

# Advanced Indoor and Outdoor Navigation System for Blind People Using Raspberry-Pi

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## Abstract

This paper focuses on providing the helping aid for the visually impaired person with an object detection and navigation system. The proposed module is divided into two, one is static object detection which uses Threshold value matching, SURF feature extraction for obstacle matching and Bivariate gaussian mixture model for high dimensional bivariate features extracted and later to convert the obtained visual information into the audio information using a raspberry-pi setup. Secondly the system deals with the dynamic obstacles too for which employs Gaussian mixture distribution in modeling background of each pixel and an on-line approximation to update the model. The moving human region is detected by background subtraction. The shadow detection and elimination are implemented in the HSV space, and finally morphological operations are introduced to eliminate noise and reconstruct moving human regions. The results show that the method models stable background, eliminates shadow, and has a good detection result. This algorithm detects the shape of the object and searches from the database provided in the hardware and converts the textual information to an audio information. The audio information is given in-terms of a vibration which protects the eardrum and also helps as a hearing aid for the partial hearing loss people. This prototype provides the blind people to navigate in a free environment.

**Keywords:** Navigation system, Object detection, Raspberry-pi, Indoor, Outdoor

## 1 Introduction

Versatility of outwardly hindered individuals is limited by their lack of ability to perceive their environment. Versatility is only the likelihood of moving without help of any supplementary individual. Thus, it important to build up the framework which helps the Visually Impaired Person (VIP). This sort of framework has a few criteria or Scenario, appeared in Figure 1.

Indoor direction frameworks are extraordinarily primary than the outside route framework. inside the out of doors direction frameworks, for the most element GPS is applied for situating of the visually impaired man or woman, at the same time as inside the indoor direction framework, GPS indicators can't bypass thru the constructing, carry, domestic and so forth i.e. inner. eventually the extra part of the designers utilized worldwide Positioning system (GPS) for outside course framework, yet within the indoor route framework exclusive methods are used by the engineers like making use of IR sensor, extremely sonic sensor, and appealing compass on hand-held device and so on [1]. Recent research specializes in creating the cross-breed frameworks, which might be beneficial inside the each situations i.e. indoor path framework and open-air course framework. This half of and half framework conquers weaknesses of the 2 frameworks.

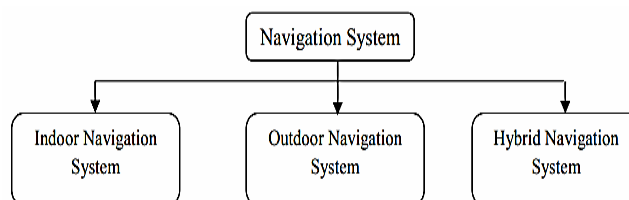
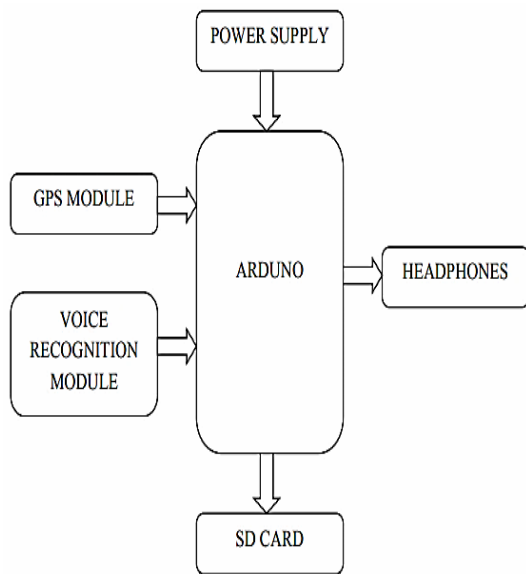


Figure 1. Types of navigation system

### 1.1 Existing System

Bansode et al. [2] made voice-based heading structure for amaze utilizing voice affirmation module and GPS module realized on Arduino board. on this structure, stun man or lady will give the reason's name in light of the fact that the commitment to voice affirmation module. GPS module always gets the degree and longitude of the present area, correlation and the point's extension and longitude. Figure 2 demonstrates piece outline of the structure.

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**Figure 2.** Block diagram of system [2]

Structure contains GPS recipient/module (used Ublox NEO6MV2 GPS Module. It is a satellite-based course structure made up of a blueprint of 24 satellites put into space.), Arduino (is an open-source PC gear and programming connection, errand, and customer gathering. It contains ATmega328 microcontroller, 14 Digital I/O Pins (6 PWM yields), Analog Inputs, 32k Flash Memory, 16 MHz Clock Speed), Voice affirmation module V3 (it gives target's name as the obligation to the structure), Headset, SD card per client (course headings are tied down in sound relationship in the SD Card), SD card and other advantageous parts. Essential point of convergence of this structure is to assist the evidently crippled people with getting course headings through sound message which depends on the decided help fit vide by the GPS (Global Positioning System). In this system, amaze singular gives the objective's name as the guarantee to the voice verification module and GPS incessantly gets the extension and longitude of the present zone, independent, the degree and longitude of the objective a territory unequivocally. The code moved in the Arduino the GPS gives the course making a beeline for the apparently crippled person. Harsur and Chitra [3] made voice-based course structure for astound people using ultrasonic sensor, which permit daze individuals to take a gander at self-coordinating in the outside condition.

Zhang et al. [4] organized and completed a wearable indoor course help for obviously crippled customers. By joining distinctive sensors of RGB-D camera, IMU, and the camera, the constraint and heading of the customer are in each functional sense achieved using atom channel. Visual odometry from the RGB-D is changed with the IMU odometry, and section number conspicuous point is seen by the SVM machine learning checks. A Novel system was proposed where the edges data about the request is detached which totally refreshes the blend execution for indoor

imprisonment. In setting of the containment and the semantic induced direct, the customer is investigated to the pinned for room. The customer can be guided by the sound yield charge to the objective viably and productively effortlessly of utilization humanistic sound interface

Chaccour and Badr [5] developed a novel approach for an indoor course structure for clearly averted and trance people. The proposed methodology has an undeniable building that draws in the subject to be totally free in his home or work. The structure gives course help and check keeping up a key separation from functionalities in indoor premises Figureuring. Not the slightest bit like unquestionable structures in the related work, the subject needs just to hold his PDA in the midst of his expulsion and doesn't require a particular health to be worked [6]. The disperse thought of the structure lives in PC vision organizing estimation radiantly to the customer.

