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A Novel Approach to Voice Based Assistive Aid for Visually Impaired

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Abstract: ***The assistive technology is one of the most basic and important system that helps a persons with a disability to work around his challenges. This paper presents progressive efforts for developing an assistive technology for visually impaired. The system is divided into two parts, first part is the selection part which will either select color or currency according to the users wish and the second part is navigation part. The selection module will help them in color identification of various object around the user and currency denomination recognition for making payment and finally aural output being produced, these processing being done in MATLAB. The navigation part is used for obstacle detection, to help them for free navigation by providing the aural instruction using text to speech converter module.***

Keywords: assistive technology, correlation, features extraction, template matching, text to speech, obstacle detection, visually impaired

1. Introduction

According to WHO, data over the last 20 years shows that there has been significant progress in preventing and curing visual impairment in many countries. But the people aged 50 and above, about 65% of people who are visually impaired, while this age group comprises about 20% of the world's population. With an increasing elderly population in many countries, more people will be at risk of visual impairment due to chronic eye diseases and ageing processes.

The technology is advancing day by day, the human machine interaction has become a must in our daily life. These technologies will help the visually impaired to take part in some of their social activities. So they require empathy, so as to mingle in the society and be independent for their routine activities. Hence visually impaired people need an assistive device that will allow blind user to navigate freely and this requirement has become crucial. Most of the visually impaired people depend on other individuals, white cane or guide dogs to travel freely. Currently, there are several visual information that helps visually impaired people to move in a right way but they all limit the freedom of the user. Walking securely and unhesitatingly with no human help within urban environment is a troublesome undertaking for visually impaired and blind individuals. The fundamental goal is to give an ease or financially savvy approach that will permit visually impaired individuals to explore freely or independently in the outdoor environment.

Based on this real context or condition we focused the work on developing assisting technologies that may help visually impaired individuals bringing them back to the society. Our main objective is to make a compact, self-sufficient system that will permit these people to travel through an environment .This voice based system can provide solution to this problem. This System is based on embedded system and digital image processing provides instructions to the user by giving audio instruction through the head phone connected to the system

This system mainly focuses on how a visually impaired will identify the colours of various object around the users, for recognising the paper currency while making payment , to find the obstacle during their navigation and all the module in the system will give voice output and will help them to the some extent.

2. Literature Survey

The assistive technologies as a product, equipment or device, usually electronic or mechanical in nature, which helps people with disabilities to maintain their independence or improve their quality of life [3].Various methodologies or the techniques have popped up over the time. BRASSAI et. al. [4] proposed a paper is an overview of different types of assistive technologies, mainly focusing on navigation and object detection, with the use of intelligent feedback by Human Computer Interfaces (HCI) with implication of Head related transfer function HRTF functions

For currency and color recognition various methodologies or designs are implemented. Some of the techniques are: Vipin Kumar Jain et al.(2013) employed a method where they have used digital image processing techniques to find the region of interest and after that Neural Network and pattern recognition techniques is used for matching the pattern[5]. By using pattern recognition Seth Mc Neillin has done recognition of coin with different background. First they have segmented the coin from background using Nechba's code and then extracted features by convolving texture templates with each image. Here the author uses five set of data and got 94% accuracy [8]. In the paper [9] the author proposed a component based framework for banknote recognition by using Speeded Up Robust Features (SURF). Color histogram method is used when we have to segregate between the range of color and the prominent color. The major limitation of color histogram is that the color histogram describes which color is present and in what quantity but doesn't provide spatial information [6]. In the paper [7] they have made a review on the recent developments on the currency note

recognition system. Based on the review they have found that most of the techniques used for recognition is Artificial Neural Network. Hanish and Padam has done currency note recognition using color images. First they have localized the currency note using scan line algorithm. In the experiment they have got 96% accuracy.

3. Proposed Assistive Technology

This paper proposes an assistive technology which will help the visually impaired people to minimize the dependence of the people around him while interacting with the society. The system have two modules, these modules will help them to some extent. Selection and navigation modules are the two modules. In the Selection module either color or currency can be selected, which will help them for identifying the color of the object around the user and also to recognizing the denomination of the currency. The navigation module will help to find obstacles around the user using ultra sonic distance sensor.

