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# Autonomous Goods Carrier for Household Applications

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***Abstract***

The demand for an autonomous robot is consistently increasing across the world. All these robots are majorly used only in large scale industries and only in a few small scale industries. But the need for a cost efficient autonomous robot that is equally helpful in household applications is essential in today's world. Not only in houses but also in airports, train stations and other places where there is heavy baggage handling, it is good when a robot can carry the goods and follow the person. This system comes up with a solution for such cases where an autonomous robot tracks the person's mobile GPS and follows with the goods.

***Keywords****—GPS, Navigation, Autonomous Robot, Arduino, Bluetooth, Person Following*

## I. INTRODUCTION

An autonomous robot is one that has the ability to work on its own in any given environment, and works without any human intervention for a given period of time. Autonomous robots include capabilities that help them understand their physical environment and automate elements of guidance and maintenance that are traditionally done by humans. Autonomous robots have applications mainly in the industrial sectors. This project is based on the autonomous robot for household purposes.

### *A. Problem Statement*

Immediate assistance and load carriage in household is a task that requires quick response from the human side. This paper focuses on an autonomous robot which has the ability to navigate from one place to another by following the person using GPS tracking.

### *B. Objectives*

To develop an autonomous following robot that could carry a minimal load and help assist in household purposes. To make the robot follow the path using GPS connected to the mobile phone. To provide immediate assistance to people or elderly persons by carrying the required materials or equipment.

## II. LITERATURE SURVEY

The research is based on line following robots which proposes a concept of autonomous control for a line following robot that can know its position, adjust velocity and lateral position, and overcome hurdles. The position is established by comparing a preset map to continuous speed and length readings filtered by a histogram filter [1].

Applying restrictions on the sensors, autonomy, and dynamics of a human-following robot in various operating conditions and applications creates plenty of challenges [2].

The development of an autonomous mobile robot system has broadened its capabilities to include medical care support, self driving car operation, and shipping companies. The robot follows the moving target person or medical doctor, with its position just being a few metres behind them [3].

The robot is programmed to follow infrared signals, which are transmitted by a small leg band worn by the patient. The primary roadblock in this type of operation is that it may begin acting as soon as it senses any infrared light. In order for the robot to realise it and begin operating, the infrared must be distinct [4].

Using a GPS receiver, the robot travels to the proper spot and eliminates barriers utilizing photo-sensors that are programmed. With just a wireless radio frequency communication module, the administrator can also examine the actual mobile tracks [5].

Automated shipment with GPS guidance BOT is a vehicle that can deliver goods alone without intervention of humans. The customer needs to input the origin and endpoint coordinates, as well as the start command, on the mobile app [6].

The goal of designing an algorithm for autonomous path generation based on a GPS (Global Positioning System) coordinate system and implementing it in real-world terrain was understood [7].

This research looks at how to automate differential drive robot navigation in areas like workplaces and restaurants by mapping the whole workspace on to the robots as a fixed source coordinate frame that can then be employed for position control and routing [8].

The robot is designed and built as a GPS-guided robotic system, with the GPS module continuously providing the current location information to the microcontroller, which intelligently finds the best path between the present location and the next stop until it arrives at its destination [9].

While following humans, the robot can use vision-based object tracking and ultrasonic sensors to avoid collisions. With its image processing system, the robot initially recognises an individual by identifying a person's region and recognising the registered colour and texture of the related garments [10].

A self-contained robot that recognizes and maintains a straight line is known as a line follower. The path could be apparent, such as a black line on a white surface, or it could be invisible, such as a magnetic field. The robot uses a closed loop control system. The robot must detect a line and navigate accordingly to stay on track, while using a feedback mechanism to correct any incorrect moves, making a basic yet effective closed loop system [11].

The work presented here refers to the development and experimental validation of intelligent control algorithms for autonomous mobile robots which can plan and implement a wide range of tasks in unorganized conditions. It's a self-contained, wheel-driven platform with a 16-node Ncube hypercube parallel CPU on board and a VME-based system for connecting effectors and sensors [12].

The design of an automated robot route begins with calculating a collision-free way for a robot from the start to the destination positions through congested workspace constraints. This article presents an overview of autonomous mobile robot route planning, emphasizing on algorithms that pick the right path for a robot to travel through a given environment. The algorithms will analyze the representation of the area or workspace to accomplish the route planning operation and then aim to plan free paths for the robot to navigate in the workspace without clashing with objects or hurdles [13].