Mahmud et al. [7-10], Proposed a special way system which urges trance people to investigate safely. % microcontroller was connected to gather the sharp hindrance recognizable proof system which allows the outwardly impeded man or lady to safeguard a vital separation from obstacles using the enter by means of vibration and voice [11-12]. The imperative objective of this arrangement was to influence the system to keen an apparently upset man or lady. keeping up in considerations the surrender reason to make it less complex for the character to make utilization of, the course help has introduced the sonars for perceiving obstructions exceptionally headings. Along these lines, the character does never again require stream the stick round to find obstacles as they do with the conventional stick. They can totally stroll with the stick and the sonars will just recognize the impediments and help the character to transport around it. The structure has toiled in vibration and voice enter which alerts the customer if any deterrent is near and inward 70cm. The sonars are adjusted in a technique to guarantee supporter holding up in making sense of hindrances in three headings. The voice cautioning and vibration consistently light up client about the tangle till the factor that the supporter developments some separation from the problem inside the extent of 70cm. This paper recommended that this guide will be a convincing, least endeavor and smooth to apply respond in due order regarding way issues of apparently blocked character [13-16].

## 1.2 Motivation

Keeping in mind the end goal to enhance the personal satisfaction for visual debilitated or visually impaired individuals, in this work we concentrate on growing new advancements to help these people to get to the open-air condition especially, for, Banks, healing facilities, post office, and other open utility [17-18]. Previously, an embedded system was developed to aid

the visually impaired person in obstacle detection using the Arduino MEGA 2560 [19]. The developed PDA helped in identifying the obstacle using a tongue electrode which stimulates the brain cell connected to the optical nerve. This system identifies the shape of the obstacle occurring, but, the matching of the obstacle feature can be questioned.

Accordingly, this work expects to assume an exceptional part in this field giving however much data as could be expected for outwardly hindered or daze individuals, which enables them to take an agreeable route [20-21]. To construct a model, an approach aiding the individual with the possible paths and obstacles considered in the framework to help individuals with incapacities. The framework expects to help them in giving the data [22]. In this framework, we will recognize a hindrance utilizing ultrasonic sensor. Obstruction discovery sensor goes about as the core of the framework.

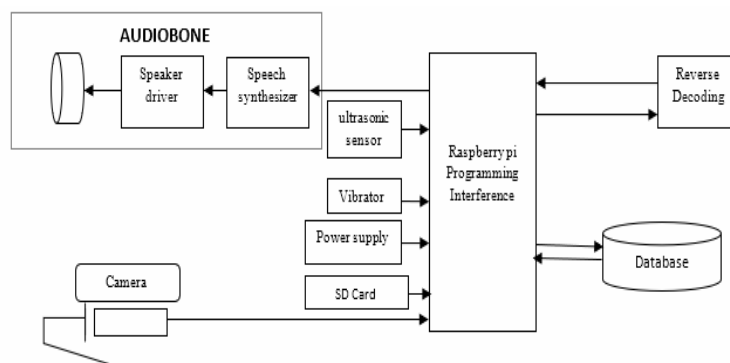
## 2 Problem Formulation

There are roughly 38 million of individuals over the world who are visually impaired and outwardly hindered, more than 15 million are from India. Dazzle people often are pulled back from the public since they feel that individuals and the public are preferential, thus they may not be invited often. The amazing accomplishment, which is the result of constant battle and diligent work between Anne Sullivan" – the instructor and Helen Keller - the visually impaired understudy brought about a progressive technique for learning and correspondence, which eventually finished in the improvement of Braille dialect. Dazzle individual does not require to feel sorry for, but rather require sympathy, to blend in the public and be autonomous for their normal tasks (action).

Subsequently visually impaired individuals require an assistive gadget that will enable visually impaired client to explore uninhibitedly and this prerequisite has turned out to be pivotal. The greater parts of the visually impaired individuals rely upon other people, white stick, or guide pooches to travel openly. considering this authentic putting or condition we focused the paintings on growing supporting innovations that can assist daze people taking them back to the public. Our primary goal is to make a minimal, impartial framework with a purpose to permit these visually impaired people to undergo a domain. This voice based totally course framework can give solution for this issue. This gadget relies upon on mounted framework and gives the direction recommendations to the customer by way of giving sound directions thru speaker that's related to raspberry pi making use of a USB jack. This route framework will identify an obstruction utilizing HC-SR 04 ultrasonic sensor and guide the dazzle person with the aid of giving a sound guideline through 3.5 mm audio system.

### 2.1 Contemplated Framework

Here the Figure 3. Exhibits the square arrangement of the errand which generally joins distinctive modules. The thing's used as a touch of this errand consolidates python" coding for getting the unit of the test and for impediment exposure. Pocket sphinx and Google API are used for changing over the exchange to substance and Espeak for changing over substance to talk. Here substance to talk mix has been used for English and Tamil tongue. Entire structure incorporates assorted modules. This outline is partitioned 6 basic modules: Initialization, User Interface, Address request disentangle, and Route Query, and Route transversal, get presentation. Each module plays a squeezing limit.



