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A Project Work Report on

"NAVIGATION SYSTEM FOR THE BLIND"

Submitted in Partial Fulfillment of the award of the

Degree of Bachelor of Engineering

in

ELECTRONICS AND COMMUNICATION ENGINEERING

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CERTIFICATE

Certified that the Project Work entitled "**NAVIGATION SYSTEM FOR THE BLIND**", is carried out by **KUSHAL MINACHI (2JI15EC721), PAVAN PREETAM MOTAGI (2JI15EC734), PRIYANJALI CHANDEL (2JI15EC740), TEJASHWINI GARAGATTI (2JI15EC756)** are bonafied students of **Department of Electronics and Communication Engineering, Jain College of Engineering, Belagavi**, in partial fulfilment for the award of **Bachelor of Engineering** in Electronics and Communication of the **Visvesvaraya Technological University, Belagavi**, during the year **2019**. It is certified that all corrections/suggestions indicated for Continuous Internal Evaluation have been incorporated in the report deposited in the departmental library. The project report has been approved as it satisfies the academic requirements in respect of Project Work prescribed for the said Degree.

S.A. 17/05/19	17/5/19	
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DECLARATION

We hereby declare that the project work embodied in this report entitled **"NAVIGATION SYSTEM FOR THE BLIND,"** has been carried out by us at Department of Electronics and Communication Engineering, Jain College of Engineering, Belagavi, under the supervision of **Prof. SHRADDHA M.** The report has not been submitted in part or full for the award of any degree of this or any other university.

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Abstract

While visually impaired persons travel between two points, they lack many useful inputs that can be seen by sighted traveller such as location, orientation, and possible obstacles ahead. Therefore they would rely on repetitive and predefined routes with the minimum obstacles. Guide dogs or even long canes are usually used to detect the obstacles. But these have their shortcomings and hence we intend to develop a system with the help of Raspberry Pi to overcome this problem. Develop a fully functional prototype for obstacle detection and course correction. Provide the blind person as a free way to reach their intended destination. Provide an easy way of interaction between the environment and a blind person. Constantly update the location of the person.

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Chapter 1

INTRODUCTION

The envisioned project intends to ease up the difficulties faced by visually impaired people in the world. Since they do not have the ability to visually interact with the environment in their day to day life,the proposed intends to help the machieve the same with the use of the following components:

1. Raspberry Pi Model 3B+
2. Raspberry Pi Camera Module
3. GSM/GPS Module
4. 3.5mm Earphones
5. Ultrasonic Sensor

We intend to use a Raspberry Pi which has image processing software along with real time system to build a jacket/hoodie which can be worn by blind people so that they can navigate through the world on their own. Python programming and OpenCV and Tensor Flow is used as the software part for this project. Furthermore, we intend to have a GSM/GPS module linked with the Raspberry Pi so that the location of the person can be tracked all the time. A simple application would also be needed to be created to make the location known.

The cameras would scan the environment and detect obstacles. The obtained data would then be processed in real time and the user would be intimated through the use of earphones about the obstacle lying ahead and thereby instructing him/her to change course and avoid collision.

1.1 Motivation

According to information from the World Blind Union (2009), in the world, there are over 160 million of blind and partially sighted people. It is well known that the loss of vision often implies loss of independence, lack of communication and human contact which increase the limitation in mobility. During the last century and, especially, after the Second

WorldWar,researchers invested many efforts in designing and developing ElectronicTravel Devices for perceiving surrounding environment,devices which would help blind people to navigate safety and independently. There are two main tasks for navigation: to detect and avoid obstacles and to follow the route. From early times, Electronic Travel Aids (ETA) have been classified in three classes: obstacle detectors or clear-path indicators, environmental sensors and navigation systems.

The first class is based on sensory or artificial vision systems. The sensory systems emit ultrasonic or laser beams to the environment, which are reflected by the object; the system calculates the distance from the object according to the time difference between the emitted and received beam. The stereo-vision systems use the object tracking algorithms and calculate the distance by using gray scale method (vOICe).

Mobility is one of the critical problems encountered by visual impaired persons in their daily life. Over decades, these people were using navigational aids like guide dogs, white cane, or electronic travel equipment. Dogs are very capable guidance for orienting the blind people outdoors, and offer impaired persons with the highest degree of mobility and independence. However this method necessitates an extensive training and selective breeding. Furthermore, trained dogs are only useful for about five years. Among the activities affected by visual impairment, navigation plays a fundamental role, since it enables the person to independently move in safety.

The heterogeneous environment, easily perceived by visually enabled people, is hardly known by partially sighted people. A challenging task for these people is independent navigation in new spaces/buildings/environments. The environment is usually signalled and labelled with visual marks and signs which are not appropriate for blind persons.

With the purpose of balancing the access to services and spaces among all persons, this work proposes an innovative navigation and information system to help the navigation of blind people within new environments (e.g. shopping centre, public office building). Visually impaired people can navigate unknown areas by relying on the assistance of canes, other people, or specially trained guide dogs. The traditional ways of using guide dogs and long-cane only help to avoid obstacles, not to know where they are.

The main objective of this project is to propose, design, implement, and test a prototype navigation system to safely guide blind people to travel from one point to another using the shortest path possible. Our contribution lies on the following aspects:

1. Study, analyse, and categorize the existing systems used to guide blind people

2. Build a prototype system to guide and navigate blind people when they travel between two points.

3. Develop a fully functional prototype for obstacle detection and course correction.

4. Constantly update the location of the person using the device.

Therefore we intend to present a prototype of a navigation system that helps the visually impaired to move within the environment. The system designed has been focused on usability of the solution, and also on its suitability for deployment in several built areas. Several proposals have tried toaddress this challenge in indoor and outdoor environments. However most of them have limitations, since this challenge involves many issues (e.g., accuracy, coverage, usability and interoperability) that are not easy to address with the current technology. Therefore, this can still be considered an open problem.