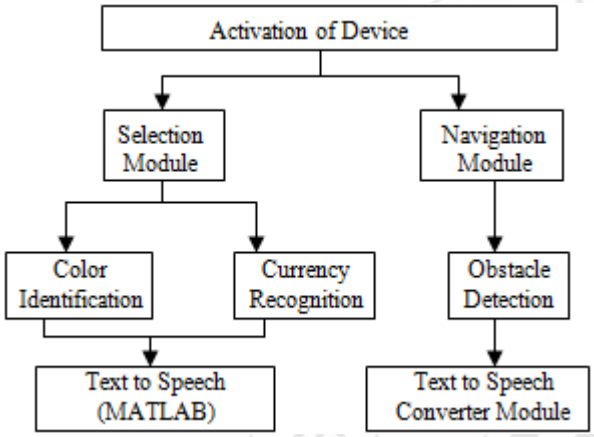

Figure 1: Overall Functional Diagram

3.1 Color Identification

Color Identification will allows the user to identify the color of an object. Currently the device works to identify five colours, i.e. Red, Green, Yellow, Black and White. The algorithm is used for identifying the color of the object. After user confirms his choice, the code gets activated whenever the object under consideration of the device. The registered input is then sent to the speech module which is responsible for providing the aural output. Aural output is produced by the Text to Speech process using MATLAB[1].

Steps for the color identification

Step 1 :The image is acquired using camera which is used as input image. The image should be of decent quality. The Image capture resolution is 640 x 480.

Step 2 :Crop the center portion of the image

Step 3 :Cropped image will be scanned for the individual channel of R, G and B intensities of the pixels[1].

Step 4 :Converting the image to gray scale

Step 5 :Depending upon the pixel value, Identify the color of the object

Step 6 : Give the aural output of the corresponding color Using text to speech

3.2 Currency Recognition

The currency denomination recognition of Indian paper currency is based on image analysis and image processing. In this system the currency recognition is done through extracting the features of the currency and the color of the currency. Every currency have the dominant color, most of the techniques uses this dominant color for recognition. But in this system taking the color of the vertical band on the extreme right area of the currency. The color of the vertical band is taken as the color of the currency. According to the color of the currency, it is classified into three groups- Red, Green and Blue. The main benefit of grouping is to reduce the probability for finding the currency.

Reserve Bank of India (RBI) on 8 November 2016 after the demonetization of ₹500 and ₹1000 banknotes and is in circulation since 10 November 2016[1] introduce new currency note of ₹2000 and ₹500. It is a part of the Mahatma Gandhi New Series of banknotes with a completely new design. The system will enable to identify both old currencies (₹10, ₹20, ₹50,₹100,₹500,₹1000)and new currencies (₹500,₹2000) notes.

In the system only three features of the currencies are extracted for the currency recognizing. In the image processing, feature extraction is a special form of dimensionality reduction. The extracted features will perform the desired task using the reduced representation instead of the full size. In the system three features of paper currencies together with pattern, color and texture are used in the recognition [2]. Features extracted are shown in the table for the old and new currencies.

Steps for the currency identification

Step 1: The image is acquired using camera which is used as input image. The image should be of decent quality. The Image capture resolution is 640 x 480.

Table 1: Features Extracted

Features	*New currency (eg:₹2000)*	*Old currency (eg:₹20)*
RBI Emblem		
Vertical band		
Denomination		

Pattern of new currency is entirely different from the existing currency, inorder to identifying the new currency notes of ₹500 and ₹2000 we need to crop the some feature of the new currency and compare it with the old currencies.

Figure 2: Feature Extracted for Identifying the New Currency

Template matching using correlation is used for the coparison.Feature extracted for the comparison is shown below. This is the first step for the currency recognition. Round part extracted is the RBI emblem, this will compare with the same position of the old currencies

Step 2: Extracting the round portion and compare with the database stored and find whether it is old or new currency.

After finding the old or new currencies and the next step is checking the color of the currency .Taking the same position for the new and old currency

Step 3: Extracting the vertical band on the extreme right area of the paper currency note

Step 4: Identify the color of the particular portion cropped using color identification algorithm which mentioned above.

Step 5: According to the color of the currency, it is classified into three group.

Table 2: Grouping the currency

RED	*GREEN*	*BLUE*
₹20	₹100	₹10
₹1000	₹500	₹50
		₹2000

Third step is to extract the denomination part of the currency .Here the position of denomination part of the old and new currency is different .According to the currency will crop the different position

Step 6: Extracting the denomination portion of the Currencies.

Step 7: Using template matching using correlation will find the exact match.