**Figure 3.** Block diagram of the proposed system

They are depicted as (1) Initialization: The fundamental development joins instating the structure library. (2) User Interface: Obtain the target area from client utilizing a mouthpiece, this speaker is connected with a raspberrypi. Here it underlines the Voice Module commenting the criticalness of touch self-overseeing and visual free interfaces as the framework

is made particularly for stagger and to a restricted degree discovered individuals. The voice interface acknowledged utilizations associations, for example, Text to Speech for the voice yields and the Google Voice Recognizer API

At the point when the individual strolls towards the impediment the ultrasonic sensor detects the protest

and cautions the individual by sending a vibrating signal. The camera is started to take a snap of the deterrent and pre-handled. The picture is gone through gaussian channel to expel the commotion and is changed over from RGB to Gray. The element extraction is performed to extricate the highlights and put away in the SD card. The highlights are gotten utilizing ORB include extraction calculation. The acquired highlights are contrasted and the database containing every single conceivable insight about the shape, measurements to foresee the question. Utilizing a GPS unit, the items area is distinguished. The insights about the obstruction identified like the shape, position and the separation where the hindrance is put is told to the outwardly tested individual through the Audio bone earphone. The utilization of sound bone, Bone Conduction rule is used wherein it sidesteps the eardrums. In bone conduction tuning in, the earphones complete the situation of your ear drums. Sound Bone earphones disentangle sound waves and convert them into vibrations that might be procured on the double through the Cochlea – so the ear drum is in no way, shape or form stressed. Early attempts at bone conduction brought about unpleasant sound top notch. be that as it may, Audio Bone has advanced new

innovation which deciphers the sound waves in over the top loyalty, stereo incredible sound. the utilization of this Audio bone gadget even individual with the to a limited extent hearing issues can be profited.

The internal working of the entire contemplated framework is discussed in two sections, (1) Identification of static obstacle and (2) Identification of Dynamic obstacle.

### 2.1.1 Identification of Static Obstacle: Indoor / Outdoor

To select the Heavy obstruction, in this content, we've propelled a half breed procedure utilizing the limit esteems; the design of the fame procedure is given in Figure 4. The Heavy impediment sensor managing nearer to the floor is snared at the base of the PDA. It peruses the cautions some of the time and each time a square or a blob is analyzed, it mirrors the sign back through the ultrasonic waves. This blob/square is then changed into remove by considering following separation equation in which speed of sound in air = 340 m/s.

$$\text{Distance} = (\text{speed} * \text{time}) / 2$$

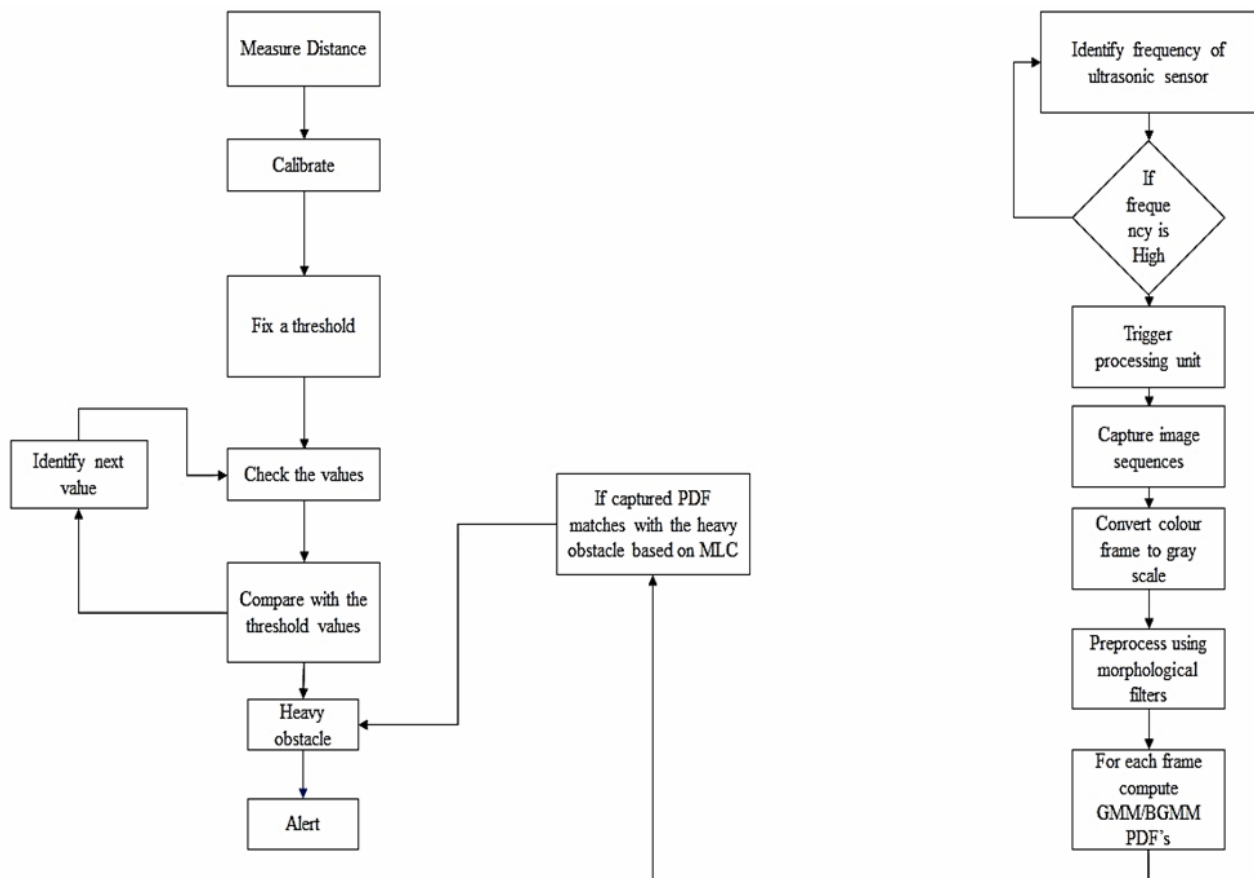


Figure 4. Architecture to detect the heavy obstacle

Initially, the value of distance is divided by 2 as it is a summative distance since the ultrasonic wave travels back and forth from source to the receptor after hitting the target.

### 2.1.1.1 Threshold Values

An edge esteem is set and is contrasted and the separation esteem. In the event that the separation esteem is over the edge (Table 1), it is considered as a Heavy snag, else it isn't. Overwhelming hindrance location computation includes the edge esteem thinking about the different examples of holding the stick (it is expected that each individual holds the stick in various ways), or, in other words for distinguishing a Heavy deterrent on the client's way.

**Table 1.** Estimation of the threshold value

Estimating the threshold value for different inputs (chosen randomly)	Threshold Values (cm) (after calculating the average value)
6,9,8,12,11,19,10,8,7, 5	9.5
3,6,9,8,7,13,12,18,15,5	10

If a lone regard may misdirect the setting of the edge regard, a game plan of ten characteristics are recorded by considering the stick positions in different edges previously the Heavy obstruction and Figureing the partition. The ordinary regard is handled using the condition outlined underneath.

$$\text{Avg-value} = (\text{sum of } n \text{ values}) / n.$$

The process is repeated at random several times and the maximum average value recorded is set as the threshold.

