Autonomous Rover Delivery System

Anuradha A. Kasangottuwar
Assistant Professor
Department of Electronics & Communication Engineering
Dayananda College of Engineering, Bengaluru, India

Sumukh Athrey
UG Student
Department of Electronics & Communication Engineering
Dayananda College of Engineering, Bengaluru, India

Aditi Sharma
UG Student
Department of Electronics & Communication Engineering
Dayananda College of Engineering, Bengaluru, India

Basvaraj Mooli
UG Student
Department of Electronics & Communication Engineering
Dayananda College of Engineering, Bengaluru, India

Kavya G
UG Student
Department of Electronics & Communication Engineering
Dayananda College of Engineering, Bengaluru, India

Abstract

This paper describes an autonomous rover which is a self-piloted vehicle that does not require an operator to navigate and accomplish its tasks. Autonomous vehicles are a recently developed subset of robotics and can come in three general forms; air, ground and submarine. My GPS controlled autonomous rover is presented which employs a GPS Receiver Module to capture the GPS signal and determine the current location of the vehicle. The system is controlled using a microcontroller, a magnetometer and dc motors. The magnetometer determines the vehicle direction by continuously providing measurement of heading. The microcontroller drives the DC motors to move the vehicle to a manually entered destination coordinates. Obstacle detection and avoidance are achieved by incorporating the ultrasonic sensor to measure the distance between the vehicle and the obstacle, and avoidance is implemented by the microcontroller. The performance of the vehicle is enhanced with a capability to detect and avoid unexpected obstructions placed in its path. The designed GPS autonomous rover is able to navigate itself independently from one location to a second, user-prescribed location, using GPS-location data. The vehicle measures the bearing angle, and changes its heading towards the destination and repeats the process as it moves to the destination. GPS offers the benefit of retrieving location information that has no bearing upon previous results. This prevents calculation errors from accumulating throughout the path. For this reason, low cost, and ease of use.

Keywords: ARM Cortex Microcontroller, Ultrasonic Range Finder, Ultrasonic Distance Sensor, GSM/GPRS Module, GPS Module, Magnetometer, Optical Detector

I. INTRODUCTION

AT a moment when a number of companies with flipchart and amazon currently out in front, are providing home delivery services. Here we are coming up with a different delivery solution using small, wheeled delivery rover. The work of getting packages from the center directly to people's door will be done by autonomous drover. It is a ground based delivery system without an operator.

The basic idea is that this autonomous delivery rover will carry out small goods deliveries of such items as groceries over short distances travelling along the pedestrian pavement. The customer will be able to track the rover's progress also the manufacturing cost of this rover will be low and they will consume very little power. Rover will have a set of sensors to observe the environment, and will autonomously make decisions about its behavior.

II. CONVENTIONAL METHODS

Conventionally all the e-services companies and postal service companies employ human support to carry out their deliveries to the customers. This system logically costs more as the services companies have to pay for the human support as well as their transportation, thus increasing the cost for user.

A. Drawbacks of Conventional Methods

- Larger transit time for the product delivery.
- Requirement for lot of human supervision.
- There are chances of security lapse.

B. Modern technology methods going to be employed

Now a day's e-service companies are looking into autonomous robot systems, which will help them deliver the product in an effective way to the customer. The autonomous features can be incorporated using mobile robot locomotion and kinematics, environment perception, probabilistic map based localization and mapping, and motion planning. The conventional delivery system can be replaced by the modern autonomous rover technology to deliver the product to the customer. This can be achieved using: GPS (Global Positioning System) to monitor the position of the rover and to help it travel to the destination Collision Detection and Avoidance to deliver the product securely and without damages.

C. Advantages of the modern technology method

Automated Delivery Rover can lower the cost of shipments by reducing transit cost. It can move at pedestrian speed which can carry up to 5kg cargo which will be locked throughout the journey and can be opened only by the recipient using security code assigned to the recipient. The system is a paragon of zero emission and energy efficiency. It fits the newer trend of going green. The rover being small in size can steer easily through congested places who performs this action.

III. LITERATURE SURVEY

Pikaso Pal, Rajeev Dey, Raj Kumar Biswas, Shubhashish Bhakta, "Optimal PID Controller Design For Speed Control Of A Separately Excited Dc Motor: A Firefly Based Optimization Approach", International Journal Of Soft Computing, Mathematics And Control (IJSCMC), Vol. 4, No. 4, November 2015. [1]

The star ship company developed autonomous rover to deliver products, the rover could drive along the side-walks to avoid traffic and deliver packages to people's door. Delivery robot in this paper travels at 4mph and while it is much slower than human delivery system, it is much more cost-effective as well as environmentally friendly. It has the capacity to courier two grocery bags worth of items, or 20 pounds, and will take between five and 30 minutes to arrive. The goods are locked inside the robot and can only be accessed through a recipient's code that will be provided through an accompanying app.