The robot might be navigated to the target in a broad and coarse-grained navigation method by successively moving toward the GPS locations of the waypoints. Meanwhile, a simple vision-based lane following approach is proposed to operate the robot in a local and quite well navigation manner in the pedestrian lane [14].

Using a trolley, hospital nurses deliver their medicines and healthcare products to patients on a daily basis. They must push or drag the cart to the patients' beds and then return it to its original position several times every day. It might be exhausting for nurses to handle a large number of patients in a single day. As a result, several devices have been developed to assist nurses in their daily tasks. This study focuses on the development of a nurse-following mobile robot [15].

A collision avoidance mobile robot can be controlled by a fuzzy controller. The purpose of these issues can be identified to direct a mobile robot along its trajectory while ignoring any static impediments in its way. In a dynamic uncertain environment, real-time obstacle avoidance is a must-have characteristic for mobile robots. The outputs are added together to create a coordinated effort to steer the robot away from barriers by controlling the motors [16].

Depending on the "artificial potential field" theory, this work offers a novel real-time collision prevention strategy for mobile robots and manipulators. With this approach, collision avoidance, which has conventionally been assumed as a high-level optimization problem, could be efficiently distributed among several degrees of control, enabling real-time robot operational processes in an uncertain environment. To implement this collision avoidance strategy on a robot arm, a new procedure is utilized to widen the problem of real-time manipulative control. Instead of wanting to control the task's relevant joint space motion after geometrical and kinematic evolutions, the problem manipulator motion control in operating space is modified [17].

Amrita University designed this cost-effective collision avoidance circuit. This robot is controlled by an ultrasonic sensor and controlled by an Arduino board. When it senses the proper path to go with the level of distance to the next obstacle, the obstacle is identified at quite a distance of approximately 15 cm. The amount of vehicles on the road is rapidly expanding, and the probability of collisions is rising along with it. The Bluetooth module serves as the interface for Android apps to interact with the device [18].

In robotics, doing a task while dynamically responding to changing external conditions is a major topic.For widespread adoption, the system should be not only efficient and robust, but also cost efficient. A system like this would be utilized in Object Detection whenever a labor or a human is unable to grasp the clue of any Objects.. Swarm Robots, on the other side, may be well adapted to low-cost designs for usage in agriculture and mining. Swarm intelligence is a way for controlling the coordination of multi-robot systems with an infinite number of robots that are generally direct and immediate. It has been discovered that a wished-for entire direct ascent arises from the interactions among robots and robot associations: This paper lays out a platform for computing swarm learning and its implications in swarm collision avoidance [19].

This article discusses basic barrier and collision prevention tests performed with a diversified multi-robot network of grounded autonomous robots fitted with laser range locators. A localization method is employed to allow the robots to move autonomously in indoor spaces, and then a behavior-based technique called NullSpace based behavioral control to create the robots traverse while avoiding collisions with each other and with laser-detected impediments. A team of four Khepera III robotic vehicles installed with a Hokuyo URG laser range finder and communicating through an ad-hoc wireless network did several experiments [20].

## III. METHODOLOGY

### A. *Product Planning and Concept Generation*

The product planning phase is the initial step in any product development process. The product plan identifies the needs and the prerequisites of the product to be developed like the product's price and the time it would take to get it to market. For a successful product plan, there are basically five steps that are required to be followed. Initially the opportunities are to be identified which is the most important step as it brings all the possible inputs together. Next comes the evaluation and prioritization step where the product to be developed is prioritized and the evaluation for any existing products are identified. Once it comes to defining the timing and resource allocation for the most productive ventures, there will always be numerous contending for too few tools.

As a result, seeking to establish priorities and schedules most often fails, mandating a prioritized phase to minimize the amount of activities to be addressed. This is the third step, which involves allocating resources and planning the project's timeline. Then the pre-project is completed as the fourth step and finally brainstorms about the possible outcomes. An Arduino controlled autonomous bot using GPS tracking for movement follows the operator with carrying the required heavy or emergency goods upon it is planned to be created based on the above discussed product planning steps.

### *B. Designing*

Now comes the product design phase where the product design environment is identified including the components to be used and also the product specifications are determined. The hardware model of the robot will be designed in Solid works or Sketchup Software. The bot's maximum payload has been chosen as 3 kg.

### *C. Circuit Design*

The circuit design is the backbone for the assembling of the robot. The circuit design is a schematic of the project components that are interfaced together to get the final hardware and get the robot to work. It also specifies the circuit connections that should be made during the hardware assembly. The circuit connections of the bot will be demonstrated using Proteus or Tinker Cad Software and also the real circuit connections will be shown.