Threshold = maximum among the avg-values

The android application is considered for alerting the user about the various signals received from the sensors. When a Heavy obstacle or an obstacle is identified, a text voice is generated to alert the user and also generates a vibration sound so that the deaf person can also get an alert. The developed app also helps to provide the user with the position of the Heavy obstacle (front, left or right).

Table 2 depicts the estimation of a Threshold value for Heavy obstacle detection. The performance of the system is tested using Metrics like precision, Recall and F-Measure and the Formulas for calculating the above are given by Precision = TP/ (TP+FP). Where TP denotes total number of Heavy obstacles correctly classified and FP denotes wrongly classified Heavy obstacles. The formula for Recall is given by TP/ (TP+FN) Where FN denotes the Heavy obstacle being not detected. F-Measure is calculated using the formula (Precision \* Recall)/ (Precision +Recall)

**Table 2.** Estimation of heavy obstacle

Status	Output	Distance from ground	Result
Heavy obstacle present	Heavy obstacle detected	10	accurate
Heavy obstacle not present	Heavy obstacle detected	12	error
Heavy obstacle not present	no output	9.5	accurate

### 2.1.1.2 SURF Based Static Object Detection

SURF algorithm uses a blob detector based on the Hessian matrix to find points of interest. The determinant of the Hessian matrix is used as a measure of local change around the point and points are chosen where this determinant is maximal. When you consider that we utilize the moved camera at the PDA, we rely upon monocular vision-based methodologies rather than stereo or centrality sensor. with a particular true objective to recognize the obvious past, Monocular inventive and sensible based totally frameworks utilize approaches like surface division [23], progression and ground airplane insistence [24], modify side affirmation and understanding synchronous parallel strains [25], et cetera. in any case, in the end, ground plane region is if all else fails required in view of its essential points of confinement. floor airplane revelation, segments every photograph into two assignments based at the highlights as ground and non-floor. Different trademark extraction designs are recorded in the composed work [26-27], among these methods, in this substance we have contemplated the SURF (animated solid breaking points) system because of the positive conditions like light, pivot, scale and computational straightforwardness. The points of confinement are evacuated in context of the characteristics like blobs, corners, and whatnot. The highlights of nonground photograph highlights are considered for the unit of void squares and liberal obstruction. SURF algorithm uses square-shaped filters as an approximation of Gaussian smoothing. SURF algorithm uses a blob detector based on the Hessian matrix to find points of interest. The determinant of the Hessian matrix is used as a measure of local change around the point and points are chosen where this determinant is maximal.

Figure 5 portrays the essential advances used in overpowering, void square distinguishing proof, which consolidates video as an enter after which preprocessing is done to pick the the edges took after by methods for division and limit extraction. Division confines picture into parts: ground aircraft and non-ground carrier. here non-floor flying machine will be checked similarly for the unfilled squares and



considerable block. The condition of the methods and division are considered as limits, which we remove the use of SURF set of rules [28]. These features are useful to pick regardless of whether a prevention is hole squares or generous snag. Those features are given in light of the fact that the enter for the Bivariate Gaussian mix indicate [29-31] that measures the probability thickness work (PDF). The PDF of both opening squares and generous obstacle is furthermore thought about and in light of the estimations of the PDF, the stature is anticipated and the alert is created and is passed as a message to the ostensibly impeded.

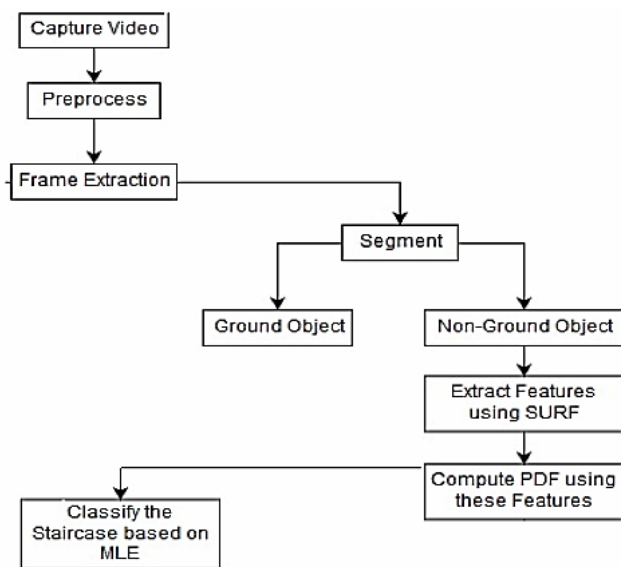


Figure 5. Methodology for identification of based on BGMM

2.1.1.3 Bivariate Gaussian Mixture Model

BGMM classifier can work with information in high dimensional space and treatment of bivariate highlights. Subsequently it recognizes the empty squares and substantial question all the more precisely. The likelihood thickness capacity of the pixel powers is given by

$$f(x_1, x_2) = \frac{1}{2\pi\sigma_1\sigma_2(\sqrt{1-\rho^2})} e^{-\left[\frac{1}{2(1-\rho^2)}\left(\frac{x_1-\mu_1}{\sigma_1}\right)^2 - 2\rho\left(\frac{x_1-\mu_1}{\sigma_1}\right)\left(\frac{x_2-\mu_2}{\sigma_2}\right) + \left(\frac{x_2-\mu_2}{\sigma_2}\right)^2\right]}$$

Here  $\mu_1, \sigma_1$  are the mean and fluctuation of the picture with first highlights and  $\mu_2, \sigma_2$  are the mean and change of the picture with the second highlights,  $\rho$  is known as the shape parameter to such an extent that  $-1 \leq \rho \leq 1$ .

