Design of an Intelligent Electric Vehicle for Blind

Abhilash G. Kammath[1] and Karthika S. Nair[2]
Department of Electronics and Communication, Sree Chithra Thirunal College of Engineering, Trivandrum, Kerala, India
E-mail: [1]abhilash0317@gmail.com; [2]karthu_mails4me@yahoo.com

Suryakumar Sudar
Department of Computer Science, Sree Chithra Thirunal College of Engineering, Trivandrum, Kerala, India
E-mail: surya@gmail.com

Abhishek Gujarathi
Department of Mechanical Engineering, Sree Chithra Thirunal College of Engineering, Trivandrum, Kerala, India
E-mail: abhishekgujarathi@gmail.com

***Abstract*—*As the technology increases we can solve many problems of the people. There are lots of persons who cannot walk very easily due to blindness. For them travelling with safety is a major problem. An intelligent electric vehicle is thus required to solve their problem. The vehicle is made with a lot of technologies such as Digital image processing for obstacle detection, edge detection and road detection, Sonar, Infrared and Lidar based Obstacle avoidance, GPS and Map based location guidance for vehicle, GSM based emergency servicing and semi automatic control system for vehicle. We propose a design of completly intelligent electric vehicle for blind which can be implemented successfully. The vehicle is designed in such a way that it can climb footpaths. The vehicle is designed to obey all traffic signals so that the design is apt for real world.*

Keywords: Artificial Intelligence, Obstacle Avoidance, Sonar, Lidar GPS & GSM.

I. INTRODUCTION

Independent mobility is a key component in maintaining the physical and psychosocial health of an individual. Further, for people having blind, independent mobility increases vocational and educational opportunities, reduces dependence on caregivers and family members, and promotes feelings of self-reliance. Psychologically, a decrease in mobility can lead to feelings of emotional loss, anxiety, depression, reduced self-esteem, social isolation, stress, and fear of abandonment. Even though the benefits of powered mobility are well documented, the safety issues associated with operation of powered vehicles often prevent clinicians and rehabilitation practitioners from prescribing powered mobility. One obstacle to safely operating a vehicle is impaired vision. So we are introducing an intelligent vehicle for blind. This vehicle is powered by rechargeable battery and the time of charging is very less. It can be operated in automatic as well as in manual mode. A lot of features are their in this vehicle which makes it distinguishable from other suggested vehicles. The vehicle can be used for blind, handicapped and elders. The main advantages are:

1. *Design:* The vehicle is designed in such a way that it can climb footpaths or steps of size 10–12 cm.
2. *Navigation:* The GPS with map is used to find the location.
3. *Obstacle Avoidance:* The Sonar, Ladar and IR sensors are used to detect and avoid the obstacles.
4. *Traffic Signal Guidance:* The digital image processing based traffic signal detection is used to detect the traffic signals.
5. *Mobile Service:* The text to speech and speech to text servicing is provided for GSM communications.
6. *Face Recognition:* The face recognition is also added using digital image processing techniques
7. *Voice Commanding:* The vehicle works based on voice commands.
8. *Electronic Control Unit:* It is the heart of the vehicle which control all the functions of electric vehicle.

II. DESIGN

The design of an electric vehicle is divided into several systems and which are again subdivided into several subsystems to reduce complexity. The design includes:

- Sensor techniques
- Speech to text and text to speech interface for GSM
- Interfacing of GPS and map with voice commands
- Digital image processing techniques
- Electronic control unit
- Mechanical design.