1.2 Problem statement

Object recognition, obstacle detection and location detection through the scientific knowledge of the working of RaspberryPi, Raspberry Pi Camera Module and GSM Module with the following objectives.

1. How to capture and process the images obtained from the Raspberry Pi camera to identify them?
2. How to achieve obstacle detection and course correction of the person wearing the intended device?
3. How to detect the location of the person wearing the device?
4. How to fabricate a jacket/hoodie which the user can wear?

Chapter 2

LITERATURE SURVEY

2.1 José Cecílio, Karen Duarte, Pedro Furtado

They have proposed an innovative navigation and information system to help the navigation of blind people within new environments(e.g. shoppingcentre,publicofficebuilding). Based on smartphones and wireless sensors deployed in the environment, they proposed an information tracking system for real time guide blind people (BlindeDroid). It offers guided navigation, answering questions, and providing objective information about places, products and services that are available surrounding the user.

In BlindeDroid, users can participate using their smart phone to do a survey over an environment and collect information about paths,objects and walking conditions and/or potentially dangerous situations. BlindeDroid was designed to be ease of use and user-friendly as possible. It was designed to minimize the amount of interaction to specify desired destinations, products or services. They have implemented the BlindeDroid as a software library in Java (J2SE and Android). Then they have developed a prototype, based on such library, and tested it on a shopping centre with two blind persons.

2.2 K. Ramarethinam, K. Thenkumari, P. Kalaiselvan

They have provided a navigation system via audible messages and haptic feedback to the visually impaired people helping them to improve their mobility independently. The system with portable self-contained feature that allows the blind people to travel through familiar and unfamiliar environment. The proposed system consists of hardware and software. In this system the Braille capacitive touch screen enables auser friendly communications with thesystems. All the operations canbe made with this touch screen.

The major components are the GPS receiver and path detector used for receiving the current position and finding the current position and finding the shortest path to the destination. The navigation process of the system will start once the user gives the destination as voice command.

The system is provided with an emergency button which will trigger an SMS that will send the present location of theuser(GPScoordinates)to are motephone number asking for help,in case emergency. In addition, the device provides user information needed, in audio format, includingtime,calendar,objectcolour,alarm,obstacledetection,navigation direction, ambient light and temperature conditions. This project will help the blind people in improving their communication ability and not to depend on none during walking in even unknown areas.

2.3 Tareq Alhmiedat, Anas Abu Taleb, Ghassan Samara

They introduced a mobile assistant navigation prototype to locate and direct blind people indoors. Since most of the existing navigation systems developed so far for blind people employ a complex conjunction of positioning systems, video cameras, location based and image processing algorithms, they have designed an affordable low-cost prototype navigation system for orienting and tracking the position of blind people in complex environments.

The prototype system is based on the inertial navigation system and experiments have been performed on NXT Mindstorms platform. In the first stage, we aim to study and analyse existing works, then develop a prototype using Lego NXT platform. While in the second stage, we aim to expand the proposed prototype to a real system using complicated hardware devices.

2.4 V. S. M. Madulika, M.S. Madhan Mohan, C.H. Sridevi, T.V. Janardhana Ra

They used object detection and real time assistance via Global Positioning System(GPS) and developed an Electronic Travelling Aid (ETA) kit to help the blind people to find obstacle free path. This ETA is fixed to the stick of the blind people. When the object is detected near to the blinds' stick it alerts them with the help of vibratory circuit (speakers or head phones).

The system consists of ultrasonic sensor, sonar sensor, GPS Module, GSM Module and vibratory circuit (speakers or head phones). The location of the blind is foundusing Global System for Mobile communications(GSM) and Global Position System (GPS).

Obstacle detection sensor is the heart of the system. Obstacle sensor is interfaced that will keep on emitting a signal generated by the Microcontroller. This signal after hitting the obstacle will be received back. This echo signal collected by the sensor receiver and based on computing signal thus alerting the person well in advance about the obstacle.

2.5 Sakhawat Hossen Rakib, Atika Farhana, A.H.M. Zadidul Karim, Galib Hashm

They designed and developed a navigation system for visually impaired personal based on nerve stimulation and ultrasonic distance measurement system by using GSM and GPS technology. For primary obstacle detection and decision making nerve stimulation is used.

Nerve stimulation circuitry is the salient feature of this system which provides a silent feedback to nerve of a visually impaired person according to the distance of any obstacle. The blind person can feel the obstacle ahead and point outt he distance from it as stimulation increases when distance to obstacle decreases.

2.6 Jack Loomis, Reginald Golledge, Roberta Klatzk

They designed a portable,self-contained system that will allow visually impaired individuals to travel through familiar and unfamiliar environments without the assistance of guides. The system,as it exists now,consists of the following functional components: amodulefor determining the traveller's position and orientation in space ,a Geographic Information System comprising a detailed database of our test site and software for route planning and for obtaining information from the database, and the user interface. The experiment reported here is concerned with one function of the navigation system: guiding the traveller along a predefined route.

2.7 Mounir Bousbia-Salah, Abdelghani Redjati, Mohamed Fezari

They developed of a navigation aid for blind and visually impaired People. It is based on a microcontroller with synthetic speech output. This aid is portable and gives information to the user about urban walking routes to point out what decisions to make. On the other hand, and in order to reduce navigation difficulties of the blind,an obstacle detection system using ultrasounds and vibrators is added to this device.

