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Real Time Sensor Based Assistive System for Blind People

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Abstract- **Reading text from scene, images and text boards is an exigent task for visually challenged persons. This task has been proposed to be carried out with the help of image processing. Since a long period of time, image processing has helped a lot in the field of object recognition and still an emerging area of research. The proposed system reads the text encountered in images and text boards with the aim to provide support to the visually challenged persons. Text detection and recognition in natural scene can give valuable information for many applications. In this work, an approach has been attempted to extract and recognize text from scene images and convert that recognized text into speech. This task can definitely be an empowering force in a visually challenged person's life and can be supportive in relieving them of their frustration of not being able to read whatever they want, thus enhancing the quality of their lives.**

Keywords—**Optical character recognition (OCR), Text detection and recognition, Text to speech conversion, Visually challenged person**

I. INTRODUCTION

Every year, the number of visually challenged persons is increasing due to eye diseases diabetes, traffic accidents and other causes. Therefore applications that provide support to the visually challenged persons have become an important tool. Recent developments in computer vision, digital cameras, and computers make it possible to assist these persons by developing camera-based products that merge computer vision technology with other existing beneficial products such as optical character recognition (OCR) systems. When a visually challenged person is walking around, it is important to get text information which is present in the scene/text boards. Reading is obviously necessary in today's society. Printed text is all over in the form of reports, receipts, bank documents, restaurant menu cards, classroom handouts, product packages**,** instructions on medicine bottles, etc. As an important form of communication, text is widely used in our daily life. For example, different sign boards, directions, shop names etc contain textual and/or symbolic information that is perceived by a human being to facilitate knowledge of environment and perhaps also help in his navigation. The need to read textual and/or symbolic information becomes essential in the case of blind or visually challenged persons. With this point of view, the system which detects the text from textual/symbolic board and recognizes the text characters from the captured scene text image and finally, textual and/or symbolic information will be converted into speech. To extract text information from image, text detection and recognition algorithms are necessary. However extracting scene image's text is a not easy task due to two key factors: 1) cluttered backgrounds with noise and non-text outliers, and 2) diverse text patterns such as character types, fonts, and sizes. The frequency of occurrence of text in scene image is very small, and a limited number of text characters are embedded into difficult non-text background outliers [1]. However, it is difficult to model the structure of text characters in scene images due to the lack of discriminative pixel-level appearance and structure features from non-text background outliers. Further, text consists of different words where each word may contain different characters in various fonts, styles, and sizes, resulting in large intra-variations of text patterns. To solve these difficult problems, scene text extraction is separated into two processes [2] text detection and text recognition. Detection of text and classification of characters in scene images is a challenging visual recognition difficulty for visually challenged people. Text detection is used to localize image regions containing text characters and strings. It aims to remove most non-text background outliers[3]. Text recognition is to convert pixel-based text into readable code. It aims to accurately distinguish different text characters and properly composed text words.

OCR is optical character recognition. OCR is used to recognize words**.** It can recognize characters, words and sentences without any mistakes, making the software more

perfect. Also, OCR software has a high rate of recognition. OCR is the electronic conversion of photographed images of typewritten or printed text into computer-readable text. A text-to-speech (TTS) system converts normal language text into speech. A Text-to-speech (TTS), as its called, is usually meant to help visually challenged people.

II. PREVIOUS WORK

A. Literature Review

In this section, we present a general review of previous work on text detection and recognition. There exists some research works for helping visually challenged people with text to speech technology. A number of portable reading assistants system have been designed particularly for visually challenged persons. P. Blenkhorn, D.G. Evans implemented a computer-based system that allows blind users to read, create and edit one type of schematic diagram, specifically data flow diagrams used in software engineering, is presented, together with the mapping from the original diagram to a suitable generic, tactile diagram [4]. Hideyuki Yoshida, Toshiki Kindo presented a newspaper reading out system to support visually impaired people. They built an adaptive newspaper reading out system that is sorting headlines in order of user's priority. The system consists of three modules: information filtering module, speech recognition module and text-to-speech synthesis module [5]. Nobuo Ezaki, Marius Bulacu, Lambert Schomaker, implemented a system that reads the text encountered in natural scenes with the aim to provide support to visually impaired persons. This paper describes a novel text-detection method geared for small text characters. This method uses Fisher's discriminant rate (FDR) to make a decision whether an image area should be binarized using local or global thresholds [6]. Shehzad Muhammad Hanif, Lionel Prevost implemented a texture based technique to detect text in grey level natural scene images. It is a wearable system to make possible navigation and to assist the blind and visually impaired persons in real world. It has three parts, a bank of stereovision, a processing unit for visual perception and a handheld tactile surface. The textual/symbolic information interpretation module to the vision system of the Intelligent Glasses will recognize the text from the captured scene and textual and/or symbolic information will be displayed on the handheld tactile [7]. Kumar J.A.V., Visu A., Raj M.S., Prabhu M.T. implemented an automated text to audio converting pen . If a person would like to read/understand any portion of text that text is converted to an audio signal. This audio signal is transmitted to the person's ears through wireless technology such as ZigBee [8].