A. Sensor Techniques

There are 2 types of sensors are used:

- Sonar (Ultrasonic Sensor)
- Lidar

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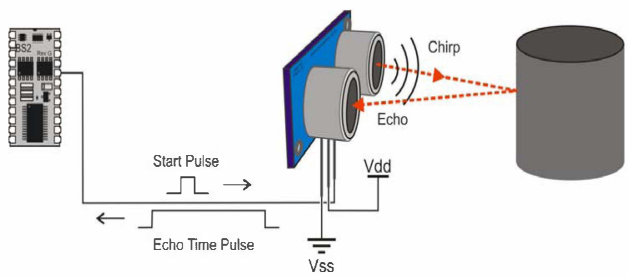
(a) *SONAR (Ultrasonic Sensor)*

The ultrasonic sensor is used for measuring how far away an object is. one of the suggested ultrasonic sensor is Ping. It can detect obstacles in the range of 3cm to 3.3m. It's also remarkably accurate, easily detecting an object's distance down to the half centimetre. The 3 ping sensors are used in the vehicle to detect the obstacle. the Ping sensor sends a brief chirp with its ultrasonic speaker and makes it possible for the BASIC Stamp to measure the time it takes the echo to return to its ultrasonic microphone. The BASIC Stamp starts by sending the Ping sensor a pulse to start the measurement. Then, the Ping sensor waits long enough for the BASIC Stamp program to start a **PULSIN** command. At the same time the Ping sensor chirps its 40 kHz tone, it sends a high signal to the BASIC Stamp. When the Ping sensor detects the echo with its ultrasonic microphone, it changes that high signal back to low. The BASIC Stamp's **PULSIN** command stores how long the high signal from the Ping sensor lasted in a variable. The time measurement is how long it took sound to travel to the object and back.

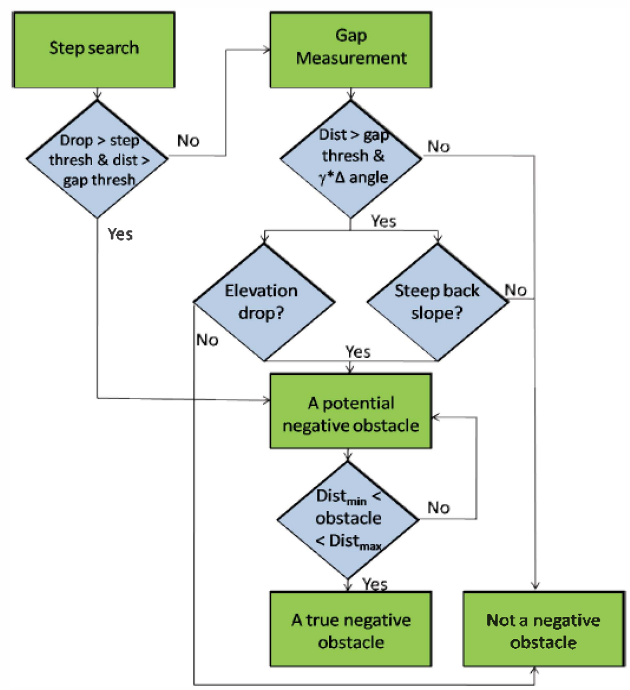


(b) LIDAR (Light Detection and Ranging)

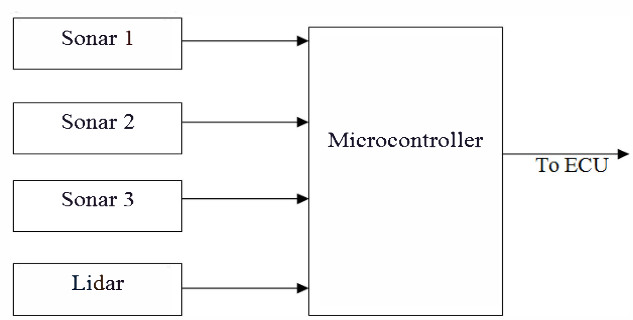
It is an optical remote sensing technology that can measure the distance to, or other properties of a target by illuminating the target with light, often using pulses from a laser. Here we using a small Lidar sensor to measure the distance to an object. The sensor works by sending out an infrared pulse and recording the time of flight for a beam of light to be emitted and reflected back to a light sensor. Basically it's a radar with infrared light. Detection of road boundaries and obstacles is essential for autonomous vehicle navigation. The lidar is used to extracts line segments from the raw data of the sensor in polar coordinates. After that, the line segments are classified into road and obstacle segments. To enhance the classification performance, the estimated roll and pitch angles of the sensor relative to the scanning road surface in the previous time step are then used. The classified road line segments are applied to track the road boundaries, roll, and pitch angles by using an integrated probabilistic data association filter.

