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Design of Assistive Device for Visually Impaired

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ABSTRACT : The paper presents a theoretical model and a system concept to provide a smart electronic aid for blind people. The system is intended to provide measures such as object detection and object classification. This paper also presents a computer vision system for visually impaired. This system understands obstacles around the subject up to 6 feet in front, left and right direction using a camera module. It effectively calculates distance of the detected object from the subject and prepares navigation path accordingly avoiding obstacles. It uses speech feedback to cognizant the subject about the detected obstacle and its distance. This proposed system uses Raspberry Pi board to process real time data collected by camera module. Based on direction and distance of detected obstacle, relevant pre-recorded speech message stored in memory is invoked. This pre-recorded speech messages are invoked using easy text to speech software which is installed in the raspberry pi board. Such speech messages are conveyed to the visually impaired using earphone. We use motion tracking algorithm to guide the user towards potential target object locations. This way, we are able to guide the user's attention and effectively reduce the space in the environment that needs to be explored. In its advance mode, the system will be able to recognize objects using image processing algorithms like face detection algorithms. Database will also be implemented to store the object names and it will be useful to classify the object for the blind People which can be heard with use of Speaker.

KEYWORDS: Raspberry Pi, Digital Image Processing , Gui, Matlab.

I. INTRODUCTION

1.1 OVER VIEW : Globally, an estimated 40 to 45 million people are totally blind, 135 million have low vision and 314 million have some kind of visual impairment. The incidence and demographics of blindness vary greatly in different parts of the world. In most industrialized countries, approximately 0.4% of the population is blind while in developing countries it rises to 1%. It is estimated by the World Health Organization (WHO) that 87% of the world's blind live in developing countries.Virtually all these people could restore normal vision with eyeglasses or contact lenses. More than 90% of the world's visually impaired people live in low- and middle-income countries. Except in the most developed countries, cataract remains the leading cause of blindness. Blindness is a condition of lacking visual perception and it is always described as severe visual impairment with residual vision. The blind people's life and activities are greatly restricted by loss of eyesight. They can only walk in fixed routes that are significant in their lives, with blind navigation equipments and the accumulated memories in their long-term exploration. For the blind, thelack of sight is a major barrier in daily living: information access, mobility, way finding, interaction with the environment and with other people, among others, are challenging issues.. A great variety ofspecialists is involved: special education teachers, Braille teachers, psychologists,orientation and mobility specialists, low-vision specialists and vision rehabilitationtherapists to name a few.Evidently, this involves a very high cost that has to be absorbed by the state. Moreover,the availability of funding and qualified personnel is insufficient to cover the actualpopulation's demand.

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Other means are urgently needed to assist this population. This chapter reviews wearable assistive devices for the blind and less portable assistive devices. In the Existing method object detection is done by using of ultrasonic sensors. Ultrasonicsensor generates high frequency sound waves and evaluates the echo which is received back by the sensor. Sensors calculate the time interval between sending the signal and receiving the echo to determine the distance to an object.

1.2 PROPOSED METHODOLOGY

The system is intended to provide object detection, object classification and distance at which the object placed. The input will be obtained from the camera module which collects real time video as input. The video will be separated in to number of frames by snapshot process. The obtained frames are arranged in sequential manner. The first frame will be set as background and the rest of the frames are subtracted with the background image to get the information about obstacle present. The obstacle will be identified with the help of

1. Motion Detection Algorithm
2. Face Detection Algorithm

1.3.1 MOTION DETECTION ALGORITHM:

Initially a reliable background updating model based on statistical and use a dynamic optimization threshold method to obtain a more complete moving object. And then, morphological filtering is introduced to eliminate the noise and solve the background disturbance problem. At last, contour projection analysis is combined with the shape analysis to remove the effect of shadow, the moving human body or an obstacle is accurately and reliably detected.

1.3 FACE DETECTION ALGORITHM:

Face detection is a computer technology that determines the locations and sizes of human faces in arbitrary (digital) images. It detects facial features and ignores anything else, such as buildings, trees and bodies. Face detection can be regarded as a specific case of object-class detection. Early face-detection algorithms focused on the detection of frontal human faces, whereas newer algorithms attempt to solve the more general and difficult problem of multi-view face detection.