Oi-Mean Foong, Nurul Safwanah Bt Mohd Razali presented a signage recognition framework for Malaysian Visually Impaired People. Their proposed framework captures an image of a public signage and transforms it into a text file using Otsu's OCR method. The text file reads by a speech synthesizer that tells the visually impaired people what the image is. This framework does not need huge database of the signage but only the character database [9]. Krishnan K.G., Porkodi C.M., Kanimozhi K. successfully presented a method where a blind person can get information about the shape of an image through speech signal. The novelty of this work is to covert the image to sound using the methodology of edge detection [10]. Hangrong Pan, Chucai Yi, Yingli Tian designed a computer vision-based system to detect and recognize bus information from images captured by a camera at a bus stop. This system is able to notify the visually impaired people in speech the information of the coming bus, and detect the route number and other related information which is depicted in the form of text. For bus detection, histogram of the oriented gradient (HOG) descriptor is in use to extract the image based features of bus facade. Cascade SVM model is applied to train a bus classifier to recognize the existence of bus in sliding windows. In bus route no recognition they design a text detection algorithm on the basis of layout analysis and text learning and then recognize the text codes from detected text regions for audio announcement [11]. Michael R.T.F. , RajaKumar B., Swaminathan S. ,Ramkumar M. proposed a system that will be helpful for the visually challenged people. This model provides the opportunity to visually challenged person to operate the mobile devices without using the keypad [12]. Adil Farooq, Ahmad Khalil Khan, Gulistan Raja implemented human-computer interface system with a complete text recognition and speech processing capability. The method uses windows text to speech conversion and image recognition (OCR) technique to analyze and extract textual information from digital scanned images. Their research uses an open source engine Asprise OCR for text extraction and is expressed in audible system. The implementation was done in Microsoft visual studio using C sharp [13]. Chucai Yi, Yingli Tian and Aries Arditi proposed a camera-based assistive text reading framework to help blind persons read text labels and product packaging from hand-held objects in their everyday lives. To separate the object from cluttered backgrounds or other surrounding objects in the camera view, they first propose an efficient and effective motion based method to define a region of interest (ROI) in the video by asking the user to shake the object. This method extracts moving object region by a mixture-of-Gaussians based background subtraction method. In the extracted ROI, text localization and recognition are conducted to obtain text information. Text characters in the localized text regions are then binarized and recognized by off-the-shelf optical character recognition software. The recognized text codes are output to blind users in speech [14].

B. Text recognition methods

Text detection is to localize image regions containing text characters and string [1]. Methods of text detection, can broadly be classified as gradient features based, color segmentation based and texture features base, histogram of the oriented gradient (HOG) descriptor, layout analysis basis and text feature learning base. Text recognition is to convert pixel based text into readable code.

III. ELEMENTS OF ASSISTANCE SYSTEM

Assistance devices designed to aid visually impaired people need to deal with two different issues: at first they need to capture contextual information (distance of an obstacle, position of the sensors, environment around the user), second they need to communicate to the user with those observed information. The contextual information captured from this assistance system are distance of the obstacle from the user using ultrasonic sensors and differentiation of the materials using IR transmitter along with Light Dependent Resistor (LDR). A basic building block of assistance system to measure the distance of the obstacle from the user is shown in the Fig.1 The elements involved are Sensors, Arduino Board, Arduino Software, Flash Memory and Audio output. The ultrasonic sensor produces ultrasonic signal and transmit it to the surroundings to sense the obstacle. If the obstacle is detected, the obstacle reflects back the signal fall on it. The processing of distance calculation is done through arduino software using arduino board. Then, this distance information is given to the user through ear phones with the help of audio recording and play back flash memory.

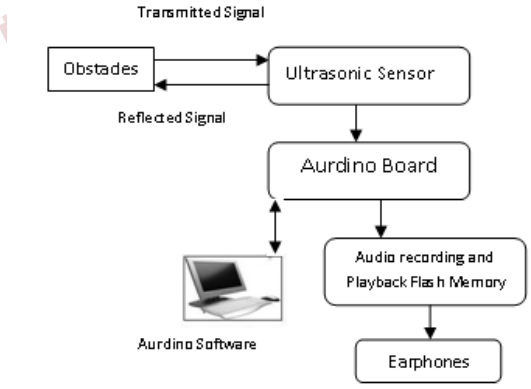

Fig. 1 Block Diagram for measuring distance between the obstacle and sensor

Block Diagram for differentiation of materials using Infrared (IR) transmitter and LDR is shown in the Fig. 2 Here, an IR transmitter sends the IR signal and it is reflected back when it falls on any object. This signal is captured by LDR. Based on the result, which is depending on the variation in the light intensity with respect to the analog voltage, the material can be differentiated using arduino software.