IV. BLOCK DIAGRAM

The basic block diagram of the autonomous rover delivery system is as follows:

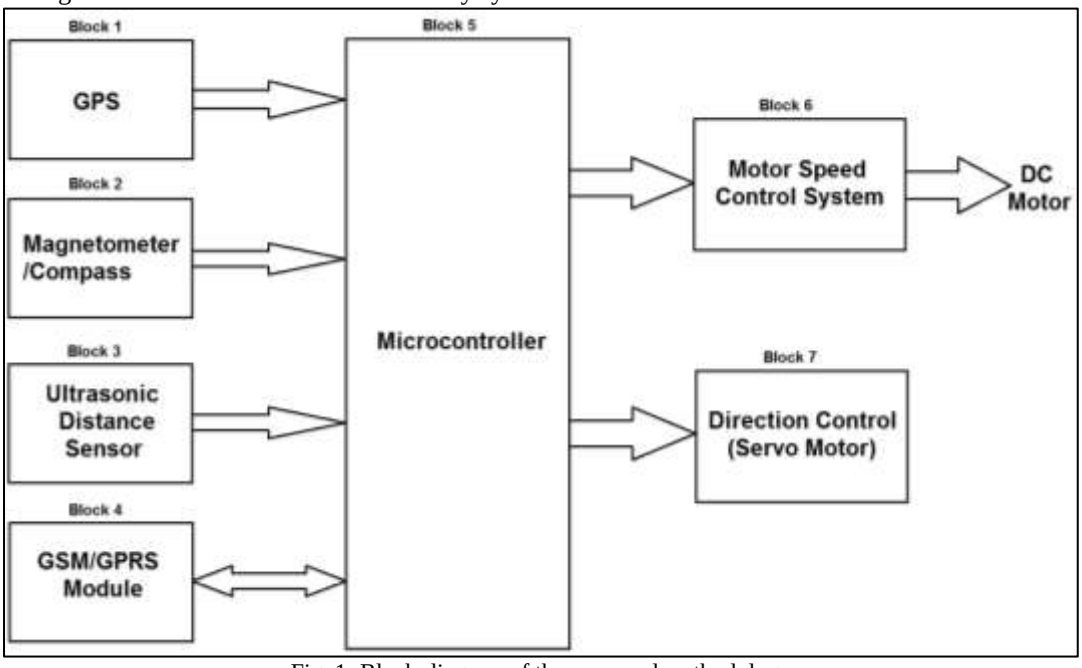

Fig. 1: Block-diagram of the proposed methodology

To navigate a vehicle autonomously, the control system must have the ability to determine its present location and direction of travel Block 1 is the GPS (Global Positioning System) which will determine the present location of the rover. The GPS data is transmitted in the form of longitudes and latitudes. The GPS module is used to move the rover from the current location to the prescribed location.

Block 2 is a magnetometer/compass which gives the direction of heading of the rover i.e. the direction it is facing. The compass will give us a heading from 0-360 degrees between the vehicle's location and the next waypoint location. This calls for matching the current heading with the needed heading and drive until we reach the GPS point.

Block 3 is the near field and far field ultrasonic sensors. Obstacle detection and avoidance are achieved by incorporating an ultrasonic sensor to measure the distance between the vehicle and the obstacle, and avoidance algorithm is implemented by the microcontroller.

Block 4 is GSM/GPRS module which connects the microcontroller to the internet using GPRS wireless network. This GPS data of the rover will be sent to a server over GPRS using GPRS module, where the further instructions for heading of the rover will be calculated and sent back to the rover. It can also be used to make calls and send messages by the rover when it has reached its destination, to notify the recipient about the arrival of their package.

Block 5 is the microcontroller which controls and synchronizes all the modules and implements the collision avoidance mechanisms.

Block 6 constitutes the motor speed control system which is used to control the speed of the rover using PID controller. It is explained further in the following sections.

The direction control motor/servo motor is used to control the heading of the rover.

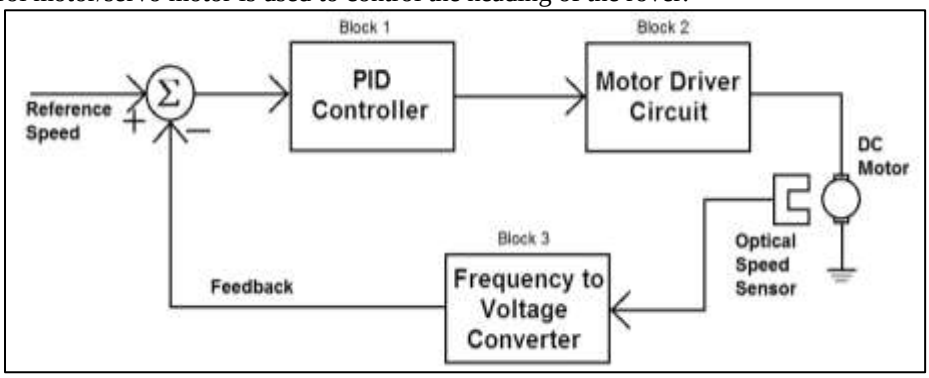

Fig. 2: Motor Speed Control System

The idea of a speed control system is to maintain the speed of the motor at the desired value under various condition. In practice, the DC motor is a nonlinear device and its speed varies because of change in load demand, disturbances, etc.