1.4 MODERN ASSISTIVE TECHNOLOGIES

Advances of technology and better knowledge in human psycho-physiological 3D worldperception permit the design and development of new powerful and fast interfaces assistinghumans with disabilities. For the blind, research on supportive systems has traditionally focused on two main areas: information transmission and mobility assistance. Morerecently, computer access has been added to the list.The most successful reading tool isthe Braille dot code. Introduced by Louis Braille in the 19th century, it has now become a Standardworldwide. Problems related to mobility assistance are more challenging. They involve spatial Information of the immediate environment, orientation and obstacle avoidance. Manyelectronic travel aids (ETAs) for safe and independent mobility of the blind have beenproposed over the last decades. They all share the same operation principle: they all scanthe environment (using different technologies) and display the information gathered toother sense (mainly hearing and touch).

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II. LITERATURE REVIEW

2.1 ASSISTIVE DEVICES WORN ON THE TONGUE:

The University of Wisconsin (USA), University of Montreal (Canada), Joseph Fourier University. The TDU proposed to retrain the way the brain processes visual information by first stimulating the tongue with an electrode array. The nerves in the tongue send signals through a different pathway to the brain stem in the area that deals with touch. Eventually, the blind person learns to interpret touch as sight in the virtual cortex. The TDU proposed to retrain the way the brain processes visual information by first stimulating the tongue with an electrode array. The nerves in the tongue send signals through a different pathway to the brain stem in the area that deals with touch. Eventually, the blind person learns to interpret touch as sight in the virtual cortex.

2.2 HEAD-MOUNTED ASSISTIVE DEVICES:

National Library Service for the Blind and Physically Handicapped (NLS)
The most sophisticated device that first became commercially available was the Binaural Sonic Aid (Sonic Guide). The Sonic Guide consisted of ultrasonic wide-beam equipment mounted on spectacle lenses (Fig. 10(a)). Signals reflected back from the 3D world were presented to the user as audio indicating the presence of an obstacle and its approximate distance to the user.

2.3 THE VOICE SYSTEM:

Philips CoDevice uses a camera as an input source. An image is translated to sounds where frequency and loudness represents different scene information parameters such as position, elevation and brightness. The disadvantage of this system is mastering the voice's visual-to-auditory language may well take years.

2.4 VESTS AND BELTS:

Carnegie Mellon University (USA). It is a wearable tactile harness-vest display that provides simple directional navigation instructions. A set of 6 vibrating motors generates tactilemessages such as forward, back, left, right, speed up and slow down to guide the user through an environment. The method is not economical and it just an approximation.

2.5 EYE RING (FINGER WORN DEVICE)

Savithru Jayasinghe, Amit Zoran. It is a wearable assistive device worn on a finger. This device uses a camera that is worn on the finger which takes continuously snaps of the obstacle and on the user's request the obstacle is processed. The obstacle is processed using smart phones and corresponding audio output is given by the smart phone after processing the image captured.

III. HARDWARE AND COMPONENTS DESCRIPTION

1.5 RASPBERRY PI BOARD:

The **Raspberry Pi** is a credit-card-sized single board computer developed in the UK by the Raspberry Pi Foundation with the intention of promoting the teaching of basics in computer science in schools. The Raspberry Pi has a Broadcom BCM2835 system on a chip (SoC), which includes an ARM1176JZF-

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S 700 MHzprocessor, VideoCore IV GPU, and was originally shipped with 256 megabytes of RAM, later upgraded to 512 MB.It does not include a built-in hard disk or solid-state drive, but uses an SD card for booting and persistent storage. There are two models available in raspberry pi

They are:

1. Model A
2. Model B

Model A:

Memory (SDRAM)	256 MB (shared with GPU)
USB 2.0 ports	1 (direct from BCM2835 chip)
Onboard	NONE
Power ratings	300 mA (1.5 W)

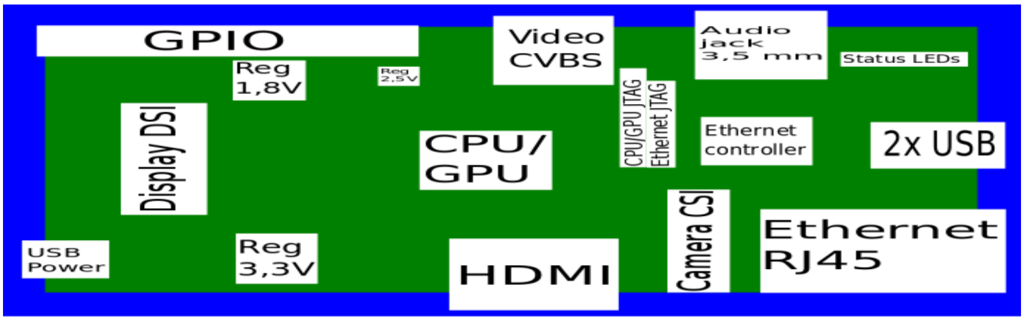
Model B:

Memory (SDRAM)	512 MB (shared with GPU)
USB 2.0 ports	2 (via the built in integrated 3-portUSB hub)
Onboard	10/100 Mbit/s Ethernet (8P8C) USB adapter
Power ratings	700 mA (3.5 W)

The Raspberry Pi does not come with a real-time clock, so an OS must use a network time server, or ask the user for time information at boot time to get access to time and date for file time and date stamping. However, a real-time clock (such as the DS1307) with battery backup can be added via the I²C interface.