The proposed system detects the nearest obstacle via stereoscopic sonar system and sends back vibro-tactile feedback to inform the blind about its localization. On the other hand, and in order to overcome the imperfections of existing electronic travelaids,the proposed method of measuring distance travelled in this system,is to use the acceleration of a moving body which in this case is the blind person.

An accelerometer, followed by two integrators is used to measure a distance travelled by the blind. This technique is considered in inertial navigation systems and suffers from drift problems caused by the double integration and offset of the accelerometer which are overcome by the foot switch When this footswitch is closed, the acceleration and the velocity are known to be equal to zero and this can be used to apply a correction.

In addition, to help blind or visually impaired travellers to navigate safely and quickly among obstacles and other hazard sfaced by blind pedestrians, an obstacle detection system using ultrasonic sensors and vibrators has been added to this aid. The proposed obstacle detection system consists then insensing the surrounding environment via sonar sensors and sending vibro-tactile feedback to the user of the position of the closest obstacles in range.

2.8 A. J. Fukasawa and K. Magatan

They developed a navigation system that supports the independent walking of the visually impaired in the indoor space. The developed instrument consists of a navigation system and a map information system. These systems are installed on a white cane. The navigation system can follow a coloured navigation line that is set on the floor.

In this system,a colour sensor installed on the tip of a white cane,this sensors ensesa colour of navigation line and the system informs the visually impaired that he/she is walking along the navigation line by vibration. This colour recognition system is controlled by a one-chip microprocessor. RFID tags and a receiver for these tags are used in the map information system. RFID tags are set on the coloured navigation line.

An antenna for RFID tags and a tag receiver are also installed on a white cane. The receiver receives the area information as a tag-number and notifies map information to the user by mp3 formatted pre-recorded voice. They have also developed the direction identification technique. Using this technique, one can detect a user's walking direction. A triaxiality acceleration sensor is used in this system. Three normal subjects who were blindfolded with an eye mask were tested with the developed navigation system. All of them were able to walk along the navigation line perfectly.

2.9 E. B. Kaiser, M. Law

They developed a wearable navigation system for visually impaired and blind people in unknown indoor and outdoor environments. This system will map and track the position of the pedestrian during the exploration of the unknown environment. Simultaneous Localization and Mapping(SLAM)from mobiler obotics is implemented.

Once a map is created the user can be guided efficiently by a route selecting method. The user will be equipped with a short range laser, an inertial measurement unit (IMU), a wearable computer for data processing and an audio bone headphones. This system does not intent to replace the use of white cane. However, the purpose is to gather contextual information to aid the user in navigating with the white cane.

2.10 Luis Guerrero, Francisco Vasquez, Sergio Ochoa

They presented an indo or navigation system that was designed taking into consideration us ability as the quality requirement to be maximized. This solution enables one to identify the position of a person and calculates the velocity and direction of his movements. Using this information, the system determines the user's trajectory, locates possible obstacles in that route, and offers navigation information to the user. The solution has been evaluated using two experimental scenarios. Although the results are still not enough to provide strong conclusions,they indicate that the system is suitable to guide visually impaired people through an unknown built environment. The main objective of the system implemented is to provide, in real-time, useful navigation information that enables a user to make appropriate and timely decisions on which route to follow in an indoor space. In order to provide such information, the system must take into account all the objects in the immediate physical environment which may become potential"obstacles"for blind people.

This kind of solution is known as a micro-navigation system. Two main aspects should be addressed by this system to provide navigation support are detection of the position and movement intentions of a user, and positioning of all the objects or possible obstacles into the environment.

The system's main components are the following: an augmented white cane with various embedded infrared lights, two infrared cameras (embedded in a Wiimotes unit), a computer running a software application that coordinates the whole system,and as martphone that delivers the navigation information to the user through voice messages. When the users request navigation information,they push a button on the cane.

It activates the infrared LEDs embedded in thecane. The software application instantly tries to determine the user's position and the presence of obstacles in the surrounding area. The user's position and movement are detected through the infrared camera embedded in the Wiimotes. These devices transmit that information via Bluetooth to a software application running on thecomputer.

The application then uses such information and also the data that it has about the obstacles in the area, to generate single navigation voice messages that are delivered through the user'ssmart phone. The system follows a common-sense approach for the message delivery.

2.11 L.Ran, S.Helal, S.Moore

They developed "Drishti" which uses a precise position measurement system, a wireless connection,awearable computer,and avocal communication interface to guide blindusers and help them travel in familiar and unfamiliar environments independently and safely. Outdoors, it uses DGPS as its location system to keep the user as close as possible to the central line of side walks of campus and down town areas; it provides the user with an optimal route by means of its dynamic routing and re-routing ability.

The user can switch the system from an outdoor to an indoor environment with a simple vocal command. An OEM ultrasound positioning system is used to provide precise indoor location measurements. Experiments show an in-door accuracy of 22 cm. The user can get vocal prompts to avoid possible obstacles and step-by-step walking guidance to move about in an indoor environment.

2.12 Larisa Dunai, Guillermo Peris Fajarnes, Victor Santiago Praderas, Beatriz Defez Garcia, Ismael Lengu

They presented a new prototype for being used as a travel aid for blind people. The system is developed to complement traditional navigation systems such as white cane and guide dogs. The system consists of two stereo cameras and a portable computer for processing the environmental information. The aim of the system is to detect the static and dynamic objects from the surrounding environment and transform them into acoustical signals. Through stereophonic headphones, the user perceives the acoustic image of the environment, the volume of the objects, moving object direction and trajectory, its distance relative to the user and the free paths in a range of 5m to 15m.

