identification module for system is inspired by one prime factor; colour is a powerful descriptor that often simplifies object identification. From the processed image, objects are divided into three preferences. As to avoid confusion to the blind people, the designed colour identification module only aims to identify colour of high preferred object in the image. Colour can be described as an attribute of visual perception consisting of any combination of chromatic and achromatic content. This attribute can be expressed by chromatic colour names such as red, green, blue etc., or by achromatic colour names such 1as white, grey, black, etc. Achromatic colour is perceived colour devoid of hue and chromatic colour is perceived colour possessing a hue [12]. Three criteria are identified to be considered for colour module in system.

• **Functionality –** Human visual system is highly adapted to visual perception of colour. They perform colour recognition simultaneously and effortlessly even in under low illumination. Sighted person can predict more colour and many term can be used to express each colour. In true colour image (24-bit RGB format) a total of 16 million (2^{24}) colours can be generated [3]. Processing all colours is excessive for the blind user. Blind people have to depend on their memory to remember the colour name and to relate each colour to another colour. Therefore, the colour to be identified in system must be useful and common to blind people.

• **Accuracy –** The colour module should be able to predict colour with minimal error. In general three factors affected the colour perception of an object; surface effect, lighting effect and the sensitivity of vision sensor [3]. Apart from the factors stated, two more factors are considered in this system. It is noted that most of object in real world are in multicolour. The identified colour also affected by the segmented object in the proposed object identification module.

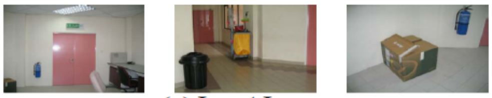
• **Simplicity –** The colour identification module has to be processed in real time. Since processing all colours require a high computational time, colour quantization is needed for system.

By considering all criteria stated above, in this paper, an algorithm is developed to classify the colours into eleven basic colours. Berlin and Kay [1] state that a total of exactly eleven basic colour categories can be drawn. The eleven basic colour categories are white, black, red, green, yellow, blue, brown, purple, pink, orange and grey. A colour quantization technique is needed to quantitize the input colour into eleven colours. There are many approaches proposed for colour quantization [4, 9]. In this work, an algorithm is designed to classify the colours into eleven basic colours. The colour information of the high-preferred object is scanned from the resized image and the mean colour value for each colour component is obtained using equation

$$\text{colour mean value} = \frac{\sum_{1}^{S_{obj}} C(i,j)}{S_{obj}}$$

VII. Experimental Result

Experimentations are done to evaluate the proposed methodology. The set of experiments were conducted to evaluate the image processing procedure using simulated and real-world images. Overall processing time for image processing and colour identification module is less than 1 second. The results of each stage in the proposed procedures for certain indoor and outdoors images are shown in Figure 3. By undertaking the colour edge detection, more information of objects boundary can be detected and extracted accurately. It is observed that objects in the image vary in terms of size, shape and location. The edge linking procedure was able to connect edge fragments in the image. Designed fuzzy logic system determines the preference/importance of the object from the feature extracted. In general, if the image contains more than one object, only one object in the image is detected as high-preferred object and other objects will be assigned as medium or low preferences. More than one object can have the same medium or low preferences. In experimentation also, a total of 200 objects in real world are tested for colour identification. It is found that the proposed colour identification algorithm was able to identify the colour of object with accuracy of 97 %.



(a) Input Image

(b) Colour Edge Detection

(c) Edge Linking

(d) Object Enhancement

(e) Noise Elimination

(f) Object Preference Output

VIII. Conclusions

This is a vision substitute system designed to aid the autonomous navigation of blind people. The system converts image characteristic into stereo sound pattern. This paper presents an improved image processing methodology for this system. In this methodology, colour image is used as input image and image processing procedures is carefully designed so that it can be implemented in real time. The proposed procedure was able to extract objects by identifying the boundary of the objects. Furthermore, noise elimination is undertaken to remove the noise form the image. A visual preferences assignment employed in this work can classify the objects into different intensity. As the processed image is transformed into stereo sound pattern, the sound produced contains less noise and thus more information about the properties of objects can be obtained. In this work, the functionality of this system is also extended by introducing colour identification module. The colour output of the object of interest is presented in verbal voice. With the added functionality, not only the blind user can discriminate the object's properties such as size, shape and orientation but they can also identify the colour of object in their environment. In this work, information regarding the distance of the object from the blind user is not considered directly, it can be developed using stereo cameras [14]. However by comparing the stereo sound patterns from relative distances between the blind person and the object, information regarding the distance of objects can be manipulated by the blind person with experience.

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