Abstract

An important step in the autonomization of robots specifically designed for mobility is Autonomous navigation the ability to navigate from a current position to a programmed point, without the manual control of a human user and crossing obstacles successfully without human help. We present here a localisation and navigation bot. Which knows it's location and which can move to the specified point autonomously. We achieved this using gps module, ultrasonic sensors, motor encoders and micro controller. The starting point and ending point are given through pc by usb cable. Using the coordinates received from GPS module, the bot moves to given point avoiding obstacles in shortest distance possible.

1. Introduction

1.1 Purpose of the Project

Robots have become part of our life these days. Starting as replacement for workers in manufacturing industries to drone delivery, as waiters in hotels and restaurants. Autonomous robots play crucial role. The demand for the autonomous bots have been increasing continuously. So, here we are making a autonomous bot .A localization and navigation bot to be specific which knows it's location and which can move to the given location all by itself. They play a significant role in the present generation.

1.2 Scope for the Project

With increase in automation, bots play a key role in present generation. Prominent companies such as John Deere, Steelcase, and HP use autonomous indoor navigation bots to humanize remote conversations and to bridge the gap between formal and informal interaction. Recently, Raffi Krikorian, VP of Engineering at Twitter bought Double, one such bot, to act as his replacement when he can't attend a meeting and to interact with his colleagues, while he is someplace else, by making Double move the isles of his office. The more autonomous they are, the higher the demand and value. Presently bots are used to maximum extent in manufacturing units. This localization and navigation bots are the future. They are used in delivery drones. The self driving cabs for which the world is waiting, this sort of bots are the key player.

1.3 Design Elements included(Atleast one apart from the marked ones)

- ☒Engineering Standards*
- ☒Prototype and Fabrication
- ☒Design Analysis*
- ☒Experimentation
- ☐Modelling and Simulation
- ☐Software Development

1.4 Realistic Constraints to be addressed (Atleast two to be selected)

- ☒Economic
- ☒Ethical
- ☒Environmental
- ☒Health and Safety
- ☒Social
- ☒Manufacturability
- ☐Political
- ☐Sustainability

2. Literature Review

2.1 Survey details

Chin-Kai Chang-He presented a vision-based navigation and localization system using two biologically-inspired scene understanding models which are studied from human visual capabilities: (1) Gist model which captures the holistic characteristics and layout of an image and (2) Saliency model which emulates the visual attention of primates to identify conspicuous regions in the image. There the localization system utilizes the gist features and salient regions to accurately localize the robot, while the navigation system uses the salient regions to perform visual feedback control to direct its heading and go to a user-provided goal location. He tested the system on their own robot, Beobot2.0, in an indoor and outdoor environment with a route length of 36.67m (10,890 video frames) and 138.27m (28,971 frames), respectively. On average, the robot is able to drive within 3.68cm and 8.78cm (respectively) of the center of the lane.

Phillip Dupree Research was the autonomization of the robot RHex, a highly mobile hexapodal robot built in the GRASP lab of the University of Pennsylvania, which was accomplished by the integration of a global positioning system (GPS) module into the robot. The GPS module gave the robot the ability to follow a “breadcrumb” path of GPS way-points. Once the GPS data was parsed, the coordinates of both the robot’s location and the path of waypoints were converted into flat-earth approximate Cartesian coordinates, and then inputted into a linear control system. Once this was accomplished, the robot had the ability to “know” its current position and navigate from it to any programmed point, providing there were no obstacles in its path.

Osama Hamzeh, and Ashraf Elnagar- Tele-robotic localization systems vary in implementation, but the cost of building such solutions is high. Therefore, utilizing such solutions in complex areas becomes a very difficult choice. We propose to use a low-cost localization and navigation solution that consists of a low cost Kinect sensor along with a normal laptop to control a small mobile robot. Our proposed solution involves remotely controlled mobile robot for navigating a pre-built MAP of an unknown environment. Experimental results confirm the success of the prototype design and implementation.