The acoustic signals represent short train of delta sounds externalized with non-individual Head-Related Transfer Functions generated in an anechoic chamber. Experimental results show that users were able to control and navigate with the system safety both in familiar and unfamiliar environments. The Real–Time Assistance Prototype device is based on object detection principle. Three important issues, “what to detect”, “how to track” and “how to represent the detected information” are explored. The hardware of the device consists of a helmet fitted with a pair of Firewire Flea2 stereo colour cameras, and headphones which operate with a TOSHIBA Laptop under Windows XP Operating System. The software of the system includes the image and acoustical processing algorithms.

The stereo-cameras record the environment information comprised between a range of 32º left and 32º right relative to the user center. Small stereophonic headphones provide the acoustic data to the user. The device provides the user with an acoustic image of the surrounding. The Real–Time Assistance Prototype emits short acoustical signals through headphones at a rate of 64 pixels per image at 2 frames per second. The working principle consists of specifying for each detected object and free-path a specific acoustical signal, which travels through the image both in direction and time as the real object moves in the real environment.

2.13 Luis A. Guerrero , Francisco Vasquez and Sergio F. Ochoa

They propsed the navigation in indoor environments is highly challenging for the severely visually impaired, particularly in spaces visited for the first time. Several solutions have been proposed to deal with this challenge. Although some of them have shown to be useful in real scenarios, they involve an important deployment effort or use artifacts that are not natural for blind users. This paper presents an indoor navigation system that was designed taking into consideration usability as the quality requirement to be maximized.

This solution enables one to identify person and his movements and also giving voice notification. Using this information, the system determines the location and possible obstacles in that route, and offers navigation information to the user. The solution has been evaluated using two experimental scenarios. Although the results are still not enough to provide strong conclusions, they indicate that the system is suitable to guide visually impaired people through an unknown built environment.

The main objective of the system is to provide, in real-time, useful navigation information that enables a user to make appropriate and timely decisions on which route to follow in an indoor space. In order to provide such information, the system must take into account all the objects in the immediate physical environment which may become potential obstacles‖ for blind people.

In order to deal with these issues the solution uses the interaction among several components as a platform to capture and process the user and environment information, and to generate and deliver navigation messages to users while they are moving in an indoor area.

2.14 Yoshiaki Hirahara, Yusuke Sakurai, Yuriko Shiidu, Kenji Yanashima and Kazushige Magatani

In this paper, they have described about a developed instrument that supports the independent walking of the visually impaired in the indoor space. This instrument is composed of a map information system and a navigation system. In map information system, optical beacons and a receiver of them are used. Optical beacons are set on the ceiling and emit the position code as infrared signal. A receiver receives the signal form a beacon and inform a map information by pre-recorded voice. The navigation system can follow the colored guide line on the floor, and informs a visually impaired user that he is on the guide line by vibration.

A white cane is a typical supporting device for the visually impaired. The visually impaired can sense some obstacles around him/her. And they can walk safely by using this cane. Therefore, the area where they know well, they can walk safely using white cane. However, they cannot walk independently in the unknown area, even if they use a white cane. Because, a white cane is a detecting device for obstacles, and not a navigation device.In such cases, helping of others are necessary. From these reasons, The research and development of a supporting instrument to help an independent walk of the visually impaired is done at various places. For example, a navigation device which used GPS like car navigation system is developing. However, most of these devices are for outdoor space, and are not for indoor space.

2.15 Tetsuya Harada, Yuki Kaneko, Yoshiaki Hirahara, Kenji Yanashima, Kazushige Magatani

They have developed the navigation system for the visually impaired which uses indoor space. In Japan, sometimes colored guide lines to the destination is used for a normal person. These lines are attached on the floor, we can reach the destination, if we walk along one of these line. In their system, a developed new white cane senses one colored guide line, and make notice to an user by vibration. This system recognizes the line of the color stuck on the floor by the optical sensor attached in the white cane. And in order to guide still more smoothly, infrared beacons (optical beacon), which can perform voice guidance, are also used.

The fundamental guidance method of this system is described followings. This system can separate two parts. One is a colored guide line which is set on the floor from the entrance to the destination. This navigation system by using colored guide lines is usually used in Japan. For example, in some hospital, from a entrance of the hospital to consultation rooms, various colored lines are set.

This system is for the patients with perfect vision, if they trace one colored guide line which is set to their destination, they can reach correct room. In our navigation system, these colored lines are sensed automatically and used for the visually impaired. Another is a white cane which includes a color sensor, a white color LED, and a control unit with a vibrator. In our system, a color sensor and a white color LED are attached at the tip of a white cane, and a control unit is set on the grip of a white cane. Picture of a color sensor, a LED and a control unit with a vibrator.

2.16 Esteban Bayro Kaiser, Michael Lawo

They proposed the navigation system for visually impaired and blind people in unknown indoor and outdoor environments is presented. This system will map and track the position of the pedestrian during the exploration of the unknown environment. In order to build this system the well known Simultaneous Localization and Mapping (SLAM) from mobile robotics will be implemented. Once a map is created the user can be guided efficiently by a route selecting method. The user will be equipped with a short range laser, an inertial measurement unit (IMU), a wearable computer for data processing and an audio bone headphones. This system does not intent to replace the use of the white cane. However, the purpose is to gather contextual information to aid the user in navigating with the white cane.

Navigation in unknown outdoor and indoor environments for visually impaired and blind people is a major problem to be solved. Navigation systems are available; however they are not capable of providing the precision that the visually impaired and blind people require. The lack of precision is due to the localization method used and the guiding through selected routes. These methods have to be categorized into two groups, outdoor and indoor navigation support.

