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GPS BASED AUTONOMOUS VEHICLE NAVIGATION IN ROBOTICS ALONG WITH DIRECTIONALITY

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Abstract-The convergence of technologies involving computing, communication, and intelligent interfaces with autonomous robotics. In Autonomous mobile robots may one day perform complex medical procedures, including surgery, on patients in dangerous or remote locations from battlefields to space, with little human guidance. This project (paper) explain about the one of the Autonomous Mobile Robot(AMR) with the application of fleet tracking, surveillance control robotic car, there two main concept in this AMR. First one is to analysis the waypoint from starting and destination points, then get the Latitude and Longitude and receive the Latitude(LAT) and Longitude(LON) using GPS receiver (Ublox Neo).Second one is to dependent on the waypoints to run a AMR with help of LAT and LON to reach the destination point in straight line with guidance of MPU6050 sensor, if any obstruction near the AMR they stop automatically with some distance using Ultrasonic sensor(HC-SR04) in front of the AMR. Finally to validate the required from starting points to the destination Points in Arduino IDE software platform. 6M

Keyword- AMR, Ublox 6M Neo, MPU6050 sensor, Ultrasonic sensor(HC-SR04), Arduino IDE

I.INTRODUCTION

1.1 ROBOTIC FUNDAMENTALS:

A Robot is reprogrammable, multifunctional manipulator, designed to move material, parts, tools or specialized devices through variable programmed motors for the performance of a variety of tasks. Over the years robots have evolved from handling simple task to the current level of complex multiple tasks with Artificial Intelligence built in it. There are two types of robots namely fixed and mobile robots.

- Fixed Robots are manipulators, used in Industry, which can't move as the base is fixed.

- Mobile Robots are the ones, whose base can move, using Wheels or Tracks or Legs

Based on the Degree of Freedom it is further classified as single DoF, Two DoF, and Three DoF etc. Also based on the sensors and external interface it is classified into:

- Obstruction avoidance
- Line Following
- Light/IR sensitive
- Blue Tooth based Robots
-

1.2 RELATED WORKS:

GPS based navigated Autonomous robot published by Mohammed Z. Al-Fizz - College of Information Engineering, Al-Nahrain University, Baghdad, Iraq, Ghufran E. Mahameda - Department of Computer Engineering, Al-Nahrain University, Baghdad, Iraq. This study proposes a procedure to find a pathusing an A* algorithm between start and goal locations in the satellite image. The selected path is sent to autonomous robot via Wi-Fi communication as a series of set points for real implementation in an outdoor environment. The mobile robot navigates its way to each point in the path using Global Positioning System (GPS) and digital compass, and 5 sharp IR sensors are used for detecting and avoiding all obstacles in its way. A Proportional-Integral-Derivative (PID) controller is used to make the robot move in a straight line and obtains minimum perturbations to the goal by controlling the speed of each side of the mobile robot motors depending on the digital compass readings.

II. PROPOSED SYSTEM

2.1 INTRODUCTION

Robots are defined as autonomous or semi-autonomous machines. The first stage being semi-autonomous, meaning the robot accepts external command from system or users. This involves that the robot does both pre-programmed actions autonomously rest of the operation is done manually. An example of semi - autonomous robot is the vacuum cleaners that can clean the room dynamically by accepting commands from users such as go and stop. This action is purely replaced by autonomously. Autonomous robots are the ones that are self-governed or self- driven.

2.2 AT MEGA 2560 MICRO CONTROLLER

The Arduino Mega ATmega2560 is a development board developed for projects by an Italian company named 'Arduino', providing an open-source hardware and software ecosystem. The main purpose of the Arduino is to communicate with the electronic devices and perform various operations in the real world. The Arduino platform has a built-in Integrated Development Environment called IDE. It helps to program any project with various other devices connected to it. It supports C and C++ programming language which are the basis of all other programming languages. This board is particularly chosen as it provides the flexibility to communicate with more devices. The board is connected through a USB printer cable to the programming console. The Arduino IDE is the open-source software platform that connects to the Arduino hardware to upload programs and communicate with them. This board comes with 54 digital input/output pins of which 15 are used as PWM outputs, 16 analog pins, 4 USARTs hardware serial ports, a power jack, a USB connection, a 16 MHz Crystal oscillator, ICSP header and a reset button.

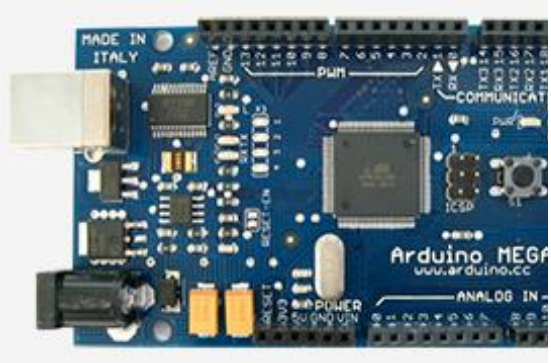


Fig: Arduino Mega ATmega2560.