Todd Litman- This report explores the impacts that autonomous (also called self-driving, driverless or robotic) vehicles are likely to have on travel demands and transportation planning. It discusses autonomous vehicle benefits and costs, predicts their likely development and implementation based on experience with previous vehicle technologies, and explores how they will affect planning decisions such as optimal road, parking and public transit supply. The analysis indicates that some benefits, such as independent mobility for affluent non-drivers, may begin in the 2020s or 2030s, but most impacts, including reduced traffic and parking congestion (and therefore road and parking facility supply requirements), independent mobility for low-income people (and therefore reduced need to subsidize transit), increased safety, energy conservation and pollution reductions, will only be significant when autonomous vehicles become common and affordable, probably in the 2040s to 2060s, and some benefits may require prohibiting human-driven vehicles on certain roadways, which could take longer.

Liu and Tomizuka -proposed the Robustly-safe Automated Driving system (ROAD) which prevents or minimizes occurrences of collisions of the automated vehicle with other road participants while maintaining efficiency. In this paper, a set of design principles are elaborated as an extension of the previous work, including robust perception and cognition algorithms for environment monitoring and high level decision making and low level control algorithms for safe maneuvering of the automated vehicle.

2.2 **Knowledge gained from the literature**

1. We have learned how to develop the algorithm
2. Learned servo motor controlling of speed variation which helps to guide the steering.
3. Appropriate usage of navigation system.
4. Information about drive

2.3 Gaps Identified

1. The technology which is present now cant be used or implemented in all existing electric vehicles.
2. The cost is very high included in existing process.

2.4 Objectives of the work

Make an autonomous vehicle which can take diversion against obstacles. The expected application lies in the mining, factories and construction industry where most of the jobs can be automated and thus reducing costs. To make the bot at the cheapest rate possible.

3. Project Plan

3.1 Methodology

A perfect material which can bear the load of the motor(s) and the battery which can also host the steering system so that the direction of the vehicle can be changed is selected. After the material is selected, linkages required for the steering system are fabricated so that it can be controlled using a servo motor.

Wheels are selected with an estimate of the final load. Both the rear wheels move in sync, so the rear wheels are connected to each other with a shaft.

A servo motor is selected based on the steering system which has already been fabricated. Now with whole load on board, a DC motor will be selected.

So the vehicle will be rear wheel drive without a gear and a MOPED type power train.

After the construction of the mechanical components, Raspberry PI with an OS installed, is tested with each and every sensor. Input from each of the sensors is tested and the type of input is understood for each and every sensor. To make the final product all the sensors should work in tandem and thus the algorithm is designed such that the Raspberry PI handles all the inputs and makes the decisions.
The algorithm is designed based on the end-product requirement. The end-product should have the following features.

- It should go from one place to other place using the GPS coordinates.
- If any obstacle is found, based on the speed the vehicle should steer itself or should come to a halt.
- If any moving vehicle is found, based on the behaviour of the vehicle, the ADV should apply brakes or should steer itself.
- Based on the behaviour of the side vehicles and the rear vehicles, the data from the sensors should be taken with which the speed, steering angle and few others should be controlled.
- When a speed braker or a pot hole is found, ADV should make the correct decision to slow down the vehicle, so that the passengers will feel comfortable.
- ADV should work even in very low light conditions without fail.
- ADV should sense some routine sounds like horns and should make way for the vehicles incoming or outgoing.
- Based on the temperature and humidity of the environment the Air conditioning should be switched on with the input from the user.
- For a given interval of time the raspberry pi should connect to the internet and dump the data. If required the user should be able to control the vehicle using internet.

(Optional) Based on the data collected and stored with each and every ride, the vehicle should use machine learning and take its own decisions.

3.2. Calculations

Dc Motor:

Data:

Vehicle weight: 17 kg

Vehicle speed: 10 km/h

Coefficient of rolling resistance Cr: 0.3

Drag coefficient Cd: 1.5

Representative frontal width: 0.75 m

Representative frontal height: 0.25 m

Air density: 1.2 kg/m^3

Estimated efficiency: 80%

Power =Force *velocity

Force: force required to overcome the rolling friction force and air drag force.

