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DIGITAL VISION SUPPORTING VISUALLY CHALLENGED

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Abstract: For easy and safe navigation of visually challenged people, by detecting obstacles & people, through a detection system which uses UVC camera. This visual detection system detects obstacles up to 300cm using Sonar and sends back the feedback by beep sound and alerts the person with the objects location. Along with this an UVC webcam is affixed with 32 bit ARM micro-controller. This is featured along with algorithm to the visually challenged people walking sticks. The above mentioned setup supports image-processing, which processes images and sends response post detection, which measures the properties of the obstacle i.e., identifying human through facial & object detection. Algorithms is implemented in open CV which executes in LINUX.

1. Introduction

Navigation is the most significant problems faced by visually challenged people. Traditionally, used navigation tools are white cane, guide or assistant dogs, etc. White cane guides them to walk, as it detects the obstacles in their path. The length of the white cane varies based on the height of the individual i.e., from the sternum to ground. Guide dogs are trained assistant dogs which helps visually challenged people to move freely without hitting the objects. But as the recent technology have grown rapidly, various navigation and mobility aids have been developed which is of great help in assisting them to cross various hurdles in their path. These assisting kits are called as Electronic-Travel-Aids. Moving securely and boldly without assistance in cities or new environment is an arduous task for visually impaired people. As, mentioned above long white cane or travel assistant dogs are used to navigate independently. Though these walking canes signals the person about obstacle prior 1m, for an average walking speed of 1.2 m/s, the response time is very less i.e., 1 second. The cane scans the floor consistently, but fails to detect certain objects such as truck-rear, low branches etc. Confidence and security can be increased only if the device could trace a hurdle free path in an unfamiliar location.

But this system carries a significant drawback, which is it can detect only the objects at a shorter distance and also the details of the objects are unknown of. To fix this disadvantage, we are here replacing these GPS trackers and sensors with cameras. These cameras perform the action of eye to these people. The controller and the camera are affixed to the walking cane and monitors the area in front of the individual. The controller receives the monitored signals and processes them, in case an obstacle is recognized in the path, the controller alerts the person with a voice signal –'Obstacle'. The significant advantage of this device, is that it can differentiate between everything, such that if it detects there is a person in front of us, it informs us as 'Person in front of you'.

2. Synopsis of Electronic Travel-Aid

The device is designed on an embedded system eBox of size 4.5”x4.5”, with a low cost X86 processor based on embedded-computer system. Ultra-sonic sensors are connected to sensor circuit, which feeds the data to eBox 2300™ through a RS-232 serial cable. USB webcam is connected with eBox 2300™ to capture the field view of person and locate a human. Headphone is connected with eBox 2300™ to get feedback as audio (beep sound) of the obstacle distance & presence of human being. The eBox 2300™ is powered by 5V, 3A DC adapter and the sensor circuit is powered by two 9V alkaline batteries. Algorithms are implemented via C++ using Visual Studio 5.0 IDE, which runs in WinCE. For a better field view, USB webcam is affixed in helmet and ultrasonic sensors are placed in the individual’s belt. 3 easy control switches are provided to control the human detection system, motion detection system, and ultrasound based distance measurement system respectively. Ebox 2300™ and sensor circuit are kept in the bag which will be held in the waist of the individual. User has to operate the device manually and they will get the audio feedback till the switches are pressed.

Human face is detected to confirm human presence. However there are cases when human face is not covered within field of view, even though human is present in front. In such cases human presence is claimed by detecting cloth and human skin i.e., if cloth is found in the area of human skin, and face is not detected, then it will be considered as human.

3. Components Used

3.1 Ultrasonic Sensor

Fig 3.1 Ultrasonic Sensor

The distance between an obstacle and the person is measured using Ultra-sonic sensor which in turn utilizes sound waves. Discharging sound waves at particular frequency and receiving it back measures the distance i.e., the elapsed time between the generation of sound wave and its reception, measures the distance between the obstacle and the sonar sensor.

3.2 Raspberry

Fig 3.2 Raspberry pi 3

3.3 Arduino Lilly pad

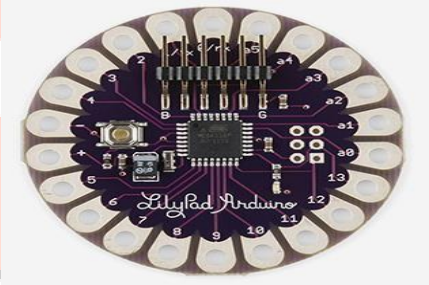


Fig 3.3 Arduino Lilly pad

Lily-Pad Arduino 328 main board is a micro-controller which is Arduino-programmed and is compatible with wearable materials i.e., e-textiles. This model has the same features as other Arduinos and this is a light-weight and is designed as a round package to avoid snagging with broad tabs that is stitched and affixed with conductive thread.

3.4 Earphones

Fig 3.4 Earphone

Headphones are mini versions of speakers which allows you to listen music without disturbing people around you. They can produce sound waves using different electromagnets with lower amplification and by creating different sealed chambers they can differ in channels and they can be either wired or wireless sounding as good as or better than the stereo speakers.

3.5 Power Bank

Power bank is custom-designed portable batteries which comes pretty handy to charge electronic devices when we are travelling.