2.3 L293D MOTOR DRIVE:

The L293 and L293D decvices are quadruple high-current half-H drivers. The L293D, which is utilised in this project, is designed to provide the bidirectionl drive currents of upto 600mA at voltages from 4.5V to 36V. It is capable of driving inductive loads such as relays, solenoids, DC and bipolar stepping motors, as well as other high-current/high-voltage loads in positive supply applications[8]. This motor driver board finds applications as Stepper motor drivers, DC motor drivers, Laching relay drivers.

Each chip contains two full H-bridges (four half h-bridges).H-bridge circuits are frequently used in robotics and many other applications to allow DC motors to run forward & backward.Generally, the H-bridge motor driver circuit is used to reverse the direction of the motor and also to brake the motor.The motor driver lets us drive two DC motors with Arduino board, controlling the speed and direction of each one independently

Fig : L293D Motor drive.

2.4 LCD (20 *4):

The LCD display is a display device which that is used to print text, make custom characters, bink text, and position text. The display is 20X4 matrix which means that the LCD has 4 rows and 20 columns. Thus, it can display 80 characters at once.

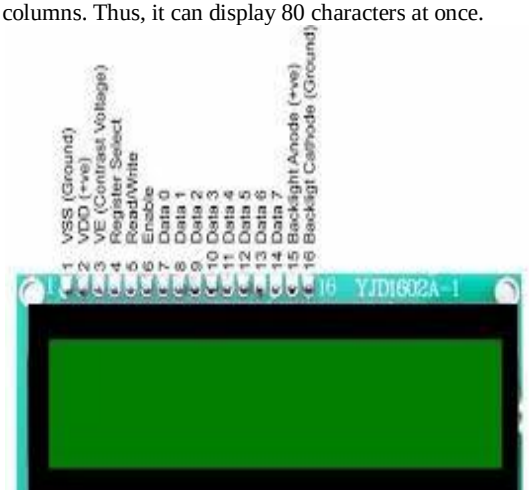


Fig : LCD display.

2.5 UBLOX NEO 6M GPS RECEIVER MODULE:

Ublox NEO 6M is a standalone GPS receiver designed for low power consumption and low cost. This module can withstand environmental conditions and electrical testing when performed for road vehicles. The receiver is of the dimension 12.2 x 16.0 x 2.4 mm, which is a 24 pin LCC (Leadless Chip Carrier) package. The module has the ability to interface serially in various forms as mentioned below.

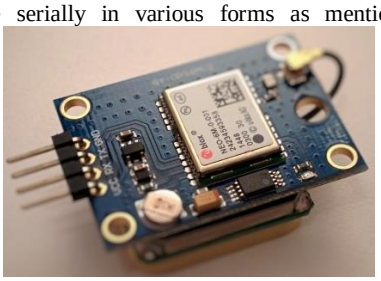


Fig : Ublox NEO 6M standalone GPS module.

2.6 IMU 6050:

The InvenSense MPU – 6050 sensor contains the MEMS accelerometer and a MEMS gyro in a chip. It is very accurate as it contains 16 bits analog to digital conversion hardware for each channel. Therefore it captures the x,y and z channel at the same time. The sensor uses the 12 C – bus to interface with the Arduino. The MPU 6050 is not expensive especially given the fact that it combines both an accelerometer and a gyro.

Also note that InvenSence has combined the MPU 6050 with a magnetometer (compass) in a single chip called MPU 9150. The sensor also contains 1024 byte FIFO buffer. If the MPU 6050 places data in the FIFO buffer, it signals the Arduino with the interrupt signal so the Arduino knows that there is data in the FIFO buffer waiting to read.

The pin AD0 selects between I^2C address 0X68 and 0X69. That makes it possible to have two of these sensors in a project.

Fig : IMU 6050.

2.7 ULTRASONIC SENSOR:

It is a device that can measure the distance to an object by using sound waves. It measures distance by sending out a sound wave at a specific frequency and listening for that sound wave to bounce back. By recording the elapsed time between the sound wave being generated and the sound wave bouncing back, it is possible to calculate the distance between the sonar sensor and the object.