2.17 First A. Jin Fukasawa and Second Kazusihge Magatani

In this paper, they have described about a developed navigation system that supports the independent walking of the visually impaired in the indoor space. Our developed instrument consists of a navigation system and a map information system. These systems are installed on a white cane. Our navigation system can follow a colored navigation line that is set on the floor. In this system, a color sensor installed on the tip of a white cane, this sensor senses a color of navigation line and the system informs the visually impaired that he/she is walking along the navigation line by vibration.

Using this technique, we can detect a user's walking direction. A triaxiality acceleration sensor is used in this system. Three normal subjects who were blindfolded with an eye mask were tested with our developed navigation system. All of them were able to walk along the navigation line perfectly. We think that the performance of the system is good. Therefore, our system will be extremely valuable in supporting the activities of the visually impaired.

Chapter 3

PROJECT REQUIREMENTS AND SPECIFICATIONS

3.1 Hardware description

3.1.1 Raspberry Pi Model 3b+

The Raspberry Pi is a series of small singleboard computers developed in the United Kingdom by the Raspberry Foundation. On Pi Day 2018, the model 3B+ was released which is the latest and the fastest Raspberry Pi model ever released. The original model became far more popular than anticipated, selling outside its target market for uses such as robotics. It does not include peripherals (such as keyboards and mice) and cases. However, some accessories have been included in several official and unofficial bundles.

The Raspberry Pi 3, with a quad-core ARM Cortex-A53 processor, is described as having ten times the performance of a Raspberry Pi 1. This was suggested to be highly dependent upon task threading and instruction set use. Benchmarks showed the Raspberry Pi 3 to be approximately 80% faster than the Raspberry Pi 2 in parallelised tasks. On the Model B and B+ the Ethernet port is provided by a built-in USB Ethernet adapter using the SMSC LAN9514 chip.

The Raspberry Pi 3 and Pi Zero W (wireless) are equipped with 2.4 GHz WiFi 802.11n (150 Mbit/s) and Bluetooth 4.1 (24 Mbit/s) based on the Broadcom BCM43438 FullMAC chip with no official support for monitor mode but implemented through unofficial firmware patching and the Pi 3 also has a 10/100 Mbit/s Ethernet port. The Raspberry Pi 3B+ features dual-band IEEE 802.11b/g/n/ac WiFi, Bluetooth 4.2, and Gigabit Ethernet (limited to approximately 300 Mbit/s by the USB 2.0 bus between it and the SoC).

The specifications of the Raspberry Pi Model 3B+ are:

- Broadcom BCM2837B0, Cortex-A53 (ARMv8) 64-bit SoC @ 1.4GHz
- 1GB LPDDR2 SDRAM
- 2.4GHz and 5GHz IEEE 802.11.b/g/n/ac wireless LAN, Bluetooth 4.2, BLE

Figure 3.1: Raspberry Pi Model 3B+

• Gigabit Ethernet over USB 2.0 (maximum throughput 300 Mbps)
• Extended 40-pin GPIO header • Full-size HDMI
• 4 USB 2.0 ports
• CSI camera port for connecting a Raspberry Pi camera
• DSI display port for connecting a Raspberry Pi touchscreen display
• 4-pole stereo output and composite video port
• H.264, MPEG-4 decode (1080p30); H.264 encode (1080p30)
• OpenGL ES 1.1, 2.0 graphics
• Micro SD port for loading your operating system and storing data
• 5V/2.5A DC power input
• Power-over-Ethernet (PoE) support (requires separate PoE HAT)
• Operating temperature, 0–50°C

3.1.2 Raspberry Pi Camera ModuleV2

The Raspberry Pi Camera Module v2 replaced the original Camera Module in April 2016. The v2 Camera Module has a Sony IMX219 8-megapixel sensor (compared to the 5megapixel OmniVision OV5647 sensor of the original camera). The Camera Module can be used to take high-definition video, as well as stills photographs. It's easy to use for beginners, as well as for advanced users. It can be used for time-lapse, slow-motion, and other video cleverness.

One can also use the libraries bundled with the camera to create effects. It's a leap forward in image quality, colour fidelity, and low-light performance. It supports 1080p30, 720p60 and VGA90 video modes, as well as still capture. It attaches via a 15cm ribbon cable to the CSI port on the Raspberry Pi. The camera works with all models of Raspberry Pi1,2,and3.

It can be accessed through the MMAL and V4LAPIs, and there are numerous third-party libraries built for it, including the Picamera Python library. The camera module is very popular in home security applications, and in wildlife camera traps.