### *D. Assembly and Analysis*

The circuit design gives the complete outline for the assembly of the robot. The components for the robot are already selected in the designing phase. The hardware part of the bot will be assembled along with the circuit connection and then will be analyzed for different loads.

### *E. Testing and Validation*

The product testing is done in the testing phase where the purpose of the product and the population on which the product is to be tested is determined. The bot will be tested for its performances on carrying different possible loads and in different paths and the final presentation will be done.

## IV. FLOWCHART

The figure 1 given below represents the methodology of the project.

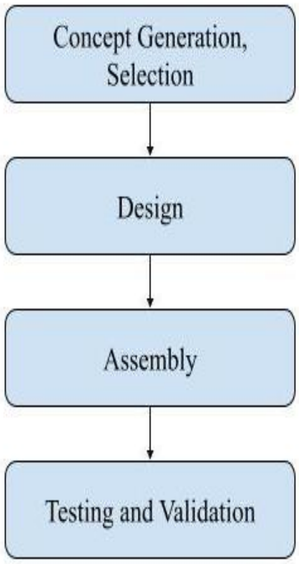


Fig. 1. Flowchart

## V. MODEL OF THE AUTONOMOUS ROBOT

The autonomous robot's design was developed on Solidworks software. Figure 2 and 3 illustrates the conceptual model.

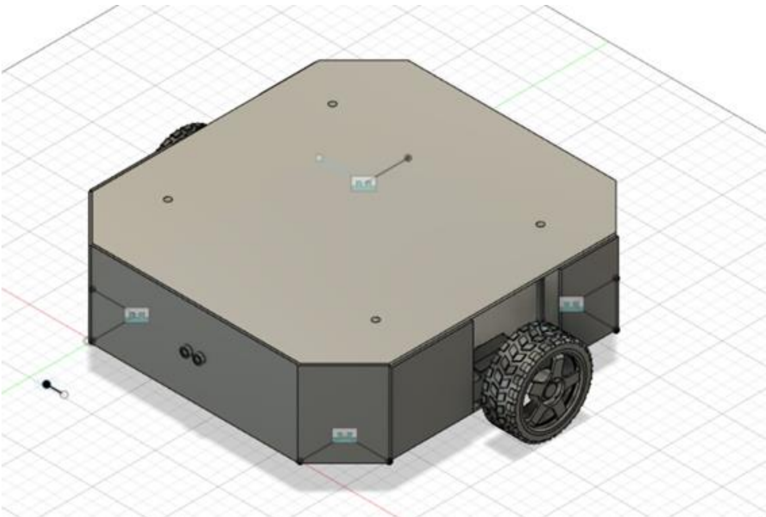

Fig. 2. Conceptual model

Four castor wheels, two in the front and two in the back are used in the autonomous robot. Two batteries are used to actuate the wheels and control the robots. This robot consists of two wheel drive mechanism. The motors used are 6 V geared motor. This robot is built in order to keep all the electronic components, such as motors and batteries, inside the robot, leaving room for the payload to be carried on top of it.

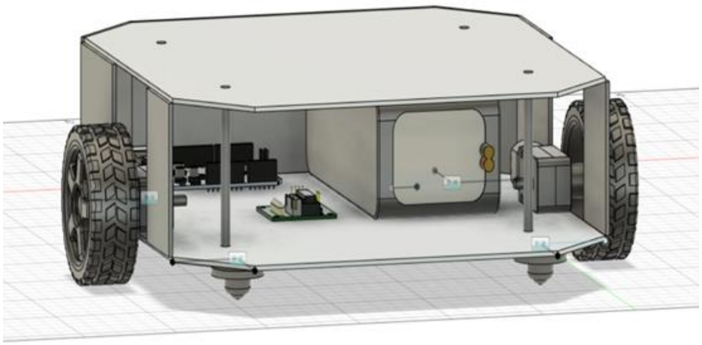

Fig. 3. Conceptual model

## VI. Circuit Diagram

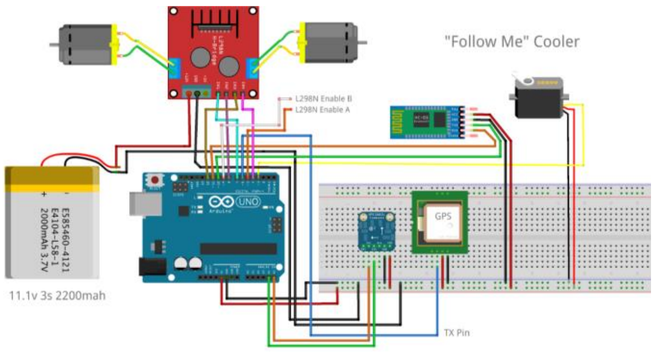


Fig. 4. Circuit diagram

Figure 4 above shows the circuit representation for the robotic system.