Negative obstacles are ditches or terrain with a steep negative slope that if traversed would be a hazard to the vehicle. Negative obstacles can be just as hazardous to unmanned vehicles as obstacles above ground because they could cause roll-over, tip-over, or high-centering ditches that are larger than the width of the diameter of the wheel are enough to cause damage to a vehicle. Obstacles of greater widths may be crossed by vehicles at high enough speeds. These hazards are difficult to detect from close up and nearly impossible from far away.

Flowchart for detecting negative obstacles.

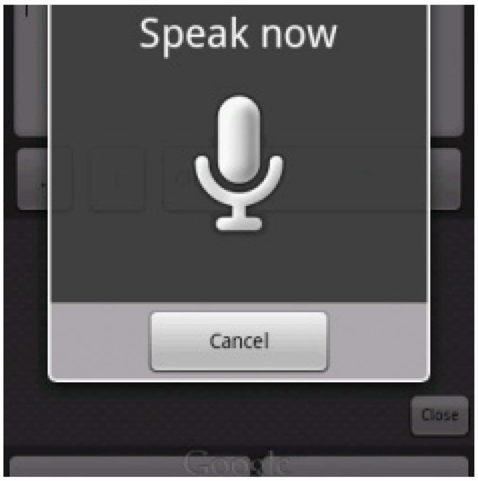


Control of sensor with microcontroller.



B. Speech to Text and Text to Speech Interface for GSM

We are using ARM Processor for digital image processing, So we develop an android application run in ARM for speech to text and text to speech. So person can use voice commands for GSM communications.The message once received is converted to speech by this application.An android application for speech recognition is also made to recognise each commands .With the help of this person can call and send messages. **Voice Text** turns the Android device into a dictation machine using Android's voice recognition software. The main portion of the app transcribes short messages into text for almost-eye-free texting. Speak into the phone and your comments will be converted into an SMS message.



A text-to-speech (TTS) system converts normal language text into speech. Synthesized speech can be created by concatenating pieces of recorded speech that are stored in a database The two primary technologies for generating synthetic speech waveforms are concatenative synthesis and formant synthesis. Concatenative synthesis is based on the concatenation (or stringing together) of segments of recorded speech Unit selection synthesis uses large databases of recorded speech An index of the units in the speech database is then created based on the segmentation and acoustic parameters like the fundamental frequency (pitch), duration, position in the syllable, and neighbouring phones. At run time, the desired target utterance is created by determining the best chain of candidate units from the database (unit selection). This process is typically achieved using a specially weighted decision tree.

C. Interfacing of GPS and Map with Voice Commands

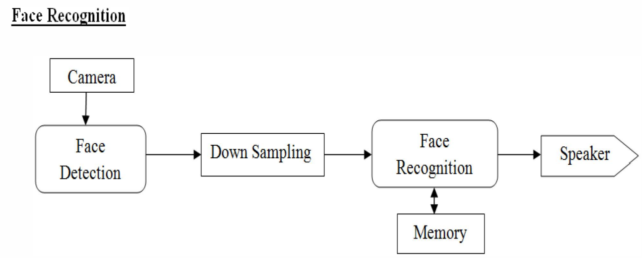
Using android, a voice guided navigation system is made by interfacing with GPS map. So blind can find the destiny and can reach the place with the help of vehicle.The voice guided navigation is coded and it is send as a 2 bit data to ECU, where it decodes and generate control signals to run the motor. ECU commands the motor driver for any action by considering all sensor outputs and the GPS guided output.