2.1.1.4 Ultrasonic Sensor Based Obstacle Detection

While the picture essentially based strategy flags the nearness of upward or descending, particular oversee is required for genuine route through the pathway. While in transit to help the outwardly debilitated all through the personality of deterrent, we delegate two ultrasonic

sensors which could recognize flat floor planes and variety of force of those planes if there should be an occurrence of descending snag and nearness of vertical plane if there should arise an occurrence of upward hindrance. This contraption is constructed utilizing a percent plastic and the ultrasonic sensor which catches the signs inside the state of a recurrence bend, this framework is progressed by methods for the utilization of an ARM processor which goes about as a handling unit for higher ID. A Bluetooth device is likewise connected with the device all together that the information might be caught and imparted to a cell gadget that may give sound-related remarks related to vibro-comments driven through the Raspberry Pi board.

2.1.1.5 Ultrasonic Sensor Based Obstacle Detection

The ultrasonic sensor activates whenever it receives the pulse of 10 ms. It has two transducers; one for transmitting and second for getting the reflected waves, if the frequency of the received wave is high, the voltage divider embedded triggers the video processing unit, which starts capturing the image sequences, filtering process removes the noise and then attribute extraction is considered for object identification. If the frame intensities remain stationary then the object is considered as stationary and if there is any change in frame intensity it is considered to be a moving object. The increase in the frame size confirms that objects are approaching, else moving away. In our present article, we confine to Heavy obstacle identification, so only stationary objects are taken into account.

If the camera is in motion, we need to capture the object more precisely. Because the blind persons cannot stay steady, some movement is generated automatically and this movement can cause an error during object detection. In order to overcome the error, a morphological filter is considered. The morphological filter helps to remove the unwanted pixel value so that the exactness in identification is possible. The morphological closing operation is considered and applied to the structural element B, such that  $A \bullet B = (A \ominus B) \oplus B$ , where the structuring element B is given by the following 3x3 matrix:

0	0	1
0	1	0
1	0	0

For adjust classification and character of the Heavy obstacle, the Gaussian mix display (GMM) adaptation is considered. the guideline objective behind the thought is that, in any picture under consideration, there could be limited wide assortment of dim stage chance thickness capacities, say 'affirm', and every pixel circulation might be displayed by methods for

one Gaussian trademark which speaks to one thing inside the photo. With this suspicion, the entire picture might be displayed by utilizing a mix of ‘alright’ component Gaussian conveyances in a couple of obscure extents  $\pi_i$ ,  $I = 1, 2, 3, k$ . The open-door thickness capacity of the model is given through

$$f_i(x/\theta) = \sum_{i=1}^k \pi_i f_i(x_i/\theta_i) \tag{1}$$

Where  $x_i$  denotes the image pixels,  $\pi_i$  denotes the mixing weight, such that

$$\sum_{i=1}^k \pi_i = 1 \tag{2}$$

Here  $\theta$  represents the parameter set and is given by  $(\pi_1, \pi_2, \dots, \pi_k, \theta_1, \theta_2, \dots, \theta_k)$ ,  $f_i$  denotes the density function of the Gaussians parameterized by  $\theta = (\mu_i, \sigma_i)$ . The database of Heavy deterrent is considered as info and every one of these pictures is displayed utilizing the GMM, and the comparing likelihood thickness capacities are put away. At whatever point the visually impaired individual explores through the street and experiences a question, consequently the camera catches the picture and procedures the picture. The picture is bunched, and the PDF of the picture is gotten and in light of the most extreme probability gauge, the closest match with that of the pictures in the database, a notice message is sent back to the visually impaired alongside vibrations, so the visually impaired individual can comprehend that there is some snag ahead and he should be caution.

### 3 Identification of Dynamic Obstacle

The standard contraption flowchart is appeared in Figure 6. The GPS recipient gets an affirmation of records from the satellites. The GPS module synchronizes with something near 4 satellites and on a few occasions up to ten satellites (on a crisp morning). The GPS module gives the NMEA string in light of the way that the yield. [32] The NMEA message is inside the sort of an ASCII message string which wires geospatial area, time and indisputable suitable substances. The NMEA sentence sorts which the module utilized on this endeavor acknowledge are GPGGA, GPGSA, GPRMC, GPVTG and GPGSV. For this endeavor best GPGGA string is required, as necessities be, a thing, written in python is utilized to empty the required data [33]. After this, the degree and longitude empower are confined from the string. These headings are then utilized inside the GPS Navigation contraption of the unavoidable course PDA. The headings are when showed up diversely in connection to a couple of predefined courses of saw regions. Each time the direction experiences a fit, the client is fit for being inside the particular area by strategies for voice input. [34]

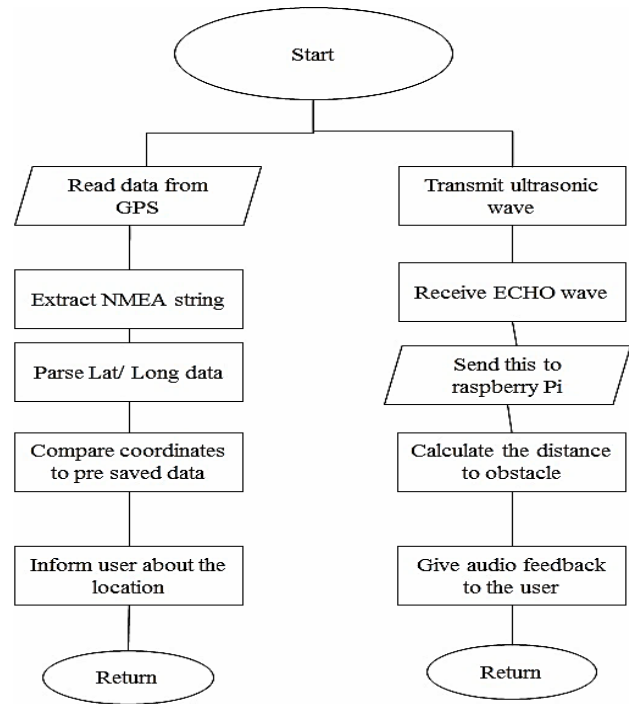


Figure 6. System Flowchart

The check disclosure framework handles the head of ultrasonic waves. The ultrasonic sensor transmits a wave and the got echoes are decoded to encounter the nearness of physical things. In [35], the ultrasonic sensor utilized on this test, HC-SR04, requires a 10s trigger heartbeat to begin its endeavor. This heartbeat is dispatched to the trigger stick of the sensor, through the Raspberry Pi. Precisely when the sensor experiences this heartbeat, it transmits 8 40 KHz pounds, and meanwhile begins off evolved a clock. When the sensor sees the reverberate beats, it stops the clock, and sets the ECHO stick high utilizing the time respect got from the clock. Resound stick is caught to Raspberry Pi and the utilization of it the Raspberry PI gets the chance to see the time taken by procedure for the ultrasonic waves to achieve the obstruction and are accessible returned. The utilization of conditions (1) (2), the program running on Raspberry Pi, picks the segment to the impediment.