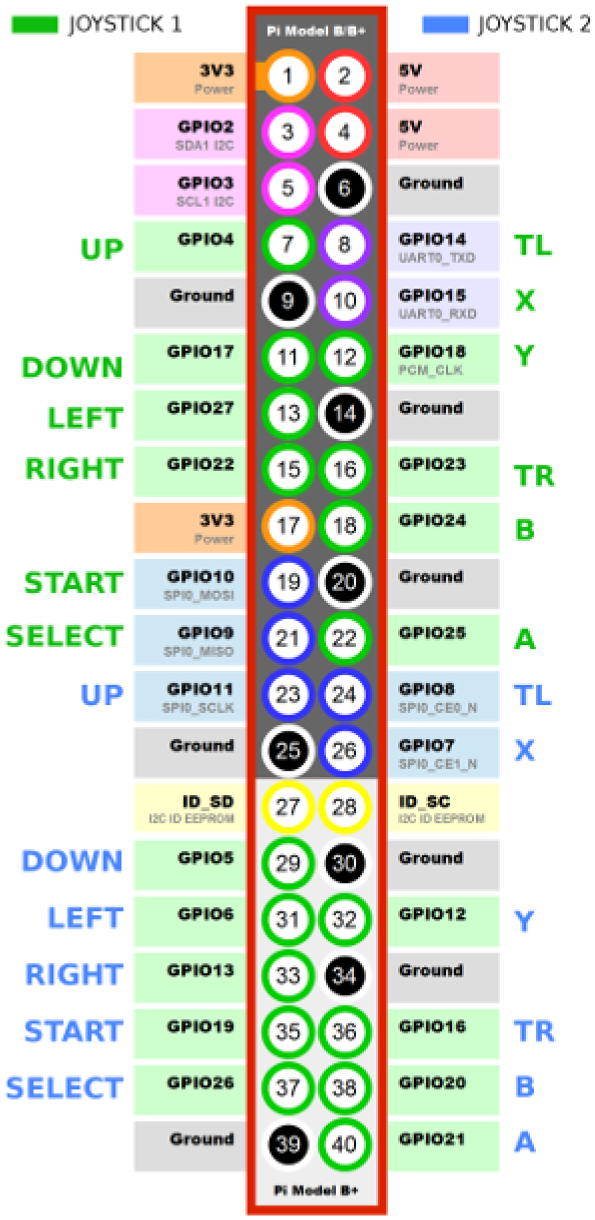

Figure 3.2: Raspberry Pi Pin Diagram

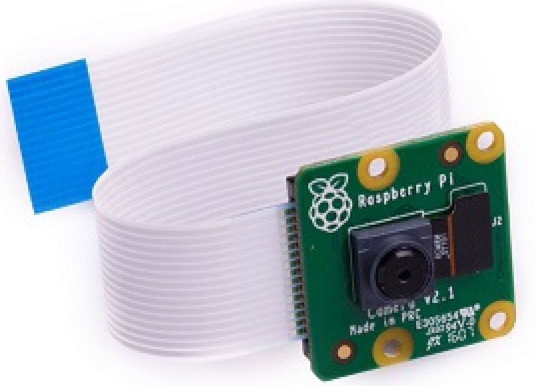

Figure 3.3: Raspberry Pi Camera Module V2

3.1.3 GSM/GPS Module

GSM/GPRS module is used to establish communication between a computer and a GSMG-PRS system. GSM/GPRS module consists of a GSM/GPRS modem assembled together with power supply circuit and communication interfaces using USB for computer. GSM/GPRS MODEM is a class of wireless MODEM devices that are designed for communication of a computer with the GSM and GPRS network. It requires a SIM (Subscriber Identity Module) card just like mobile phones to activate communication with the network.

Optical logic gates have been constructed from the optical transistor. A logic gate is a device employed in digital computers for arithmetic operations and for evaluating the truth of the proposition. There are three kinds of gates; The “AND’ gate yields a high output only when all its inputs are present.

If the two incident laser beams are chosen so that each one yields a transmitted intensity just below the steep part of the curve, the result is an “AND” gate; both incident beams must be present for high transmission. The “OR’ gate yields a high output if any of its inputs are high. If the incident beams are adjusted so that each one yields a transmission at the top of the steep region, the result is an “OR’ gate; either incident beam can yield high transmission.

A “NOT” gate has a high output when the input is low and low output when the input is high. The optical “NOT” gate exploits a light reflected from the interferometer. The reflected beam is associated with the hysteresis loop shown. Because of the loop’s shape a high input (B) yields a low output, a low input (A) yields a high output.

Figure 3.4: GSM Module

3.1.4 Ultrasonic Sensor

An ultrasonic sensor transmit ultrasonic waves into the air and detects reflected waves from an object. There are many applications for ultrasonic sensors, such as in intrusion alarm systems, automatic door openers and backup sensors for automobiles. Accompanied by the rapid development of information processing technology, new fields of application, such as factory automation equipment and car electronics, are increasing and should continue to do so. Using its unique piezoelectric ceramics manufacturing technology developed over many years, Murata has developed various types of ultrasonic sensors which are compact and yet have very high performance. The information contained in this catalog will help you to make effective use of our ultrasonic sensors.

Ultrasonic sensing is one of the best ways to sense proximity and detect levels with high reliability. Our technical support gets emails all of the time about how our sensors work and what environments our sensors work (or don't work) in. This guide was created as an introduction to ultrasonic sensing, it's principles, and how ultrasonic sensors work in your applications.

An ultrasonic sensor is an instrument that measures the distance to an object using ultrasonic sound waves. An ultrasonic sensor uses a transducer to send and receive ultrasonic pulses that relay back information about an object's proximity. High-frequency sound waves reflect from boundaries to produce distinct echo patterns.

Ultrasonic sound vibrates at a frequency above the range of human hearing. Transducers are the microphones used to receive and send the ultrasonic sound. Our ultrasonic sensors,