D. Digital Image Processing Techniques

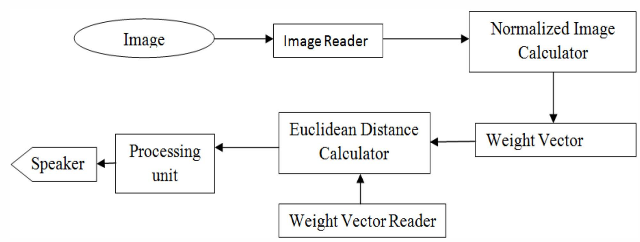
Digital image processing techniques are used in the vehicle for following purposes

- Face Recognition
- Road Detection and Footpath Detection
- Traffic Signal Detection

(a) *Face Recognition*

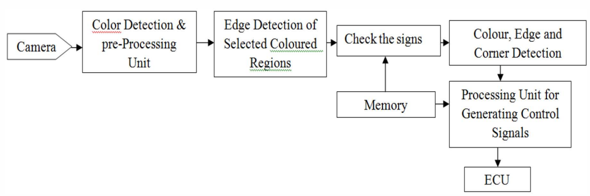


The suggested design of a real-time and complete face recognition system consisting of a face detection subsystem, a down sampling module and a face recognition subsystem. The face recognition subsystem uses the Eigen face algorithm. The complete system interfaces with a camera, sends the video data to the face detection subsystem, which in turn sends detected faces to the face recognition subsystem via the down sampling module. The face recognition system automatically identifies or verifies a person from a digital image, a video frame or a video source.



There is a reader module which stores the pixel value of unknown image in the image buffer. To recognize the unknown image the pixels are send to normalized image calculator for doing normalized image calculation. The normalized image calculator module finds the differences between the average image and the input image. The average image reader reads the image pixels from the average image buffer, and then the input image pixels are subtracted to find a normalized image. The normalized image is stored in the normalized image buffer The weight vector finder module calculates weight values for input image using the previously calculated normalized image and Eigen vector values. The Eigenvector values are read by the Eigen face reader from the Eigen face image buffer. The Eigenvector values are stored in block RAM. The weight vector reader is used by the classifier/projection module for retrieving the weight vector values that are generated in the training stage and stored in the block RAM. The classifier module utilizes weight vectors (from the weight vector reader module) and the weight vector for the unknown image (from the weight vector finder module). Then the classifier finds the distance between each weight vector from the weight vector reader module and the weight vector of the unknown image. For each calculation of distance, it compares the current distance value with the previous one. If the current value is smaller, then it is stored to the distance buffer. Finally, the index of the identified face, which corresponds to a minimum distance in distance buffer, is sent to the speaker (or other output device) as an identified name.

(b) *Road Detection, Footpath Detection and Traffic Signal Detection*



Pre-processing will load the image as well as check contrast, brightness, and clarity. If these parameters are off from our desired values for these, adjustments will be performed. This will ensure that the image is suitable for processing. If the pre-processed image doesn't meet the desired configurations then it may not be able to identify if there is any road, footpath or any sign in the image. First, the system will detect colours and then look for colours of interest. Colours like red, yellow, and white that constitute road signs will be considered colours of interest. The black colour in a width, greater than or equal to minimum pre-defined width is detected to ensure that it is road. The system will then define the region in which these colours are concentrated and outline the shape of the sign. If no sign is present, there will not be any sign to identify; nothing will be output. With the data gathered from the image, the system will determine if a sign is present. If a sign is present , then using image enhancement techniques the sign will be detected. The processing unit will generate control signals corresponding to the detected signal and send command to ECU to perform the task. For digital image processing techniques we use ARM processor for processing data.

E. Electronic Control Unit (ECU)

The electronic control unit is the heart of the vehicle. It control the overall performance of the vehicle. It receive 6 bit binary data from the video processing unit, a single bit data from the obstacle avoider mux, 2 bit binary data from code generator and 4 bit data from manual control of vehicle unit. All these datas processed and giving 4 bit binary output of motor driver to control the motor.