$$34300 = Distance=(Time=2) \tag{1}$$

$$17150 \times Time = Distance \tag{2}$$

Thus, obstacles are detected without actually touching them. The Advanced Navigation PDA has various threshold levels for distance with different sound emitted for different distance from the obstacle. This project uses 10, 50 and 90 cm, as the levels for distance measurement. The module has been programmed using Python programming language and operates on an infinite loop, which make the module to be able to function continuously. [36] The audio system for both the GPS Navigation system and Obstacle Detection system has been made using Pygame module, a programming module to create

games and animations. Various channels have been created to accommodate various voice feedback commands and sounds so as to get interfered sound playback.

### Background Subtraction Module

Background subtraction is a noteworthy preprocessing venture in numerous vision-based applications. For instance, consider the cases like guest counter where a static camera takes the quantity of guests going into or leaving the room, or an activity camera separating data about the vehicles and so on. In every one of these cases, first you have to separate the individual or vehicles alone. In fact, you have to remove the moving closer view from static background.

On the off chance that you have a picture of background alone, similar to picture of the room without guests, picture of the street without vehicles and so on, it is a simple employment. Simply subtract the new picture from the background. You get the frontal area protests alone. Be that as it may, in the vast majority of the cases, you might not have such a picture, so we have to remove the background from whatever pictures we have. It turned out to be more muddled when there is shadow of the vehicles. Since shadow is additionally moving, straightforward subtraction will stamp that likewise as frontal area. It muddles things.

## 4 Results and Discussion

### 4.1 GPS Navigation Module

The two frameworks have been inspected as far as it matters for me before all else. The ability of the HC-SR04 move toward becoming inspected in the first place. It has been resolved out that the negligible separation that the sensor can gauge is 5cm. The most extreme separation the sensor wound up fit for measure was 200 cm. 200 cm is well past the range we requirement for our prevalent route PDA. The GPS collector gave rectify NMEA string impacts as appeared in Figure 8. The exactness of the GPS recipient was inspected the use of online guide benefits as demonstrated in Figure. The GPS Navigation device inside the endeavor is being analyzed for part of Electronics Engineering Block, Madras Institute of age, Anna school, Tamil Nadu. The machine needs to legitimately distinguish the two entryways of the branch of Electronics Engineering Block and advise the client in this manner. The directions of the entryways are appeared in Table 3. all through contraption testing each area was viably recognized eventually of each run. The snag location framework was tried autonomously and it can identify remove from as little as 4 cm to two hundred cm, the even precision from the GPS recipient is acquired to be <

1.89 m, 95% of the time the individual explored as demonstrated in Figure 7. The framework moreover performed remedy sound in each separation assortment. To run those frameworks simultaneously, the two distinctive python contents were kept running on Raspberry Pi. The contents kept running without obstruction and functioned as foreseen.

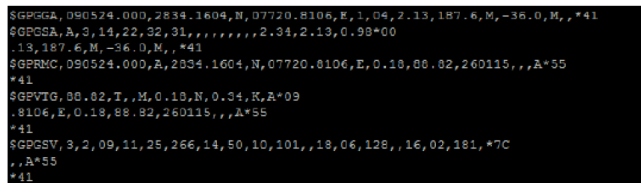


Figure 7. NMEA strings

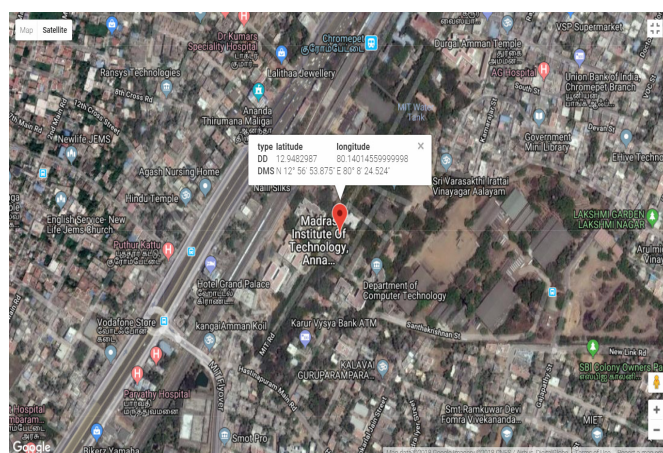


Figure 8. GPS accuracy test result

Table 3. List of coordinates for the gates of department of electronics engineering block

Location	Latitude range	Longitude Range
Department of Electronics Engineering Block Gate 1	12.9482787 to 12.9482987	80.139935 to 80.140145
Department of Electronics Engineering Block Gate 2	12.9480413 to 12.9480653	80.1399819 to 80.1400059

### 4.2 Static Obstacle Detection Test Result

The made stick may be more valuable to the apparently crippled to investigate appropriately each indoor and out of gateways. It yields first rate brings about recognizing the obstacle on the course of the customer up to various 3 meters. The fundamental thing features of the proposed device are low charge, enduring quality, and adaptability. despite reality that the contraption is set up with sensors and distinctive parts, the percent stick associated for this delineation’s measures cycle 600 grams horizontal accuracy of



<1.89 m, 95% of time. At some stage in the experimentation way, its miles affirmed that, at whatever point the sensor recognizes an unfilled sign, sensor gets activated and delivers a sound banner detailing that a Heavy deterrent is ahead of time. The experimentation is reiterated the usage of GMM likewise and the outcomes are depicted in the Figure 9. The system is reiterated if there ought to be an event of character of checks and in this situation, BGMM is thought about and basing the best probability criteria, the hole squares or overpowering limits are seen and the subsequent signs are created.