The accuracy of ultrasonic sensor can be affected by the temperature and humidity of the air it is being used in. The distance can be calculated with the following formula:

DISTANCE L = ½ * T * C

L – Distance

T – Time between the emission and reception

C – Sonic speed

Detection is not affected by accumulation of dust or dirt. Presence detection is stable even for targets such as mesh trays or springs. Since ultrasonic sensor waves can reflect off a glass or liquid surface and return to the sensor head, even transparent parent targets can be detected.

Fig : Ultrasonic Sensor.

2.8 **MECHANICAL EXPERIMENTS CHASSIS:**

A robot chassis can be used as a base of the robotic project. The chassis have simple and quick construction. It has many pre – drilled holes and slots that allow other components like sensors and tilt assemblies to be quickly attached. Here Acrylic chassis is used for placement of hardware components because it is off light weight. Large diameter wheels give the robot low torque but high velocity. The length of the chassis is 17.4cm and the breath is 15cm. The configuration follows a formula

A * B/C

A – Number of wheels
B – Number of driver wheels
C –Number of steered wheels

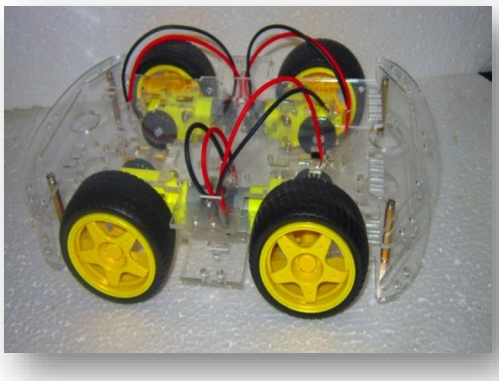


Fig : Chassis.

2.9 **LONG BO MOTORS:**

It is a DC motor with battery operation. All the microcontroller-based robots use this. It is used to convert electrical energy to mechanical energy. The RPM is 60 – 300. The torque and RPM are inversely proportional. It uses permanent magnet (i.e.) ferrite magnets. It has the capability to absorb shock and vibration as a result of elastic compliance. It is not possible to connect the motor drive directly to the microcontroller thus connected with the help of H – bridge concept.

Fig : Wheels.

2.10 WHEELS:

The locomotion modes may be wheels, tracks, legs and hybrids. Wheels are commonly used for many terrestrial and planetary robotic vehicles.
Wheel formula = Total number of wheels * number of actuated wheels * number of steered actuated wheels.
The four wheels are driven by the Motor drive. The diameter of the wheels is 6.5cm, and the radius is 3.75cm. The distance covered for 2 second is 3.5cm.

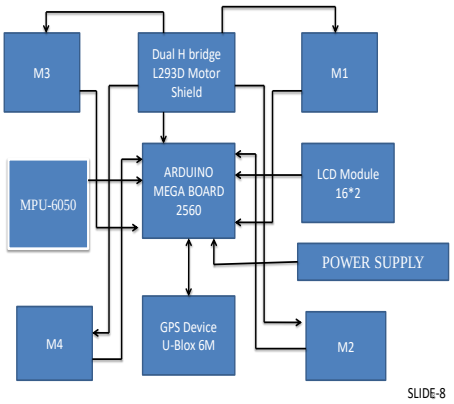
2.11 LI – PO BATTERY:

Robots are no longer limited to bulky, low powered, non-rechargeable batteries. The introduction of portable personal electronics has been a massive surge in battery research within the last decade. Lithium polymer battery is used, since the module is autonomous the power supply should be portable. The capacity of the power supply is 7.4V and it is rechargeable.

Fig : Li-Po Battery.

III. OTHER ELEMENTS:Circuit operations

BLOCK DIAGRAM OF PROPOSED SYSTEM:



The ARDUINO MEGA BOARD 2560 is an open source electronic platform which supports both ADC and DAC conversions. Its software Arduino IDE version 1.6.5 is used for programming the board. It is based on two algorithms namely

- Autonomous route calculation algorithm
- Control algorithm

The entire moving process depends on the L293D motor drive which drives the BO motors according to the H – Bridge concept. Before the robot starts to move the way points are fixed between the starting and ending points. It goes to each waypoint, stops for a few seconds once it reaches the location and then continues on its path towards the next way point. The distance is calculated using **'Haversine formula** 'which calculates the great-circle distance between two points – that is, the shortest distance between the earth's surface.
Haversine formula
$a = \sin^2(\Delta\varphi/2) + \cos\varphi_1 * \cos\varphi_2 * \sin^2(\Delta\lambda/2)$
$c = 2 * \text{atan2}(\sqrt{a}, \sqrt{(1-a)})$

d = R * c
where φ = latitude

λ = longitude
R = earth's radius (mean radius = 6,371km)
d = Haversine distance
c = angular distance in Radians
a = square of half the chord length between two points