Rolling frictional force = Cr*mg

Air drag force= Cd* density*A*(v^2)

Assumption:

Velocity v=10 km/h

Calculation:

Rolling frictional force= 0.3*17*9.81= 50.031N

Air drag force= 1.5*1.2*0.75*0.25*2.78*2.78= 1.048N

Force= 50.031+1.048= 51.079 N

Power= 51.079*2.78= 142W

Efficiency (80%) = 142*(100/80) = 178W

Final power required: 178W

Servo motor:

Data:

Mass acting on each tyre: 17/4 = 4.25kg

Radius of each tyre: 6inch

Thickness of tyre: 4cm

Calculation:

Moment of inertia (I) = (1/4) m(r^2) + (1/12)m (l^2)

= 0.25*4.25*6*6*2.54*2.54 + 0.0833*4.25*4*4

$= 246.774 + 5.667$

$= 252.441$ kg.cm^2

$= 0.02524$ Kg. m^2

Assumption**:**

N= 60rpm

Angular velocity $\omega = 6.2832$ rad/sec

Angular acceleration $\alpha = 3.14$ rad/sec^2 Taking t=2sec

Torque required to steer a wheel=T1

Torque T1= I*α

= 0.02524*3.14

= 0.0793 Nm

Now, force required at the end of the link to provide the above torque,

F1*L2=T1

F1=0.0793/0.075

=1.0573 N

Servo motor Torque (which can provide this amount of force at end of the link)

=1.073*0.7

=0.74 Nm

=0.74/0.098 kgf.cm

=7.553 kgf.cm

Servo motor torque for both wheels=7.553*2

=15.106 kgf.cm

3.3. Motor Details

Dc motor:

Torque: 175kg.cm

Rpm: 100

Power: 180W

Servo motor:

Torque: 16kg.cm

Speed: 0.14sec/60degree

Volts: 6.0

3.4 Phyton program for Ultrasonic Sensor:

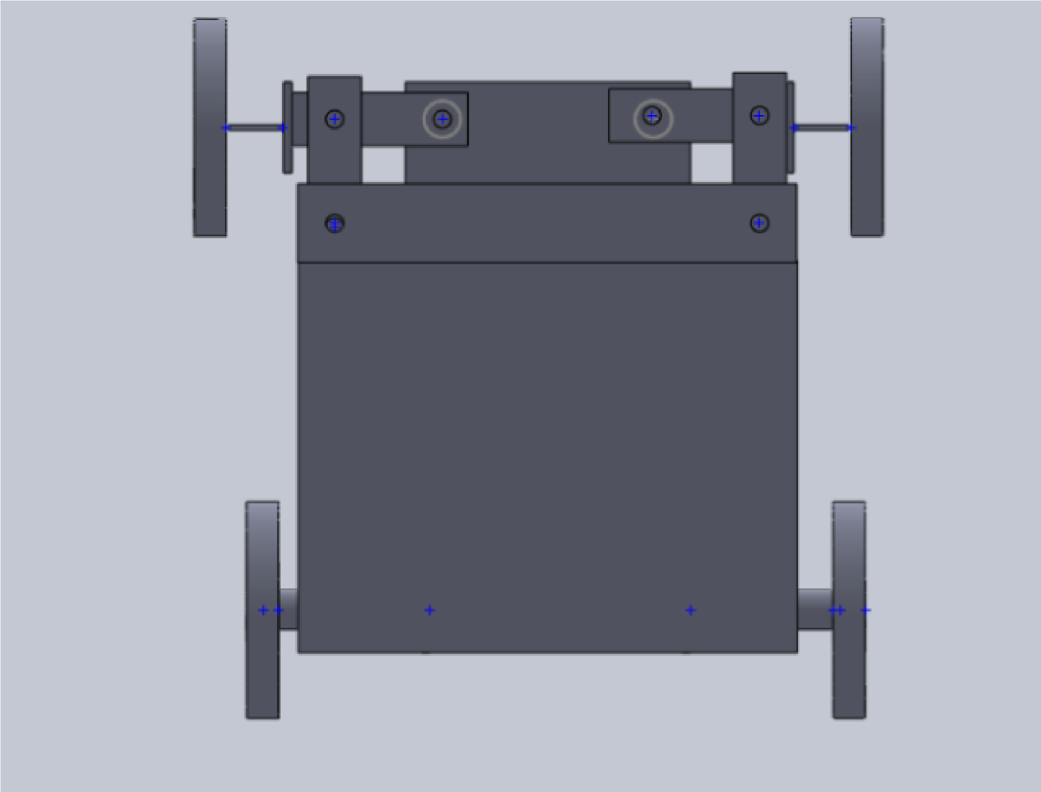
```
#Libraries

import RPi.GPIO as GPIO

import time

#GPIO Mode (BOARD / BCM)
GPIO.setmode(GPIO.BCM)

#set GPIO Pins
GPIO_TRIGGER = 18
GPIO_ECHO = 24

#set GPIO direction (IN / OUT)
GPIO.setup(GPIO_TRIGGER, GPIO.OUT)
GPIO.setup(GPIO_ECHO, GPIO.IN)

def distance():
# set Trigger to HIGH
GPIO.output(GPIO_TRIGGER, True)

# set Trigger after 0.01ms to LOW
time.sleep(0.00001)
GPIO.output(GPIO_TRIGGER, False)

StartTime = time.time()
StopTime = time.time()

# save StartTime
```