List of components present in the Raspberry pi board:

1. BCM2835 which includes an ARM1176JZF-S 700 MHz processor, Video Core IV GPU
2. SD card
3. Audio outputs-3.5 mm jack
4. Low-level peripherals: 8 × GPIO
5. Video outputs: Composite RCA (PAL and NTSC), HDMI (rev 1.3 & 1.4), raw LCD Panels via DSI



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3.1.1 BCM2835

The BCM2835 is a cost-optimized, full HD, multimedia applications processor for advanced mobile and embedded applications that require the highest levels of multimedia performance. Designed and optimized for power efficiency, BCM2835 uses Broadcom's Video Core IV technology to enable applications in media playback, imaging, camcorder, streaming media, graphics and 3D gaming.

3.1.2 ARM1176JZF-S 700 MHZ PROCESSOR

ARM11 is a family of ARM architecture 32-bit RISC microprocessor cores.Micro architecture improvements in ARM11 cores include:

3.1.3 VIDEO CORE IV GPU

Video Core is low-power mobile multimedia processor architecture.Its two-dimensional DSP architecture makes it flexible and efficient enough to decode as well as encode a number of multimedia codecs in software, while maintaining low power usage. It supports Full HD 1080p.

3.1.4 SD CARD

Secure Digital (SD) is a non-volatile memory card format for use in portable devices. SD card families initially use a 3.3-volt electrical interface. The SD cards changed the MMC design in several ways:

1. Asymmetrical slots in the sides of the SD card prevent inserting it upside down, while an MMC goes in most of the way but makes no contact if inverted.
2. Most SD cards are 2.1 mm (0.083 inches) thick, compared to 1.4 mm (0.055 inches) for MMCs. The SD specification defines a card called Thin SD with a thickness of 1.4 mm, but they are rare, as the SDA went on to define even smaller form factors.
3. The card's electrical contacts are recessed beneath the surface of the card, protecting them from contact with a user's fingers.
4. The SD specification envisioned capacities and transfer rates exceeding those of MMC, and these have both grown over time.

Cards may support various combinations of the following bus types and transfer modes. The SPI bus mode and one-bit SD bus mode are mandatory for all SD families.

3.1.6 DISPLAY SERIAL INTERFACE

The Display Serial Interface (DSI) is a specification by the Mobile Industry Processor Interface (MIPI) Alliance aimed at reducing the cost of display sub-systems in a mobile device. It is commonly targeted at LCD and similar display technologies. It defines a serial bus and a communication protocol between the host (source of the image data) and the device (destination of the image data). At the physical layer, DSI specifies a high-speed differential signalling point-to-point serial bus. This bus includes one high speed clock lane and one or more data lanes. Each lane is carried on two wires (due to differential signalling). All lanes travel from the DSI host to the DSI device, except for the first data lane (lane 0), which is capable of a bus turnaround (BTA) operation that allows it to reverse transmission direction.

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3.2 CAMERA MODULE

A sample video with a stationery background and a single object moving is considered. This video is converted into frames using a frame separation algorithm. This converts the input video file into images of jpg format. These images are provided in sequence as input to the program. It has a resolution of 800*1000 pixels.

3.3. HEADPHONE

The output is taken from the audio jack pin of the Raspberry pi camera module.

This output will be instructed to the user with the help of headphones.

IV. IMPLEMENTATION OF PROPOSED METHODOLOGY

4.1 INTRODUCTION

Digital Image Processing refers to processing of digital images by means of a digital computer. Digital image can be defined as two dimensional function f(x,y)

and the amplitude of f at any point gives the gray level or intensity of the image.

Image Processing is done in three levels:

1. Low level processing involves primitive operations like noise reduction ,image sharpening etc.
2. Mid level processing involves partitioning an image into regions or objects.
3. Higher level processing involves “making sense” of an ensemble ofrecognized objects.