- When a road is detected video processing unit will generate the binary output logic high (R)
- When a footpath is detected video processing unit makes the binary output logic high (F)
- When a traffic signal is detected, it is compared with the signals stored in the memory and generate a corresponding four bit binary output for action (T0, T1, T2, T3)
- When an obstacle is detected by any one of the sonars (S1, S2, S3) then the mux output becomes logic high (a).

S1	*S2*	*S3*	*a*
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

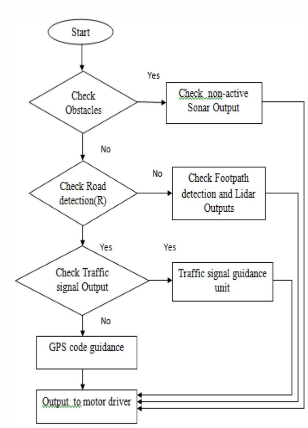
- After detecting the path by GPS and map, code generator continuously generate two bit binary code to give direction to the vehicle (C0, C1).

C0	*C1*	*Direction*
0	0	Straight
0	1	Right
1	0	Left
1	1	OFF State

- The manual control of vehicle is done by generating 4 bit binary codes by operating 2 switches on both sides(P0, P1, R0, R1)

P0	*P1*	*R0*	*R1*	*Direction*
0	0	0	0	Stop
0	1	0	1	Forward
0	1	0	0	Left
0	0	0	1	Right
1	0	1	0	Backward