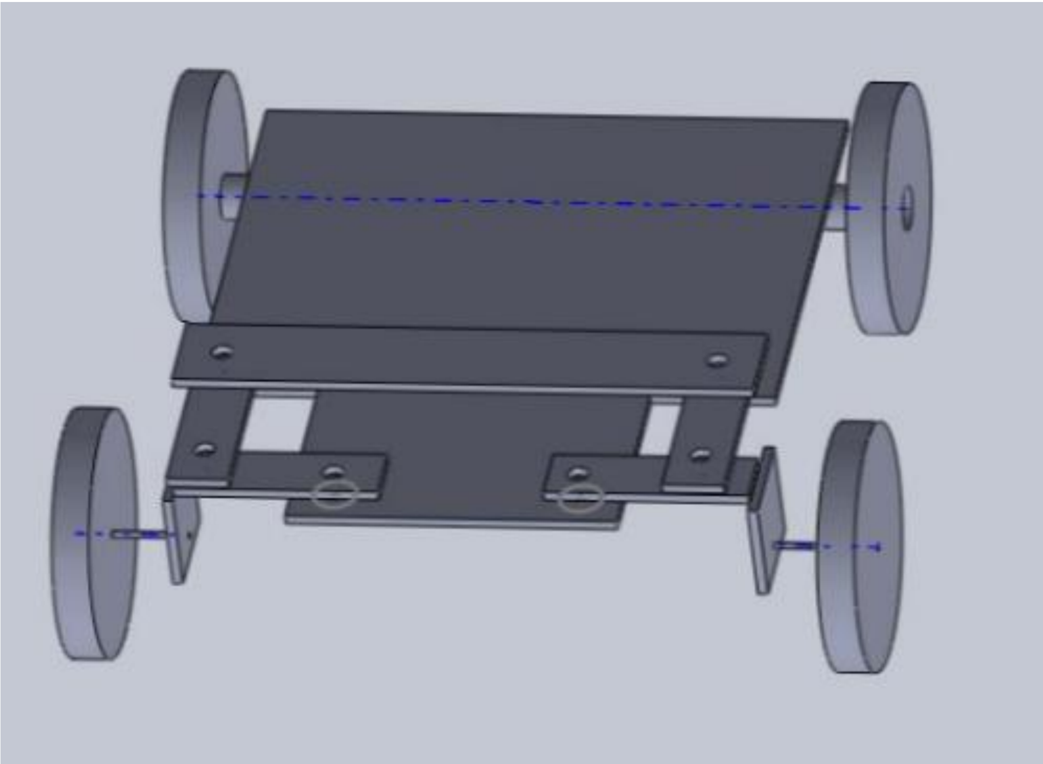
```
while GPIO.input(GPIO_ECHO) == 0:
StartTime = time.time()

# save time of arrival
while GPIO.input(GPIO_ECHO) == 1:
StopTime = time.time()

# time difference between start and arrival
TimeElapsed = StopTime - StartTime
# multiply with the sonic speed (34300 cm/s)
# and divide by 2, because there and back
distance = (TimeElapsed * 34300) / 2

return distance

if __name__ == '__main__':
try:
while True:
dist = distance()
print ("Measured Distance = %.1f cm" % dist)
time.sleep(1)
# Reset by pressing CTRL + C
except KeyboardInterrupt:
print("Measurement stopped by User")
GPIO.cleanup()
```

4. Progress of work

4.1 Work done till date

1. All the material required for the chassis is brought.
2. The ply wood is shaped according to the design requirement.
3. Necessary slots for the bearings and the pipe are done.
4. Temporary assembly of the steering mechanism is done.
5. Assembly of the overall chassis is done.
6. Installation of operating system to raspberry pi.
7. Calibration of ultrasonic sensors.
8. Calibration of servo motor which assists rotating of ultrasonic sensors.
9. Calculation of power required for DC motor.
10. Calculation of torque required for servo motor.
11. Selection and procurement of DC motor, servo motor and battery.
12. Installation of belt drive.

