GPS Guided Obstacle avoidance Bot

Using Atmega- 328 microcontroller

Sandesh Bharadwaj, Himavanth Reddy, Varshitha Bhavni.

Indian Institute of Information Technology, Design and Manufacturing, Kancheepuram
School of Computer and Electrical Engineering (SCEE)

***Abstract*—This paper presents an attempt to develop an autonomous robot with the ability to navigate using ultrasonic sensor for collision and obstacle detection and a GPS and a magnetometer for localization and heading determination using ATMega 328. An algorithm for path planning and obstacle avoidance is also presented in this paper.**

***Keywords*—Bluetooth, Mictrocontroller, Arduino, GPS, Ultrasonic, Magnetometer, Great-circle navigation**

I. Introduction

The relationship between information technologies and process control has reached a new stage, encouraging the creation of applications such as monitoring and control through the Internet, teleworking, telemedicine, and tele-robotics, mechatronics. Robotics is closely related with control applications to simplify complex man-work. The success of robots has come about as a result of a combination of factors.

Development of autonomous navigating mobile robots is one of the most interesting topics in the research field at present. Despite the technological advancement of our civilization, many problems are faced when designing autonomous robots such as avoiding moving obstacles, localization, and sensor integration.

II. OBJECTIVES OF THIS PROJECT

1. Autonomous travelling within set waypoints with obstacle avoidance
2. Manual override with Bluetooth

III. SOFTWARE DEVELOPMENT

Bluetooth-compatible devices perform “inquiries” to detect and find other Bluetooth enabled devices within the area [1]. When performing an inquiry, an application must wait to about 10 seconds for a 95% chance of detecting every device. Not only does this process take time, it also consumes power.

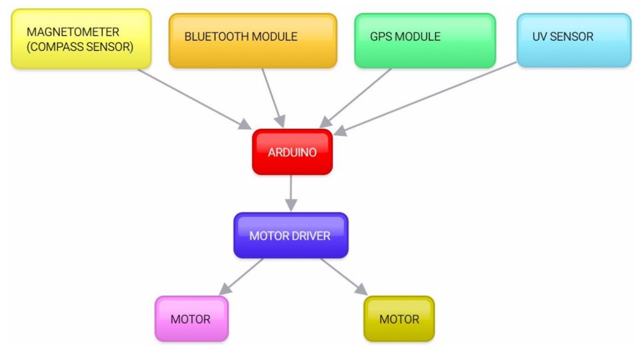


Fig 1. Block Diagram for the GPS Guided Obstacle avoidance Bot

IV. HARDWARE ARCHITECTURE AND IMPLEMENTATION

Arduino Uno is a microcontroller board based on the ATmega328P (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Bluetooth antenna in our module picks up the packets sent from the cell phone.

Fig 2. Arduino Uno

HC-06 Bluetooth module is a slave-only module that can easily achieve serial wireless data transmission. Its operating frequency is among the most popular 2.4GHz ISM frequency band (i.e. Industrial, scientific and medical). It adopts Bluetooth 2.0+EDR standard. In Bluetooth 2.0, signal transmit time of different devices stands at a 0.5 seconds interval so that the workload of Bluetooth chip can be reduced substantially and more sleeping time can be saved for Bluetooth.

Fig 3. HC – 06 Bluetooth Module

GPS module SIM28M is a standalone L1 frequency GPS module in a SMT type and it is designed with MTK high sensitivity navigation engine, which allows you to achieves the industry's highest levels of sensitivity, accuracy, and Time-to-First-Fix (TTFF) with lowest power consumption. The GPS module communicates with the GPS satellites and determines its latitude, longitude and other parameters using triangulation.

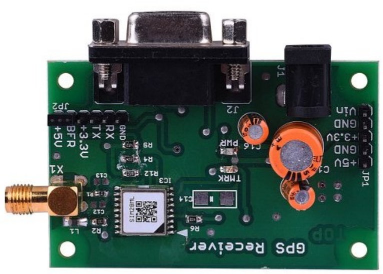


Fig 4. SIM28M GPS Module

The HC-SR04 ultrasonic sensor module uses sonar to determine distance to an object like bats do. It provides 2cm - 400cm non-contact measurement function, the ranging accuracy can reach to 3mm. The module includes ultrasonic transmitter, receiver and control circuit. It offers excellent non-contact range detection with high accuracy and stable readings in an easy-to-use package.