They use a sophisticated electronic circuit which takes in charge from a charger and then charging other devices, in other words, they are also referred to reverse charging devices. The devices can be charged from and to using various Input-Output ports like type-c and USB ports. Their capacity is measured in terms of milli-amperes which generally ranges from 300mA to 25000mA and they use lithium-ion batteries. These portable chargers are very powerful because they are relatively compact, lightweight, and provide great power to weight ratio. They can have one to one port or one to many ports to charge multiple devices at the same time.

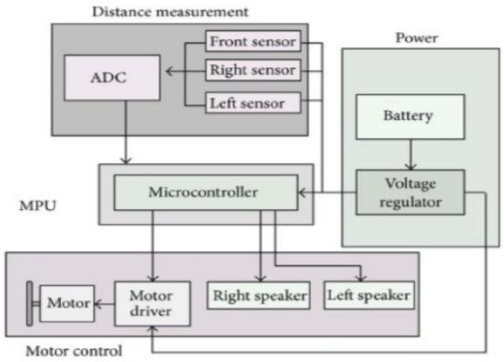
Fig 3.5 Power Bank

3.6 Memory Card

Fig 3.6 SD card

SD card is a non-volatile storage and removable flash memory device used in portable electronic devices like computers and Smartphones to store information. They have high read, write, modification speed, and they can also be encrypted in order to keep the data safe and secure. This component is used in raspberry pie to store data. This is very helpful when we need to scale up or scale down our systems.

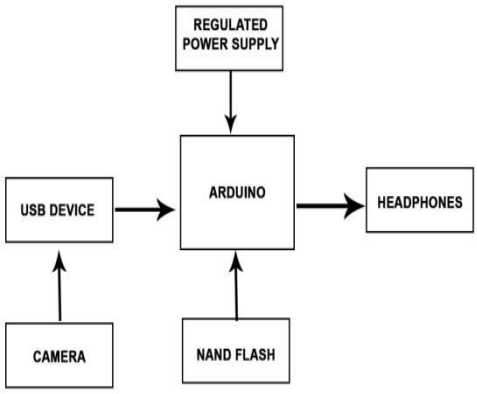
4. Block diagram



5. Methodology

On left, right and front of the helmet 3 ultra-sonic sensors are used, which is connected to an Arduino, which controls its working on measuring

the distance of the objects which is present before the individual. To capture the objects in the form of images and process those via image-processing camera modules are used. This proposed design is composed of two division i.e. a) Object detecting division b) Traffic signal information unit for pedestrian crossing. The ultra-sonic sensor in this system detects the obstacles in the way of a blind person. HC-SR04 is a 4-pinned ultra-sonic sensor, which is affixed on the spectacles as depicted in figure: 2, in this pin-1 is connected to a 5V DC power supply, pin-2 is connected to P3.5 pin in the AT89c51 microcontroller, such that it triggers the ultra-sonic sensor, then pin-3 is connected to P3.2 so it receives echo's as high pulse when an object is detected and finally pin-4 is grounded. There are three major parts in the ultrasonic sensor which detected the objects from the individual's position i.e. a timer, a receiver and a transmitter. The distance is calculated when timer triggers the transmitter which emits series of pulses, and timer waits for the receiver to detect the reflection of the pulses, after which the timer stops. Thus the time measured here is divided by two & then multiplied with the speed of sound and the resultant is the distance between the obstacle and the sensor. Using the output of the microcontroller, the relay coil gets energized via the ULN2003 IC driver, which then activates the voice module and thus the voice message of the detected object is relayed to the visually challenged individual via Google voice recognition API: Voice recognition can be attained in multiple ways on Linux (same on Raspberry Pi), the accuracy and the accept is high and strong, also it is recorded and stored in a flat file. This stored file is transferred to Google and is converted to text file which is then saved as 'stt.txt'.



Measuring of distance: Distance, time and speed relation is depicted in equation-1. The measured distance is 2 times the actual distance, as it includes the return-time. Therefore only ½ of the distance is taken represent the actual distance between the object and user

Distance calculation using equ (1)

D= [(Elapsed time) * (SV)/2] ------ (1)

where,

D is Distance in cm

SV is Sound velocity in cm/s

Elapsed time is time taken by the sensor to transmit and receive the ultrasound wave.

Human Detection: Human face is detected to for human presence detection. But at times face is not covered in the field view of camera even though human is present before the individual. In this case human presence is detected through their cloth or human skin i.e. if either cloth or skin is present in the place of human face, then it will be detected as human. Detection of face is a computer technology which determines the size and location of face in digital image. Only features of face are detected, everything else are neglected. In a photo a face is searched and the image of face is cleaned by image processing for better recognition. Detection of obstacle is also a computer technology which relates computer vision and image processing for

dealing semantic obstacles eg: human, building, cars, etc. as digital image and video.

6. Conclusion

Navigation of visually challenged people using an electronic eye is presented here. This electronically designed travel kit boosts the confidence in the individual to move independently in new environment. Significant issue with the user to use this aid is that it should be modest, easily carried and should be small & light weight. This device is developed covering all the above factors. Individual wears helmet with camera and headphone affixed to it.

Performance of this ETA device is measured, by testing it in laboratory environment. 3-way control switch is used for manual control. The first switch detects the hurdles in the path, the second switch detects the human within the field view of camera and the final switch detects the movement of the people in from of them. ETA device gives feedback through audio as a response to the pressed switch. Example: if the first button is pressed, obstacles in the path will be detected and a low or high level beep sound based on distance of the object will be produced. Comfortable operation of device and to interpret the feedback audio, an appropriate training is adequate.

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