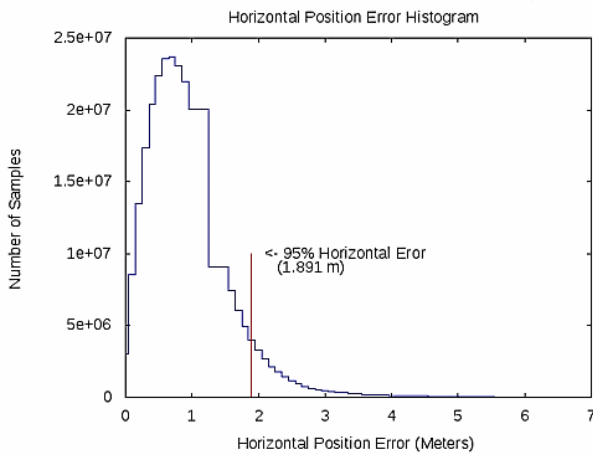


Figure 9. Single frequency GPS receivers attaining

### 4.3 Static Obstacle Detection Test Result

The made stick may be more valuable to the apparently crippled to investigate appropriately each indoor and out of gateways. It yields first rate brings about recognizing the obstacle on the course of the customer up to various 3 meters. The fundamental thing features of the proposed device are low charge, enduring quality, and adaptability. Despite reality that the contraption is set up with sensors and distinctive parts, the percent stick associated for this delineation’s measures cycle 600 grams. At some stage in the experimentation way, its miles affirmed that, at whatever point the sensor recognizes an unfilled sign, sensor gets activated and delivers a sound banner detailing that a Heavy deterrent is ahead of time. The experimentation is reiterated the usage of GMM likewise and the outcomes are depicted in the Figure 9. The system is reiterated if there ought to be an event of character of checks and in this situation, BGMM is thought about and basing the best probability criteria, the hole squares or overpowering limits are seen and the subsequent signs are created.

Table 4 and Table 5 exhibits the execution of Heavy obstacle acknowledgment and class cost. It may be found from the outcomes that the false helpful cost and fake negative extent regards are less, which indicates the viability of the proposed progression. The

confusion system impacts construe that the adjustment praised a preposterous affectability and specificity of 94.70% and 98.25% independently; such execution makes the shape suitable at an absurd acknowledgment cost with an absolutely low oversights charge.

Table 4. Heavy obstacle detection results

CONFUSION MATRIX		OUTPUT	
		Heavy obstacle	Absence of Heavy obstacle
INPUT	Heavy obstacle	95.40%	4.60%
	Absence of Heavy obstacle	10.70%	89.30%
Accuracy		95.36%	
Precision		97.81%	
Recall/ Sensitivity		94.70%	
Specificity		98.25%	

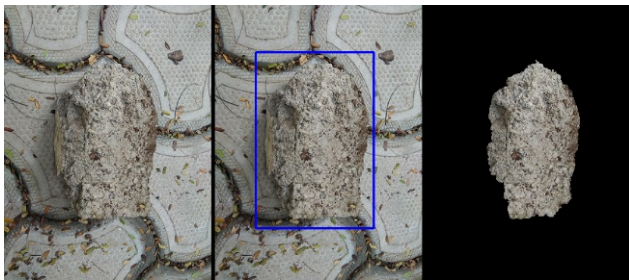
Table 5. Classification rates for detection of heavy obstacle/ hollow obstacle on a pathway

CONFUSION MATRIX		OUTPUT	
		Heavy obstacle	Hollow obstacle
INPUT	Heavy obstacle	94.50%	5.50%
	Hollow obstacle	10.70%	89.30%
Accuracy		0.95	

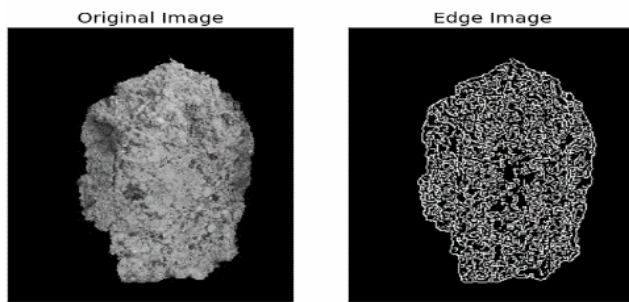
Figure 10 is the original image captured by the camera when the ultrasonic sensor senses the obstacle and triggers the vibrator. The image is captured and converted to gray scale and is pre-processed using the gaussian filter. The processed image is then used for ROI extraction using the graph cut algorithm by segmenting the desired obstacle portion and the edges are detected for the precise understanding of the obstacle for feature extraction which is shown in Figure 11(a) and Figure 11(b).



Figure 10. Original image of an obstacle captured by the camera



(a) The specific region of the obstacle is segmented



(b) Closer portion of the obstacle is segmented and the edges are drawn

Figure 11. Region of interest

The features of the obtained obstacles are then extracted using ORB algorithm and stored in the database. Then the obtained features of the obstacle and the features already present in the database are matched and the object is identified. The feature matching is shown in the Figure 7. Based on the matching the object detail is given as a voice message to the visually challenged person to overcome the obstacle. The Figure 11 to Figure 12 shows the results of obstacle detected for a static object when a visually challenged person walks the pavement.

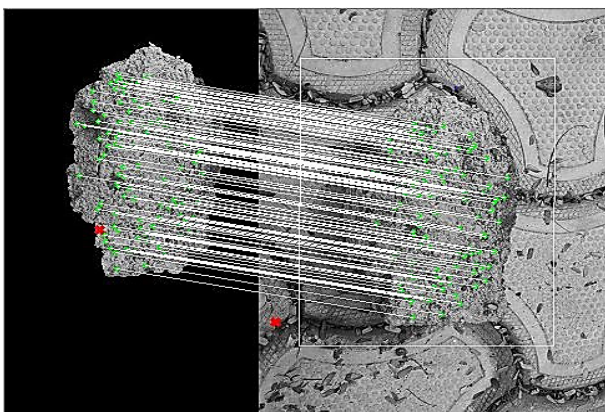


Figure 12. Feature matching is performed using SURF algorithm

#### 4.4 Dynamic Obstacle Detection Test Result

The Figure 8 shows the result obtained when the moving obstacle is identified in the path of the visually challenged person. From Figure 13(a), it is inferred that the moving object is identified with the direction

of movement, 8 directions of movement are included in the algorithm for an efficient identification of the obstacle to instruct which way the user has to take to avoid the hindrances. The instruction is given as per Figure 13(b) and Figure 13(c) where the time, and guidance are given.