As the robot moves, in order to make it go in a straight line the Gyroscope sensor is used. If it suffers a deviation it is corrected using a feedback loop control which is derived from a PID control system under the condition that the heading angle and the normal angle should always be equal. In the presence of any obstacles during navigation the robot is made to stop before a certain distance with the help of an Ultrasonic Sensor. Then location of its position can be tracked with the help of U-blox neo 6M GPS module. This transceiver uses a patch antenna to receive and amplify the downlink signal. These signals are displayed in the LCD as latitude and longitude values along with the distance it had covered. The power required is supplied with the help of Li – Po battery. The diameter of the wheel used is 6.5cm and the radius is 3.75cm. The distance covered for 2 second is 3.5cm. All these hardware components are mounted on an acrylic chassis for light weight purpose.

IV.VALIDATION:

4.1 OUTPUT OF GPS AS DISPLAYED IN LCD:

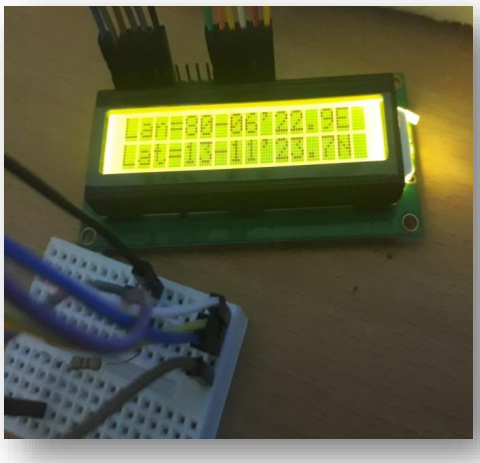


Fig : Output of GPS as displayed in LCD.

V. OUTPUT OF DEMO GPS TESTING:

The first time when the GPS module is connected to the Arduino Mega, it is interfaces using SoftwareSerial program. The data received is raw data as shown below.

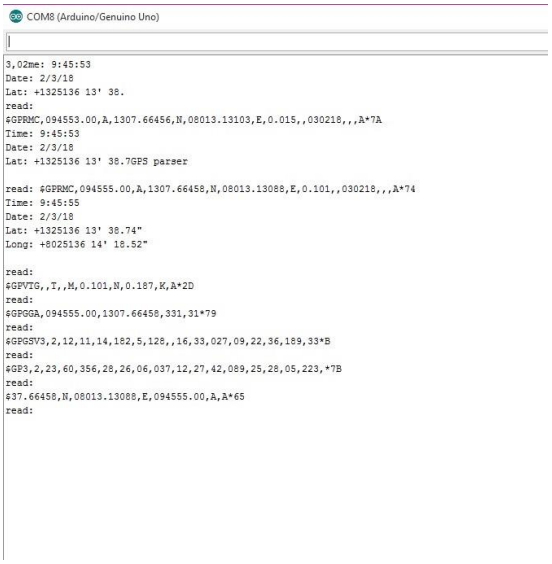


Fig : Output of demo GPS testing.

*$GPGLL,1305.08749,N,08009.83651,E,091157.00,A,A*6F*
*$GPRMC,091157.00,A,1305.08749,N,08009.83651,E,0.264,,261217,,,A*77*
*$GPGGA,091157.00,1305.08749,N,08009.83651,E,1,06,2.40,-9.6,M,-86.9,M,,*52*
*$GPVTG,,T,,M,0.264,N,0.488,K,A*27*
*$GPGGA,091158.00,1305.08683,N,08009.83558,E,1,06,2.40,-9.0,M,-86.9,M,,*56*
*$GPGSV,4,4,14,31,42,015,33,32,23,062,20*7A*

These sentences are NMEA sentences which are not parsed. NMEA protocol is followed by almost all marine electronic devices. This data cannot be understood easily. Hence, another library file called TinyGPS Plus is used. This library file is very helpful as the raw data received by the GPS is parsed and then sent to Serial monitor.

VI.CONCLUSION AND REFERENCE

CONCLUSION:

An autonomous vehicle tracking robot platform has been successfully designed. It is mainly focused on to move the vehicle in places where human survival is not possible. The robot platform was tested to be fully functional. It has proven that the mobile robot successfully finds its path between its start location and its destination depending on the information from the GPS and the Gyroscope (compass). Without using this PID controller the mobile robot does not move in a continuous straight line, it deviates around the selected path and takes more time to reach its final target. By controlling the speed of each side of the mobile robot motors depending on the gyroscope readings, the perturbations is decreased to 50% and the speed of the mobile robot is decreased to 33.3% but as smooth movement which makes it to reach the destination in approximately the same time without PID.

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