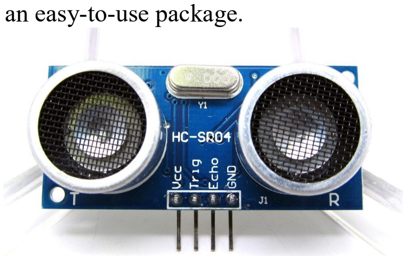


Fig 5. HC – SR04 Ultrasonic Sensor

HMC5883L is a surface-mount, multi-chip module designed for low-field magnetic sensing with a digital interface for applications such as low-cost compassing and magnetometry. The HMC5883L includes high-resolution magneto-resistive sensors plus an ASIC containing amplification, automatic degaussing strap drivers, offset cancellation, and a 12-bit ADC that enables 1° to 2° compass heading accuracy. The I2C serial bus allows for easy interface. The HMC5883L is a 3.0x3.0x0.9mm surface mount 16-pin leadless chip carrier (LCC).

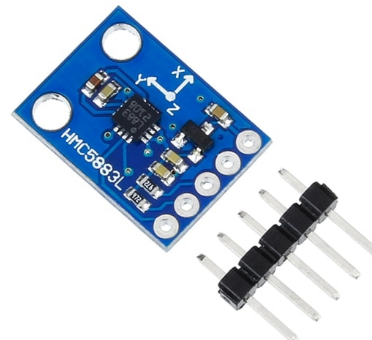


Fig 6. HMC5883L Magnetometer

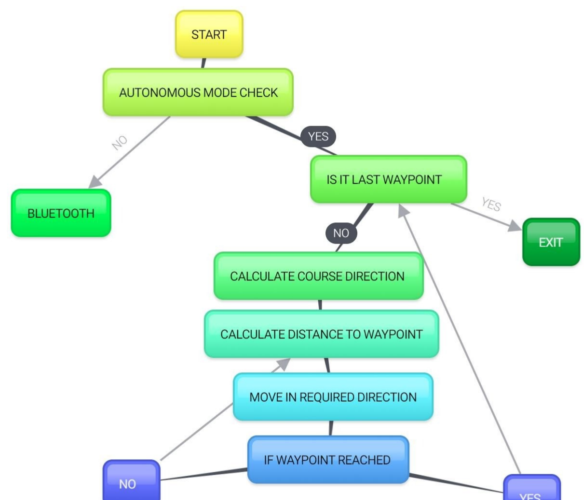


Fig 7. Process flow chart for the GPS Guided Obstacle avoidance Bot

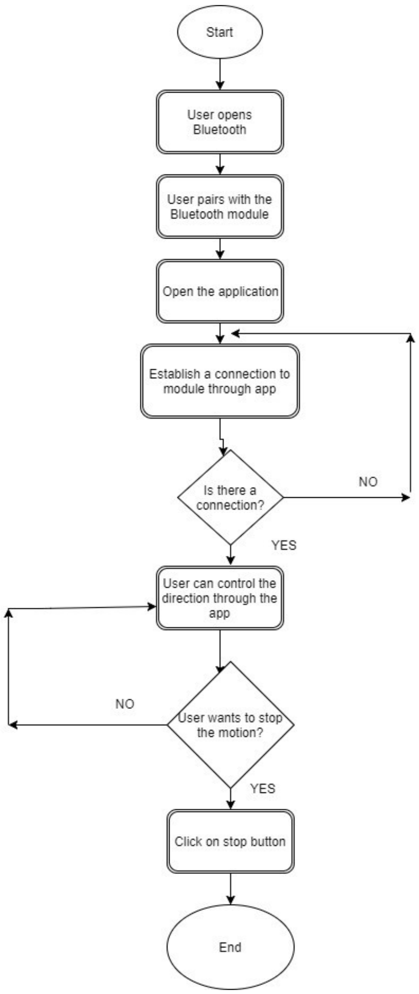


Fig 8. Process flow chart for the Bluetooth Module override

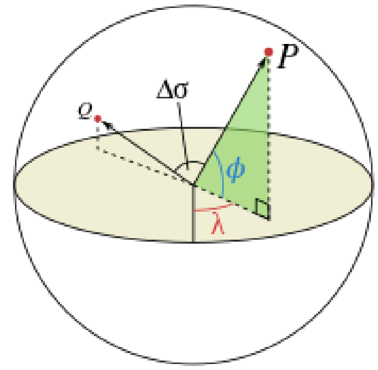
V. COMPUTATIONAL FORMULAE

Grade Circle Distance Formula:

The great-circle distance or orthodromic distance is the shortest distance between two points on the surface of a sphere, measured along the surface of the sphere (as opposed to a straight line through the sphere's interior). The distance between two points in Euclidean space is the length of a straight line between them, but on the sphere there are no straight lines. In spaces with curvature, straight lines are replaced by geodesics. Geodesics on the sphere are circles on the sphere whose centers coincide with the center of the sphere, and are called great circles.

Through any two points on a sphere that are not directly opposite each other, there is a unique great circle. The two points separate the great circle into two arcs. The length of the shorter arc is the great-circle distance between the points.