Figure 3.5: Ultrasonic Sensor

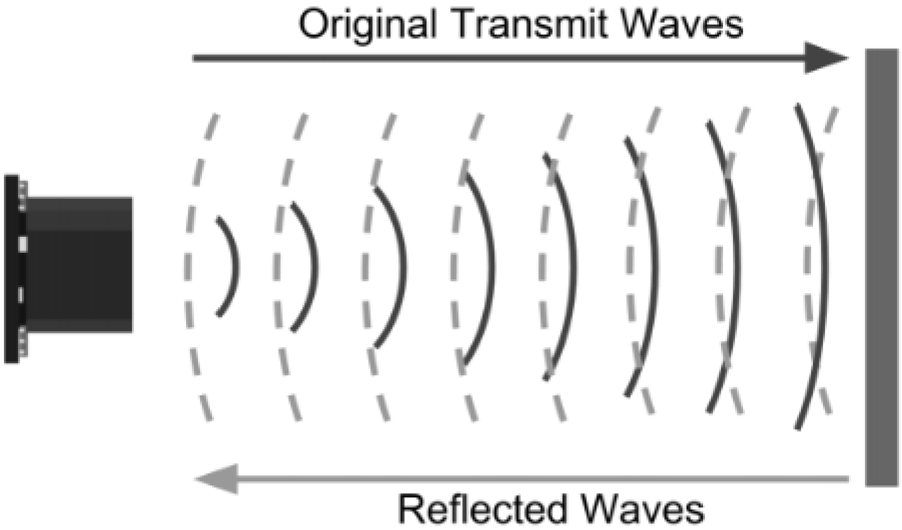

Figure 3.6: Ultrasonic Sensor working

like many others, use a single transducer to send a pulse and to receive the echo. The sensor determines the distance to a target by measuring time lapses between the sending and receiving of the ultrasonic pulse.

Sound travels at approximately 340 meters per second. This corresponds to about 29.412µs (microseconds) per centimeter. To measure the distance the sound has travelled we use the formula: Distance = (Time x SpeedOfSound) / 2. The "2" is in the formula because the sound has to travel back and forth. First the sound travels away from the sensor, and then it bounces off of a surface and returns back. The easy way to read the distance as centimeters is to use the formula: Centimeters = ((Microseconds / 2) / 29). For example, if it takes 100µs (microseconds) for the ultrasonic sound to bounce back, then the distance is ((100 / 2) / 29) centimeters or about 1.7 centimeters.

3.2 SOFTWARE DESCRIPTION

3.2.1 OpenCV

OpenCV (Open Source Computer Vision Library) is an open source computer vision and machine learning software library. OpenCV was built to provide a common infrastructure for computer vision applications and to accelerate the use of machine perception in the commercial products. The library has more than 2500 optimized algorithms, which includes a comprehensive set of both classic and state-of-the-art computer vision and machine learning algorithms.

It has C++, Python, Java and MATLAB interfaces and supports Windows, Linux, Android and Mac OS. OpenCV leans mostly towards real-time vision applications. And the support of Numpy makes the task more easier.

OpenCV (Open source computer vision) is a library of programming functions mainly aimed at real-time computer vision. Originally developed by Intel, it was later supported by Willow Garage then Itseez (which was later acquired by Intel). The library is cross-platform and free for use under the open-source BSD license. OpenCV supports the deep learning frameworks TensorFlow, Torch/PyTorch and Caffe.

OpenCV provides:

1. Advance vision research by providing not only open but also optimized code for basic vision infrastructure. No more reinventing the wheel.

2. Disseminate vision knowledge by providing a common infrastructure that developers could build on, so that code would be more readily readable and transferable.

3. Advance vision-based commercial applications by making portable, performance-optimized code available for free – with a license that did not require code to be open or free itself.

3.2.2 Python

Python is an interpreted, high-level, general-purpose programming language. Created by Guido van Rossum and first released in 1991, Python has a design philosophy that emphasizes code readability, notably using significant whitespace. It provides constructs that enable clear programming on both small and large scales. Van Rossum led the language community until July 2018.

Python is dynamically typed and garbage-collected. It supports multiple programming paradigms, including procedural, object-oriented, and functional programming. Python features a comprehensive standard library, and is referred to as "batteries included".

Python interpreters are available for many operating systems. CPython, the reference implementation of Python, is open-source software and has a community-based development model. Python and CPython are managed by the non-profit Python Software Foundation.

Python is a multi-paradigm programming language. Object-oriented programming and structured programming are fully supported, and many of its features support functional programming and aspect-oriented programming. Many other paradigms are supported via extensions, including design by contract and logic programming.

Python uses dynamic typing, and a combination of reference counting and a cycle-detecting garbage collector for memory management. It also features dynamic name resolution (late binding), which binds method and variable names during program execution.

3.2.3 TensorFlow

TensorFlow is a free and open-source software library for dataflow and differentiable programming across a range of tasks. It is a symbolic math library, and is also used for machine learning applications such as neural networks.TensorFlow was developed by the Google Brain team for internal Google use. It was released under the Apache 2.0 open-source license on November 9, 2015.

TensorFlow can run on multiple CPUs and GPUs (with optional CUDA and SYCL extensions for general-purpose computing on graphics processing units). TensorFlow is available on 64-bit Linux, macOS, Windows, and mobile computing platforms including Android and iOS.

Its flexible architecture allows for the easy deployment of computation across a variety of platforms (CPUs, GPUs, TPUs), and from desktops to clusters of servers to mobile and edge devices. TensorFlow computations are expressed as stateful dataflow graphs. The name TensorFlow derives from the operations that such neural networks perform on multidimensional data arrays, which are referred to as tensors. During the Google I/O Conference in June 2016, Jeff Dean stated that 1,500 repositories on GitHub mentioned TensorFlow, of which only 5 were from Google.

TensorFlow provides stable Python and C APIs; and without API backwards compatibility guarantee: C++, Go, Java, JavaScript and Swift. Among the applications for which TensorFlow is the foundation, are automated image captioning software, such as DeepDream. Rank Brain now handles a substantial number of search queries, replacing and supplementing traditional static algorithm-based search results.

3.2.4 NumPy

NumPy is a library for the Python programming language, adding support for large, multi-dimensional arrays and matrices, along with a large collection of high-level mathematical functions to operate on these arrays.NumPy is a highly optimized library for numerical operations. All the OpenCV array structures are converted to-and-from NumPy arrays. So whatever operations you can do in NumPy, you can combine it with OpenCV, which increases number of weapons in your arsenal.