### A. *Arduino Controller*

The microcontroller used is Arduino uno. There are 14 digital pins on the board, with 6 of them providing pwm output. In order to programme the Arduino Uno, the Arduino IDE software is used. One can use arduino uno, arduino nano or arduino mega according to the application and the requirements of the project. The arduino uno is suitable for almost all applications. The bootloader here on ATmega328 on the Arduino Uno appears preprogrammed, making it possible for the programmers to add new code even without an extra hardware programmer. It uses the standard STK500 communication protocol. The Arduino Uno microcontroller is either powered over USB or through an external battery. Automatically, the power source is determined.

### B. *L298N Motor Drive*

The L298N is indeed a motor driver that can regulate the speed of the dc motors and its directions simultaneously. DC motors with voltages varying between 5 to 35 V and maximum currents of up to 2 A are powered by this module. The system contains two screw terminal blocks for motors A and B, and also a screw terminal block for the ground pin, motor vcc, and a 5 V pin that could be used as an input or output. The module has an embedded 5 volt regulator where it can be powered on or off using a jumper.

### C. HC-05 Bluetooth module

The primary bluetooth module which is used to interact between two microcontrollers, besides an Arduino, or to make a connection with any bluetooth-enabled device, such as a computer or smartphone. The HC-05 has two operating modes: data and AT command. The data mode allows users to send and receive information from some of the other Bluetooth devices, whereas the AT command mode allows users to modify the normal device settings.

## VII. WORKING

As the robot is intended to carry goods to various areas, it requires a dependable and effective navigation system.

The installation of a tracking device in a vehicle, on a piece of equipment, or on a person is necessary for GPS tracking. This vehicle tracking gadget gives precise position information so that it can report on the exact location of a vehicle, equipment, or person. It also keeps track of a vehicle's, equipment's, or person's movements. A GPS tracking gadget, for example, can be used to find out where a truck is on its route, where a youngster is, or even where valuables are being carried. It is utilized to figure out where the individual is and how to get there.

The robot links to a smartphone by Bluetooth and explores via GPS. All of the electronics will be contained in the base, allowing for the transport of other items. The sensors, Bluetooth, and control logic are all controlled by an Arduino Uno and a 5 V battery. The motors were driven by a 3s LiPo battery. For extended reach, an HC-05 Bluetooth module was installed on the front of the platform. The remaining components were placed inside and connected to the Arduino through the breadboard, including an L298N motor driver, PAM-7Q GPS, and HMC6883L compass. Since the compass uses I2C, the SLC and SDA pins were wired to A5 and A4, respectively. Digital I/O was then used to connect the remaining pins. For power, the motors were linked to the L298N motor driver module.

The main power supply was a 3s LiPo, with the ground linked to the Arduino power source for control logic. The most important part is configuring the blynk app according to the need for the project. In the end, the code is checked and uploaded to the Arduino after everything has been configured. While outside, the GPS will take a few seconds to establish a satellite lock. It will start flashing after it has done so. Make sure the HC-05 bluetooth module is linked to the Android smartphone. If asked for a passcode, use the default 1234. Launch Blynk and simply hit the play button. Figure 5 given below represents the final assembly of the robot. When the connections are done, the robot will be able to follow the human based on tracking the GPS from the person’s mobile phone. The robot following the human is shown in figure 6 and 7 below. Here, the person has a mobile phone with GPS enabled which makes it easier for the bot to track and follow.