The template is sample image used to recognize the similar objects in source image. The template matching means that the position of the given pattern is determined by a pixel-wise comparison of the image with a given template that contains the desired pattern. For the pattern comparison correlation is used [10].

The width of the template is taken as [2W,2H] and the correlation response between two images f and t at each position (x,y) is defined [1][10]as:

$$c(x,y) = \sum_{k=-W}^{W} \sum_{l=-H}^{H} f(x+k, y+l)t(k,l) \quad (1)$$

This is often called cross-correlation

A common way to calculate the position of the pattern in the image f is to evaluate the normalized cross correlation value at each point for f and template t .This equation gives a basic definition for the normalized cross correlation coefficient [10]

$$c = \frac{\sum_{x,y}[f(x,y)-\bar{f}][t(x,y)-\bar{t}]}{\left(\sum_{x,y}[f(x,y)-\bar{f}]^2 \sum_{x,y}[t(x,y)-\bar{t}]^2\right)^{1/2}} \quad (2)$$

Normalized correlation returns values with a maximum range of "1".Accepted matches with a threshold value c(x,y) >0.9.In practice coefficient greater than about 0.7 or 0.8 indicates a good match[10].

To evaluate the performance of the proposed system, we tested unknown dataset of 160 banknotes which includes ₹10, ₹20, ₹50, ₹100, ₹500, ₹1000 and ₹2000. The test database includes clean, worn, torn, and noisy banknotes. For the recognition of new currency (₹500 & ₹2000) and the old currency (₹10, ₹20, ₹50, ₹100, ₹500 & ₹1000) we made a database of 160 bank notes of corresponding position. The result indicates system has 95% recognition ability.

Step 8: Text to Speech function will give aural output according to the match.

3.3 Text to Speech using MATLAB

Speech synthesis is the artificial production of human speech. A computer system used for this purpose is called a speech synthesizer, and can be implemented in software or hardware.

A text-to-speech (TTS) system converts normal language text into speech and also refers to the ability of computers to read text aloud. A TTS will converts written text to a phonemic representation, then converts the phonemic representation to waveforms that can be output as sound.

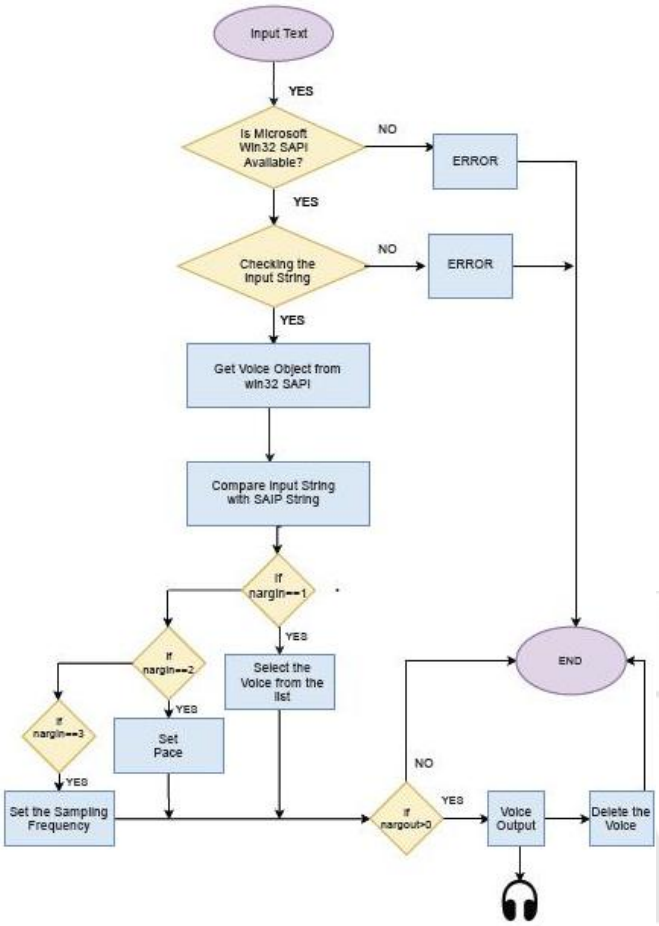

Figure 3: The flow of the text to speech using Microsoft Speech Application Programming Interface (SAPI).

The Speech Application Programming Interface or SAPI is an API developed by Microsoft to allow the use of speech recognition and speech synthesis within Windows applications. Applications that use SAPI include Microsoft Office, Microsoft Agent and Microsoft Speech Server. In general all versions of the API have been designed such that a software developer can write an application to perform speech recognition and synthesis by using a standard set of interfaces, accessible from a variety of programming languages.