Python bindings of the widely used computer vision library OpenCV utilize NumPy arrays to store and operate on data. Since images with multiple channels are simply represented as three-dimensional arrays, indexing, slicing or masking with other arrays are very efficient ways to access specific pixels of an image. The NumPy array as universal data structure in OpenCV for images, extracted feature points, filter kernels and many more vastly simplifies the programming workflow and debugging.

The core functionality of NumPy is its "ndarray", for n-dimensional array, data structure. These arrays are strided views on memory. In contrast to Python's built-in list data structure (which, despite the name, is a dynamic array), these arrays are homogeneously typed: all elements of a single array must be of the same type. Such arrays can also be views into memory buffers allocated by C/C++, Cython, and Fortran extensions to the CPython interpreter without the need to copy data around, giving a degree of compatibility with existing numerical libraries. NumPy has built-in support for memory-mapped ndarrays.

Chapter 4

METHODOLOGY

First the image is obtained from the environment through the Raspberry Pi Camera. Then the obtained image is matched with the existing images in the database for object recognition. Once the object present in the image is recognised, its distance from the person is measured. A voice notification through the earphones is given to the to the user about the impending obstacle and its distance from the user which help avoid collision. Sideby, the location of the user is constantly updated.

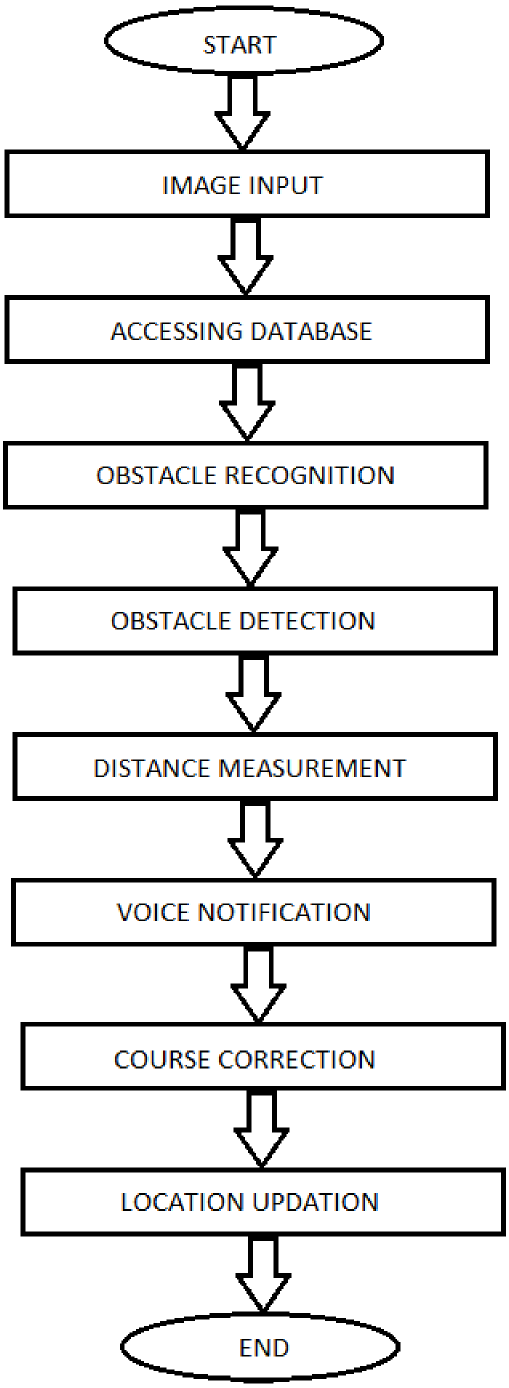

Figure 4.1: Flow Chart of the working of the prototype

Chapter 5

RESULT

1. The device gives a time response of 2 seconds which is optimum for course correction.
2. The device recognizes around 30 classes of object which are common in outdoor navigation.
3. The voice notification notifies the user about the obstacle ahead and its distane from the user which makes the device user friendly and easier to understand.
4. Ultrasonic sensor has a range of 5 metres. It measures the distance of obstacles from the device which is then notified to the user for course correction.
5. The function of location updation helps the family members of the user to keep the track of his/her present location.

Chapter 6

APPLICATIONS

1. The project proposed here is application specific and hence the applications of this project is limited to certain key areas. Since visually impaired people do not have the luxury of normal eyesight that a normal human enjoys. The intended project aims to overcome this issue.

2. Through the development of this product a visually impaired person will be able to navigate his way through the open world and get a feel of the objects in the environment and detect them and interact with them. Provide the visually impaired person with the ability to navigate through the world on their own.

3. Provide safety for the visually impaired person using the product by updating their location to their beloved ones in case of emergencies.

Chapter 7

FUTURE SCOPE

1. Emergency button can be added to notify the visually impaired person's family members when he faces any problem.
2. The device can be used for indoor navigation by making some changes in the code related to the indoor obstacles.
3. Using google maps and voice notification the person can be notified about his present location.
4. Notification can be given for the direction of course correction i.e the person should move left or right.
5. For a hearing impaired person instead of voice notification vibrators can be used.

Chapter 8

CONCLUSION

The proposed navigation aid has been developed in order to enhance the independent mobility of blind individuals. The entire system is very cost effective and all the modules are very easy to handle. Raspberry Pi is used which reduces the interfacing and costing of the device. The device notifies the blind person about the obstacle ahead and also gives the distance from the obstacle which helps him change his course. Real time interface of the Global Positioning System (GPS) module helps in tracking the person at each and every time instance.Test results show that the proposed system can provide more abundant surrounding information and more accurate navigation, and verify the practicability.

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