PID controller stands for Proportional-Integral-Derivative controller. PID controller is a control loop feedback mechanism in which the motor speed is sensed by an optical switch and converted to feedback voltage. It is compared with the reference signal (i.e. desired speed) by the error detector. The PID controller acts on the error signal and generates appropriate control voltage. The PWM generator block than varies the duty cycle of the voltage supplied to the motor to control its speed.

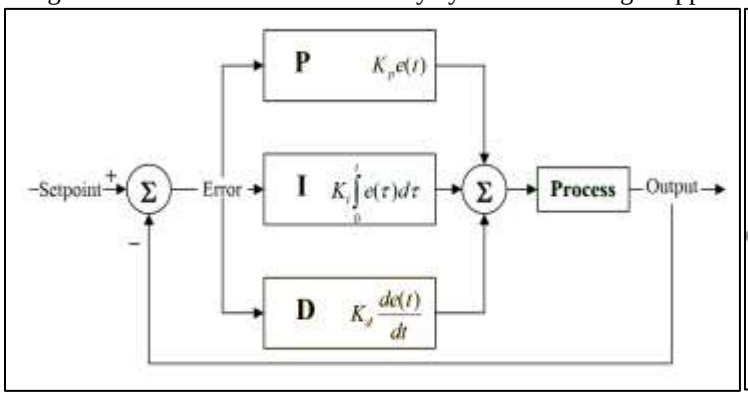

Fig. 3: PID controller

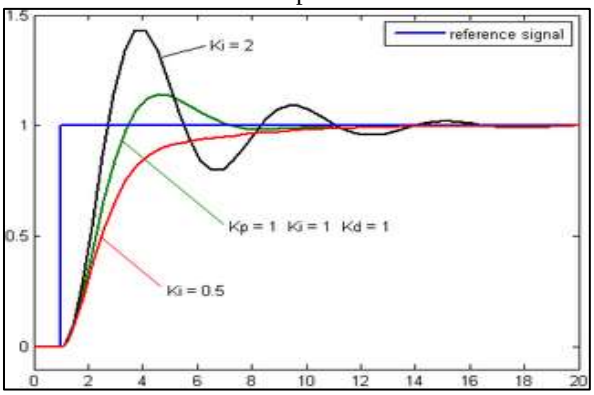

Fig. 4: PID controller output

The controller output or the final form of PID algorithm is -

$$controller(t) = K_p\theta(t) + K_i \int_0^t \theta(\tau)d\tau + K_a \frac{d}{dt}\theta(t)$$

Where, Kp: Proportional gain, a tuning parameter, Ki: Integral gain, a tuning parameter

Kd: Derivative gain, a tuning parameter, e: Error SP - PV t: Time or instantaneous time (the present),

T: Variable of integration; takes on values from time 0 to the present.

Motor driver circuit used is L293D/L298H to drive the DC motor and to control its direction of rotation.The speed measurement of the motor is done using an optical switch. It is a LED and photo transistor pair, which generates pulses corresponding to motor speed. A slotted disk having 12 slots is fixed on the motor shaft and it cuts the path between the LED and photo transistor when the motor rotates. For one rotation of the motor, the optical switch generates 12 pulses.F/V Converter (Frequency to Voltage Converter) is used to convert the pulses from the optical switch to a DC voltage (0-5V) proportional to the motor speed. LM2907N is used as F/V converter.

V. EXPECTED RESULTS

The expected results or the outcome of the project work could be summarized as follows:

The rover will monitor its location constantly using the GPS and travel to the destination using heading and collision avoidance algorithms. The GPS location of the rover is stored over the database and it is directed autonomously to the destination. The rover will expect a security pin before delivering the package to the recipient and failure to provide it will result in the rover not delivering the package, thus securing the package.

VI. APPLICATIONS

- It can be used within industries to transport parts without human supervision
- It can be used by e-service companies to deliver goods to customers with security
- It can also be used by postal and courier services for fast and effective delivering of packages.

VII. CONCLUSIONS

The Autonomous Delivery Rover was successfully implemented. The security measures of the rover for the packages was effective and found satisfactory. The maximum distance that can be travelled by the rover on the single charge was satisfactory with some error in the arrival at the final positions according to GPS location.The range of the rover for delivery purposes can be increased by incorporating solar charging of the rover batteries enabling it to charge on the go and travel farther. The Collision avoidance can be improved by using ultrasonic sensors with larger range finding capabilities.

REFERENCES

[1] Pikaso Pal, Rajeeb Dey, Raj Kumar Biswas, Shubhashish Bhakta, "Optimal Pid Controller Design For Speed Control Of A Separately Excited Dc Motor A Firefly Based Optimization Approach", International Journal Of Soft Computing, Mathematics And Control (IJSCMC), Vol. 4, No. 4, November 2015.
[2] Michael Predko, "Programming Robot Controllers", McGraw-Hill, Dec 2007.
[3] http://Garagelab.Com/Profiles/Blogs/Gps-Guided-Autonomous-Robot.
[4] http://Letsmakerobots.Com/Content/Fundamentals-Gps-Guided-Vehicle.
[5] http://Arx.Sagepub.Com