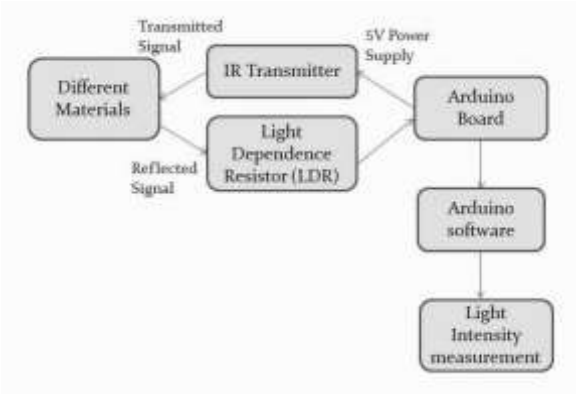

Fig. 2 Block Diagram for Material Differentiation

A. Ultrasonic Sensors

Ultrasonic sensors are designed for contactless and wear free detection of a variety of targets by means of sonic waves. It is not important, whether; the target is transparent or colored, metallic or non-metallic, firm, liquid or powdery. Environmental conditions such as spray, dust or rain seldom affect their function.

B. Arduino

Arduino is a tool for making computers that can sense and control more of the physical world than the desktop computer. It's an open-source physical computing platform based on a simple microcontroller board, and a development environment for writing software for the board. Arduino can be used to develop interactive objects, taking inputs from a variety of switches or sensors, and controlling a variety of lights, motors, and other physical outputs. Arduino projects can be stand-alone, or they can communicate with software running in the computer (e.g. Flash, Processing, MaxMSP.) The boards can be assembled personally or purchased and open-source IDE can be downloaded for free.

C. Light Dependent Resistor (LDR)

Light dependent resistors are the resistors whose resistance varies with the intensity of light incident on it. The resistance is typically very high when no light is incident and it begins to reduce as light is incident on it. LDR or a photo sensor finds its application in many robotics/embedded system applications such as line following robot, light seeking robot, garage door opener when cars light incident on it, solar tracker etc. It is known by many names such as LDR, photo resistor, photo conductor etc. The resistor has a component which is sensitive to light. One of the semiconductor materials used in constructing a LDR is cadmium sulphide (CdS).

Since an electrical current would involve movement of electrons, it drifts as per the potential difference applied at

two ends. A LDR or photo resistor is made up of a semi conductor material which has a high resistance, offering only less number of free electrons for conduction. As light (of sufficient frequency) is incident upon this semiconductor material, photons are absorbed by the lattice of the semiconductor. A part of this energy gets transferred to the electrons in the lattice which would then have sufficient energy to break free from the lattice and participate in conduction. Hence, the resistance of the photo resistor reduces with varying intensity of incident light.

IV. OBSTACLE DETECTION AND DISTANCE CALCULATION

A. Obstacle Detection

Ultrasonic sensors are used for obstacle detection and calculation of its adaptive distance from the visually impaired person as in Fig. 1. Ultrasonic sensors are used in pair as transceivers. One device which emits sound waves is called as transmitter and other who receives echo is known as receiver. These sensors work on a principle similar to radar or sonar which detects the object with the help of echoes from sound waves. An algorithm is implemented in C-language on AT89CS667 microcontroller. The time interval between sending the signal and receiving the echo is calculated to determine the distance of an object. As these sensors use sound waves rather than light for object detection, this can be comfortably used in ambient outdoor applications also.

B. Distance Measurement

The known relationship between distance, time and speed is used here (distance is the product of speed and time). Distance calculated is twice the actual distance because it includes returning time also. Hence, only half of the distance is considered. Using equation 1 the distance is calculated.

$$D = [(EPWHT) * (SV)/2] \text{ ----- (1)}$$

Where,
D = Distance in cm
EPWHT = Echo pulse width high time
SV = Sound velocity in cm/s

V. CONCLUSION

The main objective of this proposed work is to assist blind or visually impaired people to safely move among obstacles and other hazards faced by them in daily life. To investigate the performance of the whole strategy, several trials have been conducted on the multi-sensor structure for different materials.

The assistance device in this work will tell the user about the distance of the obstacle from the user and different types of materials are distinguished based on light intensity phenomenon for indoor environment. In the distant future it can be extended to a system to suit outdoor environments. Also, the audio output to the user can be given using ear phones.

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