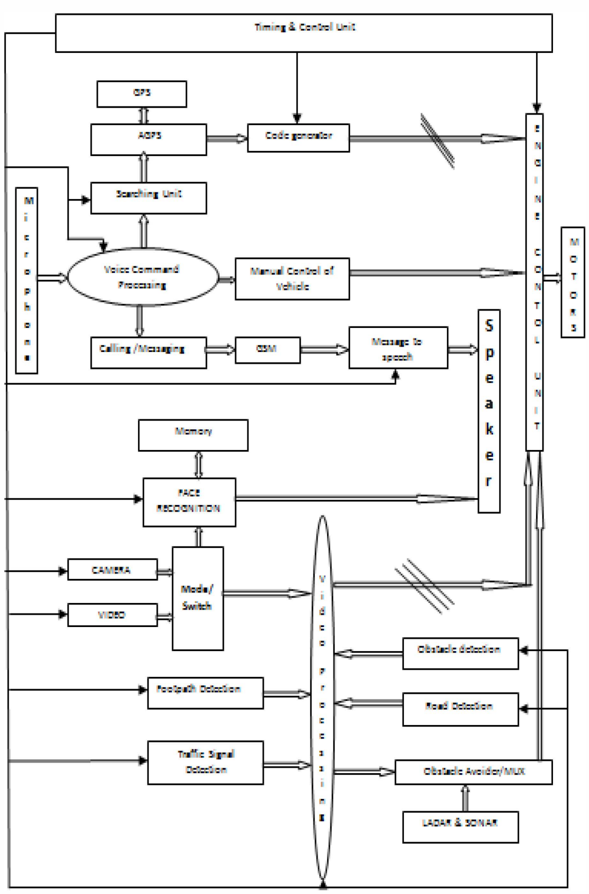
Flow chart of ECU control is



III. WORKING

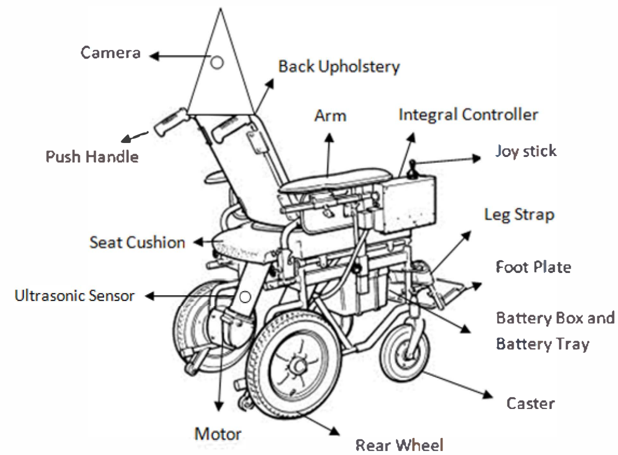
The vehicle can be operated manually as well as automatically. If the vehicle is in automatic mode, then while starting sonar start to sense obstacles, if the obstacles are not present in front of the vehicle then it checks whether it is in road or not. If it is in road then vehicle will check for traffic signals. If any traffic signal is found then traffic guidance unit guides the vehicle movement else vehicle is guided by GPS code guidance unit. If any obstacle is detected then it will check is there any sonar non-active. If yes ,then vehicle will move to that direction to avoid obstacle else vehicle stops. The person can use voice commands for GSM communications. With the help of text to speech and speech to text applications person can read and send the messages in addition to calling. With the help of face recognition, blind can detect persons.

Complete Block diagram working of Electric Vehicle.

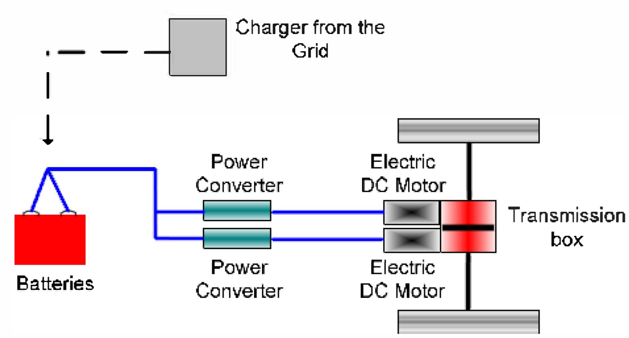


IV. DESIGN OF ELECTRIC VEHICLE

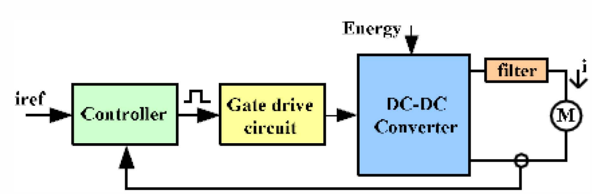
The electric vehicle consists of a car seat, two pneumatic tyres and two castor wheels mounted on a metal chassis. The system is powered by two 48V batteries stored beneath the seat. This configuration allows the chair to cross more obstacles than would otherwise be possible, but it also



complicates the system dynamics and makes control more difficult. Optical position encoders are installed in the wheelchair motor casings. These sensors provide feedback for speed and position control. There are circuits for power supply filtering, motor operation, feedback control, sensor operation and autonomous control. A camera is placed at the top of the seat for digital image processing. The arm-rest mounted joystick which may have additional controls to allow the user to tailor sensitivity or access multiple control modes.



The motors power supply comes from two power converters (DC-DC converters) which are supplied by three 12V batteries in a series connection. These batteries can be recharged from the mains network (grid). The vehicle uses two 11kW@48V DC motors. The option of operate with low voltage motors is related with safety concerns; in counterpart this motors needed a high current value.



The DC-DC converter is to regulate the power delivered to the motor; the controller generates a square voltage waveform according the current error; the gate drive circuit commands the state of the switches of the DC-DC converter; the output filter reduce the ripple current in the motor to provide low losses.

V. CONCLUSION

This paper presents the architecture of Intelligent Electric vehicle using embedded system and digital image processing techniques. Features associated with it are Obstacle avoidance, Footpath climbing, Road and Edge detection, Face Recognition, GPS based navigation assistance and the design of the vehicle. The future prospects in relation to electric vehicle is to improve its mechanical properties, reliability and clinical feasibility.

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