(a) a moving object ball was identified

(b) the camera started recording the video mentioning the date and time of movement

```
Python 2.7.11 (v2.7.11:6d1b6a68f775, Dec 5 2015, 20:40:30) [MSC v.1500 64 bit
AMD64] on win32
Type "copyright", "credits" or "license()" for more information.
>>>
-----RESTART: C:/Users/AMU/Desktop/ananandan/motion.py-----
Something is moving !
Stop Walking
Something is moving !
Stop Walking
Something is moving !
Stop Walking
Something is moving !
Stop Walking
Something is moving !
Stop Walking
Something is moving !
Stop Walking
Something is moving !
Stop Walking
Something is moving !
Stop Walking
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Stop Walking
Something is moving !
Stop Walking
Something is moving !
Stop Walking
Something is moving !
Stop Walking
Something is moving !
Stop Walking
Something is moving !
Stop Walking
Something is moving !
Stop Walking
```

(c) sends the audio signal to the visually impaired when the object moves and instructs to stop walking

Figure 13.

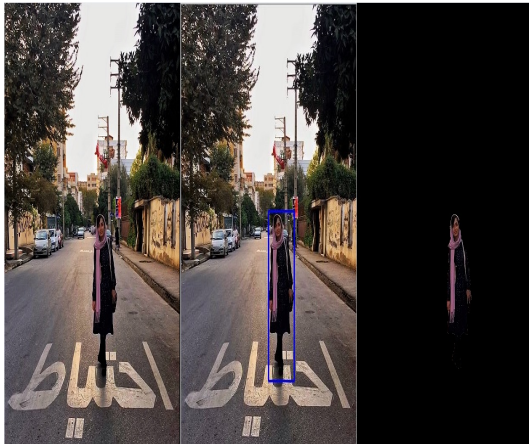
To find the obstruction inside the outside condition versatile gaussian blend demonstrate end up connected. it's miles a Gaussian total based history/Foreground Segmentation calculation. It makes To discover the hindrance inside the outside condition flexible gaussian mix show wind up associated. it's miles a Gaussian aggregate based history/Foreground Segmentation count. It makes use of a way to deal with show each heritage pixel with the guide of a blend of k Gaussian flows (okay = 3 to 5). The weights of the mix address the time degrees that the ones shades live inside the scene. The more then likely recorded past shades are the ones which live more and extra static. One irreplaceable limit of this computation is that it picks the privilege wide combination of gaussian dissemination for every pixel. (remember, in extraordinary case, we took an okay gaussian spreads all through the game plan of rules). It gives higher versatility to varying scenes due light changes and whatnot.

Additionally, when the client takes a way packed region the moving obstruction is identified as appeared



in Figure 14(a) and Figure 14(b). Where moving human, trees and a vehicle are distinguished utilization of an approach to display every legacy pixel with the guide of a mix of  $k$  Gaussian circulations (alright = 3 to 5). The weights of the blend speak to the time extents that the ones hues live inside the scene. The more then likely recorded past shades are the ones which live

more and additional static. One indispensable capacity of this calculation is that it chooses the right wide assortment of gaussian circulation for each pixel. (keep in mind, in extreme case, we took an alright gaussian disseminations all through the arrangement of guidelines). It gives higher adaptability to differing scenes due light changes et cetera.



(a) Human detection using background subtraction



(b) Moving obstacle detected in the outdoor environment

**Figure 14.**

It has some discretionary parameters like length of records, scope of gaussian mixes, limit and numerous others. It's far all set to some default esteems. Here, you have a decision of picking whether shadow to be recognized or now not. In the event that detectShadows = true (which is so as a matter of course), it distinguishes and stamps shadows, anyway diminishes the speed. Shadows will be set apart in dark shading

Similarly, when the user takes a path over crowded area the moving obstacle is detected as shown in Figure 14(a) & 14 Figure 14(b). Where moving human, trees and a vehicle are identified

High Dimension data means data with large number of features, attributes or characteristics that leads to curse of dimensionality so it needs to be handled using various techniques like Principal Component Analysis, low variance filter, high correlation filter, random forest, backward feature estimation, wavelet transform etc. But the number of samples may be less.

## 5 Conclusion

This paper focuses on developing an advanced navigation system for visually impaired people to assist them in the outdoor environment. The scope for this paper is to improve the capabilities of the blind people to navigate without a hassle in the open environment by providing them with the direction and the voice instruction. This device developed is of low cost and user friendly. The outdoor environment being a challenged environment with unexpected events occurring, several accidents are met. To avoid such

instances raspberry- pi interfaced with camera is developed and given to the impaired people as a personal assistance device for advanced navigation purpose. The audio bone device is integrated with the raspberry- pi to feed the instruction regarding the object identified to the visually impaired person. The audio bone facilitates the partial hearing loss people to hear directly through the cochlea without surpassing the eardrum. The Personal assistance device was tested in three two area and for two different cases. First the static obstacle was detected while walking over the pavement, secondly the dynamic obstacles where detected and instructed as an audio signal to the user. The heavy obstacle was detected for a free path of navigation by utilizing the Bivariate gaussian mixture model classifier yielding 95% of classification accuracy. A outdoor obstacle detection was performed using a adaptive gaussian mixture model to subtract the background from the required foreground and the presence of the obstacle like moving people, and vehicles under various illumination condition are dictated to the visually challenged Person via audio bone device. The algorithm involves for modeling each pixel as a Gaussian mixture model, updating the parameters of the background model in real time, eliminating shadow in the HSV space, and eliminating noise influences and reconstructing moving human regions by morphological operations. Thus, it can accurately detect moving human in cluttered scene. More importantly, as much foreground pixels as possible are remained.

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