Moving object detection comes under mid- level processing

4.2 BACKGROUND OF MATLAB

MATLAB is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation.MATLAB stands for matrix laboratory which is a standard computational tool for advanced courses in mathematics, engineering and sciences. MATLAB is a choice for research and analysis as it is complemented by a family of application specific solutions called tool boxes. Image processing tool boxhelps in digital image processing

4.3OBJECTIVE

We aim to implement a robust moving object detection algorithm that can detect objects in variety of challenging real world scenarios.We organize the video into frames in which the background is stationary.We use image processing tool box for obtaining the object by subtracting the frames.The moment of the object is described using edge detection techniques. We will collect experiment datasets for these scenarios for testing our algorithm performance.

4.4 GRAPHICAL USER INTERFACE

4.4.1 INTRODUCTION

A graphical user interface (GUI) is a user interface built with graphical objects, such as buttons, text fields, sliders, and menus. In general, these objects already have meanings to most computer users.The action that results from a particular user action can be made clear by the design of the interface.

4.4.2 CREATING GUIS WITH GUIDE

MATLAB implements GUIs as figure windows containing various styles of uicontrol objects. You must program each object to perform the intended action when activated by the user of the GUI. In addition, you must be

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able to save and launch your GUI. All of these tasks are simplified by GUIDE, MATLAB's graphical user interface development environment.

4.4.3 THE IMPLEMENTATION OF A GUI

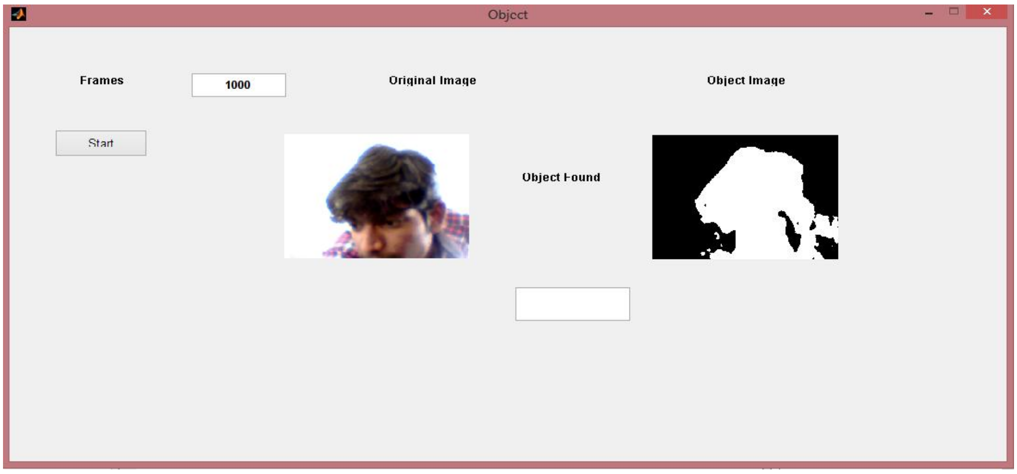
While it is possible to write an M-file that contains all the commands to lay out a GUI, it is easier to use GUIDE to lay out the components interactively and to generate two files that save and launch the GUI **A FIG-file** - contains a complete description of the GUI figure and all of its children (uicontrols and axes), as well as the values of all object properties.

4.4.4 USER INTERFACE CONTROLS

The Layout Editor component palette contains the user interface controls that you can use in your GUI. These components are MATLAB uicontrol objects and are programmable via their Callback properties. The various componenets available are as follows

1. Push Buttons
2. Sliders
3. Toggle Buttons
4. Frames
5. Radio Buttons
6. Listboxes
7. Checkboxes
8. Popup Menus
9. Edit Text
10. Axes
11. Static Text
12. Figures

4.5 MATLAB OUTPUT



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V.CONCLUSION

The miniaturization of actuators and electronics has allowed the creation of new devices and systems that can be embedded into clothing. These wearable systems facilitate the user's ability to perform normal daily tasks without feeling encumbered by burdensome devices. In particular, this chapter has focused on wearable assistive devices for the blind. A brief non-exhaustive survey of wearable assistive devices for this population has been presented to illustrate the most representative work done in this area. Devices worn chest have been proposed over the last decades to provide wearable solutions to the problems of reading and mobility. For the blind, hearing and touch become the first and second major senses, respectively. They will never replace vision but they still gather much information from the environment for daily tasks. That is the reason why assistive devices provide acoustical and tactile feedback to compensate for visual information. Despite efforts and the great variety of wearable assistive devices available, user acceptance is quite low. Audio books and Braille displays (for those who can read Braille) and the white cane and guide dog will continue to be the most popular reading/travel assistive devices for the blind. Acceptance of any other portable or wearable assistive device is always a challenge in blind population. Motivation, cooperation, optimism, willingness/ability to learn or adapt new skills is not a combination that can be taken for granted.

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