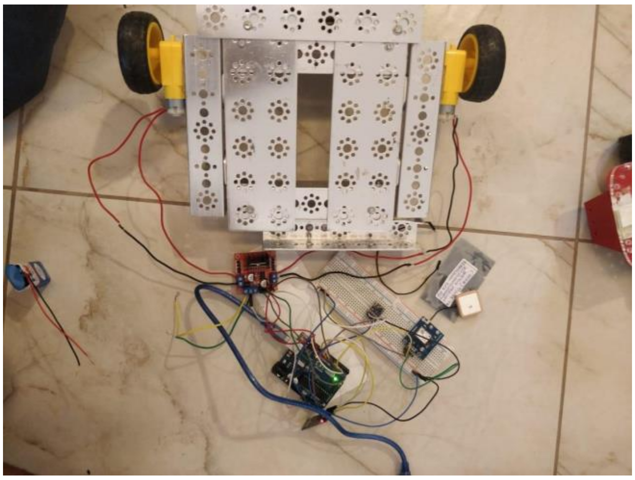

Fig. 5. Hardware model

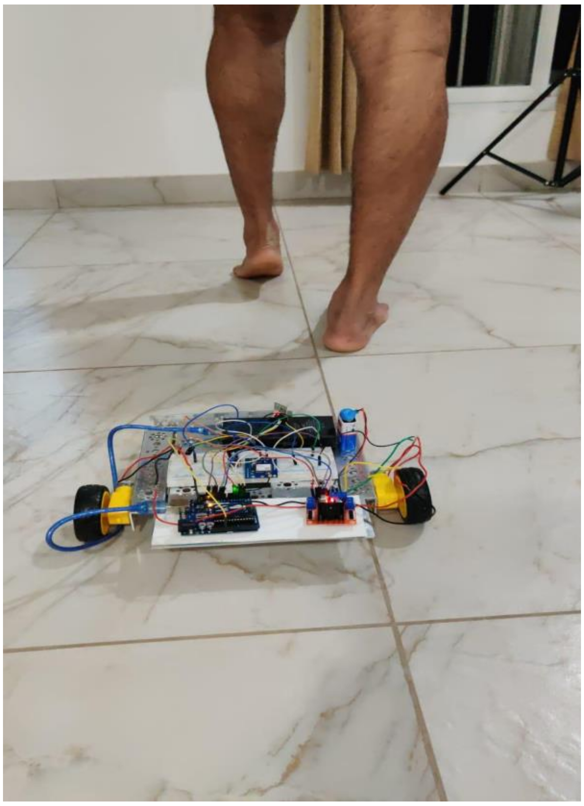

Fig. 6. Robot following the human

VIII. FURTHER STUDY

Further this project can be extended as an autonomous vehicle that can navigate to its desired location with the help of GPS tracking and also with the help of obstacle and collision detection and avoidance. Initially, the bot does not require an obstacle avoidance system as it follows the operator in the path where the operator travels and obviously, the operator will not be moving in a path full of hurdles and obstacles. Even then, the obstacle avoidance system is mandatory because the robot's purpose also includes reaching a target location.In that circumstance, the robot must navigate all around hurdles in its path. As a result, the installation of this technology will undoubtedly boost the robot's performance.

Obstacle avoidance features can be enabled by the addition of sensors or some vision systems. The sensors that proved to be effective in helping the bot to avoid hurdles are ultrasonic sensor and proximity sensors. The inductive proximity sensor recognises and skips metallic materials in the bot's pathway, while the capacitive proximity sensor senses any non-metallic materials in the bot's direction.

The other way of avoiding obstacles is by adding the suitable vision system which could identify and avoid the obstacles present. Vision systems comprises cameras which capture the hurdles and send the signal to the controller which in turn instructs the actuators to avoid the detected obstacles.

However, the implementation of this additional system could increase the cost of the bot but it can be effective in the case of applications by avoiding delays caused by the obstacles during the performance of the robot carrier.

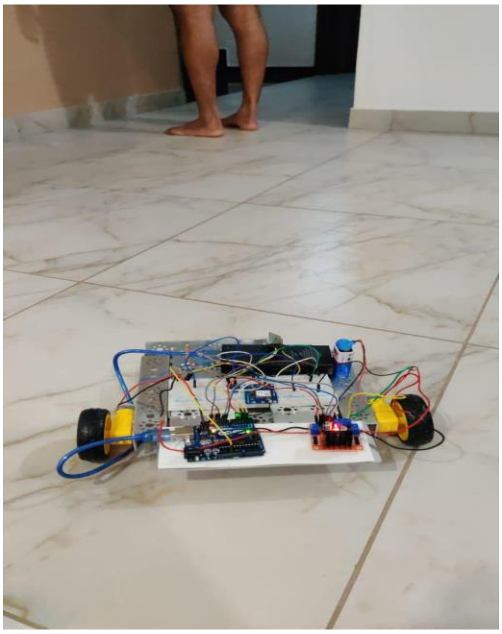

Fig. 7. Robot following the human

## IX. CONCLUSION

Thus, an autonomous goods carrier for simple household appliances was built and tested. It could effectively carry the proposed weight of around 3 kg. Hence, it could aid in the immediate as well as in the necessary situations by correctly following the operator or even reaching towards the given target location.

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