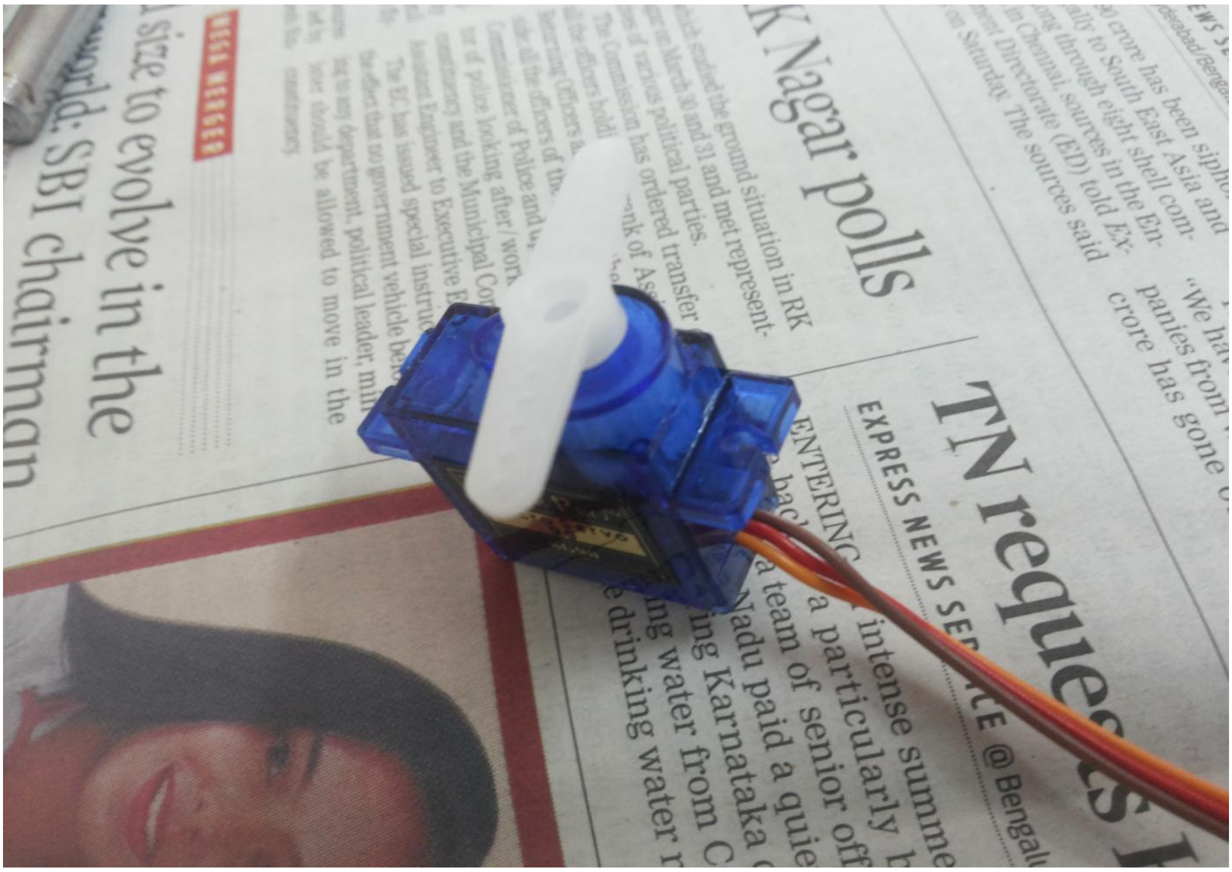

Top View


Isometric view

Real prototype view

Raspberry pi

Ultra sonic sensor



Servo motor

4.2 Work to be done

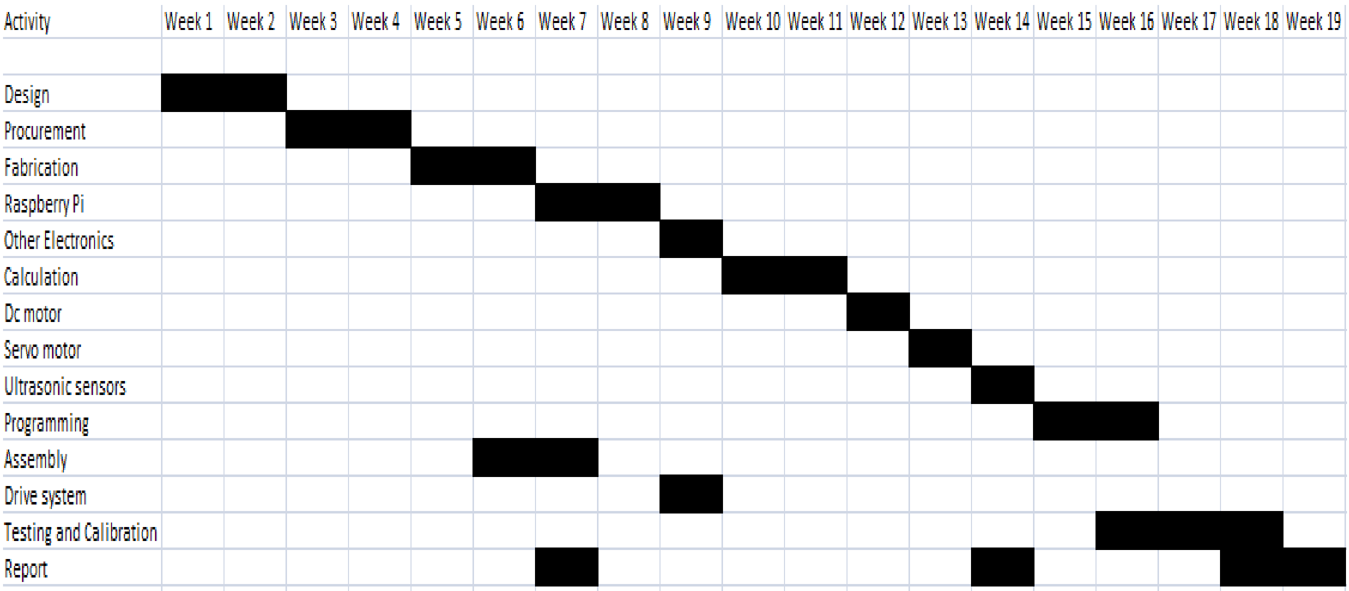
1. Attachment of sensors to the vehicle.
2. Installation of the servo motor to the steering system
3. Installation of the primary motor and battery equipment to the vehicle.
4. Testing and improvements of the vehicle performance.

5. Time Frame

5.1 Time Schedule and milestones

Review 1: chassis design and getting started with raspberry pi
Review 2: calibration of ultrasonic sensors and servo motor.
Final Review: Affective programming and entire working of bot.

5.2 **Gantt chart**



References

1. Vassilis Varveropoulos. Robot Localization and Map Construction Using Sonar Data.
2. Osama Hamzeh, and Ashraf Elnagar. Localization and Navigation of Autonomous Indoor Mobile Robots
3. Erickson H.; LaValle M., Navigation among visually connected sets of partially distinguishable landmarks, Submitted in partial fulfillment of the requirements for the degree of Master of Science in Computer Science in the Graduate College of the University of Illinois at UrbanaChampaign, 2012 [Tathe, A., Ghodke, M. and Nikalje, A.P., 2010. A brief review: biomaterials and their application. *International Journal of Pharmacy and Pharmaceutical Sciences*, *2*(4), pp.19-23.
4. Chin-Kai Chang* Christian Siagian* Laurent Itti. Mobile Robot Vision Navigation & Localization Using Gist and Saliency
5. G. Schindler, M. Brown, and R. Szeliski, "City-scale location recognition," in Computer Vision and Pattern Recognition, IEEE Computer Society Conference on, vol. 0. Los Alamitos, CA, USA: IEEE Computer Society, 2007, pp. 1–7.
6. Phillip Dupree (Mechanical Engineering) - Columbia University. Autonomizatio of a mobile hexapedal robot using a GPS.
7. https://en.wikipedia.org/wiki/Autonomous_car
8. https://www.wired.com/tag/autonomous-vehicles/