Block diagram shows the flow of the text to speech using Microsoft Speech Application Programming Interface (SAPI). The Speech API is an effective tool in text to speech converter. It is necessary to have the SAPI 5.1 SDK installed and MATLAB release R2012b.Selected the Microsoft Hazel Desktop - English (Great Britain) as the computer's default voice. Microsoft Speech API (SAPI) contains many interfaces and classes for managing speech. For TTS, the base class is SpVoice. The audio format is mono, 16 bit, 16k Hz by default. Pace is the rate of speech used in TTS.PACE ranges from -10 (slowest) to 10 (fastest) and default will be 0. Sampling frequency (FS) is set the sampling rate of the speech to FS kHz. FS must be one of the following: 8000, 11025, 12000, 16000, 22050, 24000, 32000, 44100, 48000 and default is 16 KHz.The output text is converted to speech using TTS for both Color identification and for Currency recognition [12]-[13]

3.4 Obstacle Detection

The device provides a feature to help the user navigate both indoors and outdoors. In order to achieve this functionality, sensor HC-SR04 is used. Average length of the stride of a person is 0.7 m to 0.8 m .Hence, the module is programmed give instruction using TTS converter module, whenever there is an obstacle within 40 cm of the user. This gives ample time and distance to user to change his direction of motion[14]. On sensing obstacles the sensor passes this data to the microcontroller. The microcontroller (8051) then processes this data and calculates if the obstacle is close enough. If the obstacle is not that close the circuit does nothing. If the obstacle is close the microcontroller sends a signal to text to speech module [15] and gives a voice output "OBJECT IS DETECTED" .It is suitable for both moving and stationary objects. This module will differ from other because it will continuously active for the entire process.

For the text speech converter using, sunrom1231 TTS module[15]. Board plays wav files from memory card giving high quality sound output. The board is controlled from an external microcontroller or PC which sends simple ASCII string telling board what to play. The board is a tiny Audio-Sound module that can play back pre-stored audio files such as voice and music from a micro-SD memory card. The module supports various 8/16 bit stereo/mono uncompressed audio files having sampling rate from 8Khz to 48Khz. The board is controlled through simple serial commands. Board is a very flexible, compact and low cost embedded audio.

4. Result and Discussion

4.1. Color Identification and currency Recognition

The color identification was identified only five colors at present, but it can extendable to number of colors using matlab.The experiment is carried out for more than 50 different shades of the particular colors. The accuracy obtained for colors are good and but disadvantage of using camera is that it need proper light for the process and for acquiring images during night, special lighting devices are necessary.

The currency recognition will recognize old currencies (₹10,₹20,₹50,₹100,₹500,₹1000) and new currencies (₹500,₹2000) denomination.it was tested over 160 currency notes, including the faded, shaded and wrinkled paper currency. And for each features we made 25 images of database. The accuracy was about 95%. The module presents a shortcoming in the form of inability to differentiate between a fake currency note and a real one.

It is based on robust monetary characteristics of the banknotes rather than processing the whole image. These features are selected by keeping in mind the two important criteria. Firstly, the features should have good discrimination power. Secondly, the features should be easily extractable. The selected feature include, Aspect Ratio, set of effective color features etc. Due to less number of features, the methodology adopted is less time consuming as compared to

the recognition techniques that are based on processing of the whole image.

Text to speech using MATLAB worked properly for both color identification and color recognition .TTS gave the corresponding voice for each currencies and color. Color Identification, Currency Recognition and TTS, all the process are being done in MATLAB R2012b.

Figure 4: Camera and Stand used for Accessing the Currency and Colored object

4.2 Obstacle Detection and TTS Module

Obstacle detection and TTS Module is done in embedded system. The experiment is carried out for a total of 500 observations for the former. The obstacle within range of 30cm are detected with a accuracy of 100%.The obstacle is tested in a restricted indoor and outdoor environment with obstacles like table, chair, staircase, on road, another person and similar thing around. TTS module is carried out many experiments and module gave 100% accuracy

5. Conclusion and Future Work

In this paper we have proposed a novel method of assistive technology for visually impaired. The developed system touches upon on various activities that the visually impaired can carry out and in the experimentation process we have achieved a success rate of approximately 97%.The future challenges involve improving the efficiency of various modules and eliminating the various shortfalls, as discussed above.

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