The Earth is nearly spherical, so great-circle distance formulas give the distance between points on the surface of the Earth correct to within about 0.5%.

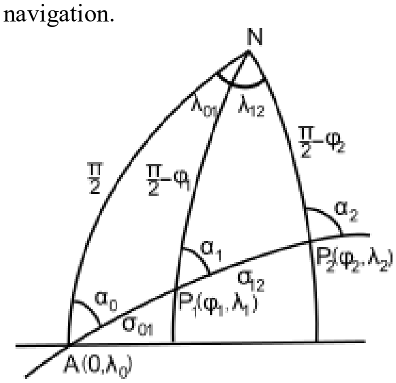


$$\Delta\sigma = \arctan \frac{\sqrt{(\cos\phi_2 \,.\, \sin(\Delta\lambda))^2 + (\cos\phi_1 \,.\, \sin\phi_2 - \sin\phi_1 \,.\, \cos\phi_2 \,.\, \cos(\Delta\lambda))^2}}{\sin\phi_1 \,.\, \sin\phi_2 + \cos\phi_1 \,.\, \cos\phi_2 \,.\, \cos(\Delta\lambda)}$$

$$d = r\,\Delta\sigma$$

Where,
d = distance
r = radius of sphere
φ_1,λ_1 = Geographical latitude and longitude of point 1
φ_2,λ_2 = Geographical latitude and longitude of point 2
r = radius of earth (6,371 meters)

Great Circle Navigation Formula:
A great circle track is the shortest distance between two points on the surface of a sphere; the Earth isn't exactly spherical, but the formulas for a sphere are simpler and are often accurate enough for navigation.



$$\tan\alpha_1 = \frac{\sin\lambda_{12}}{\cos\varphi_1 \,.\, \tan\varphi_2 - \sin\varphi_1 \,.\, \cos\lambda_{12}}$$

Where,

α_1 = Course deviation w.r.t the Magnetic North
φ_1,λ_1 = Geographical latitude and longitude of point 1
φ_2,λ_2 = Geographical latitude and longitude of point 2
$\lambda_{12} = \lambda_1 - \lambda_2$

Some Common Mistakes

- Electromagnetic interference with ESD devices
- Over voltage can burn the Arduino
- GPS Parsing Error
- Malfunctioning of Magnetometer
- Ultrasonic sensor precision depends on Temperature and Relative Humidity

VI. APPLICATIONS AND FUTURE SCOPE

Applications:
• Surveillance Device
• Transportation Device
• Wheelchairs
• Military Applications
• Hostages Rescue

Future scope:
In future we plan to implement our project as follows It will contain following 3 components:
• A Robot Mounted with camera
Image Processing can be done with Raspberry Pi with a mounted camera

• Self – Driving Bot
The Project can be upgraded to a level where waypoints can be input through an app similar to google maps and the bot navigates its way from Point A to Point B with obstacle detection

• A mission control center
Since it is autonomous, the bot can be used as a means of information gathering by the mission center and then relay that information to the team on the frontlines.

VII. ANDROID APP

This application allows us to control a Bluetooth Controlled Bot, this is done using a Bluetooth enabled android phone. This app lets you control the car with either of the buttons or the phone's accelerometer [6]. A slider bar allows us to connect and control the bot's velocity if the bot's circuit has this feature. There are also two buttons for front and the back light. A flashing light lets us know as soon as the phone is connected to the bot and the arrows light up according to the direction of the movement of the bot [7].

VIII. CONCLUSION

It has been proven that the mobile robot successfully finds its path between its start location and target point, depending on information from the GPS and digital compass sensors.

In this paper we have introduced design and implementation of a low cost, flexible and wireless solution for easy transportation hence reducing tedious labor work.

IX. REFERENCES

[1] http://www.sciencedirect.com/science/article/pii/S221302091630163X

[2] Ryoma Arai, Hiroshi Takemura, Hiroshi Mizoguchi,. A study of functions for robot returned from parking to store autonomously

[3] B. Z. Sandier. ROBOTICS Designing the Mechanisms for Automated Machinery, 2nd ed., Waltham, MA.: The Academic Press, pp.1, December 1998
https://www.researchgate.net/publication/231182479_Bluetooth_based_home_automation_system_using_cell_phone

[4] http://home.iitk.ac.in/~amit/courses/768/00/gatram/

[5] https://www.engineersgarage.com/contribution/android-phone-controlled-bluetooth-motion-vehicle

[6] https://www.slideshare.net/PankajRai42/bluetooth-controlled-robot-60795241.

[7] http://electronicsforu.com/electronics-projects/hardware-diy/arduino-android-phone-controlled-robot

[8] Mohammed Faiz, Ghufran Mahameda.. "GPS based naviagated autonomous robot"..Vol 3. No.4 Apr 2015. Inernational Journal of Emerging Trends in Engineering research