# Automatic Delivery Robot

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***Abstract*****—** *A self-delivery Robot is an intelligent machine that is capable of executing tasks by itself, without explicit human control or otherwise stated Self Delivery Robot is battery powered motorized robot. They can deliver items or packages to consumers without the interference of a delivery person. Through Self-Delivery Robot better control of transport management can be handled within the city. It is used to develop a robot cart which will be used for many delivery purposes like in any food or item parcel, in any offices, hospitals samples, and food and also helps to reduce the pollution as it uses batteries.*

***Keywords—Close Range Delivery; Control of Transport Management ; Flexible for Automated Fulfilment***

## 1. INTRODUCTION

Delivery is one of the essential processes of online orders. Though delivery is done by delivery executives even so for close-range delivery, a delivery robot can be used as it saves time and more parcels can be delivered. Self-delivery robot is expected to revolutionize the delivery system, yielding low-priced and efficient ways of delivering. Self Delivery Robot is battery powered motorized robot that can deliver items or packages to the consumer without the interference of a delivery person. They are not only used for long-distance delivery but also used inside office buildings for transferring some items. Self-Delivery Robot is an intelligent machine that is capable of executing tasks by itself, without explicit human control or otherwise stated Self-Delivery Robot is battery powered motorized robot that can deliver items or packages to consumers without the interference of a delivery person. Through Self-Delivery Robot better control of transport management can be handled within the city. Organizations such as hotel, airport and private organization or university with extensive ground of their own have a good opportunity to use this product to deliver items within their building area such as snacks, documents, books, stationary items any many more items to guest, student and staff. Self-Delivery Robot is not a big industry but it's a growing as people are slowing adopting this product as it is mainly driven by increasing cost-efficient and flexible for automated fulfilment which helps to reserve time and bring down the human error. As there is a growth in e-commerce as well as online food orders Self Delivery Robot can help to reduce the time of delivery and at this pandemic era it is best as no human contact will occur while receiving the parcel. Delivery can be achieved by delivery executives but in hard time like pandemic it's very risky for every human being to have contact to each and every customer and still we need to fulfil the demand of the supply chain. Here's how Self-Driving Robot are poised to change the game. Self-Driving Robot can help in various ways like: It reduces human error and rework caused due to errors. It increases efficiency and productivity for supplying. It improves safety of workforce in precarious work environment. Amplify revenue, by improving perfect order fulfilments rates, fast delivery and eventually customer satisfaction. It reduces man power on mundane task so employees can concentrate on strategies efforts that can't be automated. It can collect the data and analyse data for providing best service in the near future. It reduces employee injuries.Self-Driving Robot are helping define the supply chain of the future by aiding companies shrink long-term costs, supply labour as well as utilization stability worker's productivity is increased, the error is reduced, optimize pickup, sorting and deliveries and possibility of delivery to difficult location is increased. Since Self Driving Robot can potentially move items, they have a strong

grip potential to make deliveries further convenient and efficient. These days pollution in a major problem all over the world. Yes, we cannot stop it but there are some possibilities to reduce pollution. Self-Driving Robot uses batteries as well as solar panel as source of power to run which does not discharge and residue, this helps to maintain clean and healthy environment.

## 2. SYSTEM HARDWARE DESIGN

In the present age delivering parcel is quite a usual thing/process. Most of the population orders product online and then the product travels till it reaches the consumer who ordered. Travelling through a vehicle consumes a lot of fuel which causes pollution. We cannot stop pollution due to fuel but we can reduce it, SELF DRIVING DELIVERY ROBOT can help to reduce pollution and at the same time deliver the parcel who stays near the starting point. Self-Driving Delivery Robot local delivering the parcel from the hub station to the short-range consumer who are nearly 6 km from the hub. The research is predicated on semi-structured expert interviews, desktop and secondary data analysis. It is not the aim of this paper to offer a comprehensive overview of the world of autonomous delivery robots, which is impossible thanks to the massive number of developments in this sector. Nevertheless, the paper highlights technical, legal, and regulatory issues that are evolving with the event of autonomous delivery robots. Self-delivery robots are placed in the context of Industry 4.0 and machine to machine systems so that exiting concepts are firstly 8 applied to case of delivery robots.

### *3. Ultrasonic Sensor*

The human ear can hear sound frequency around 20HZ ~ 20KHZ, and ultrasonic is the soundwave beyond the human ability of 20KHZ. Ultrasonic transmitter emitted an ultrasonic wave in one direction, and started timing when it launched. Ultrasonic spread in the air, and would return immediately when it encountered obstacles on the way. At last, the ultrasonic receiver would stop timing when it received the reflected wave. As Ultrasonic spread velocity is 340m / s in the air, based on the timer record and then we can calculate the distance (s) between the obstacle and transmitter, namely: s = 340t/ 2, which is so-called time distance measurement principle. The principle of ultrasonic distance measurement used the already-known air spreading velocity, measuring the time from launch to reflection when it encountered obstacle, and then calculate the distance between the transmitter and the obstacle according to the time and the velocity. Thus, the principle of ultrasonic distance measurement is the same with radar.

### *4. Global Positioning System (GPS)*

The Global Positioning System (GPS) is a navigation system using satellites, a receiver and algorithms to synchronize location, velocity and time data for air, sea and land travel. The satellite system consists of a constellation of 24 satellites in six Earth-cantered orbital planes, each with four satellites, orbiting at 13,000 miles (20,000 km) above Earth and traveling at a speed of 8,700 mph (14,000 km/h). While we only need three satellites to supply a location on earth's surface, a fourth satellite is usually wont to validate the knowledge from the opposite three. This display the physical design of our robot, which has two levels with all components mounted on it. The top level consists of a single ultrasonic sensor, an IR sensor, a LED and a food holder. The ultrasonic sensor is used for detecting the customers(moving obstacles) in the restaurant, because we assume that all the still obstacles are below the top level, and there is also a LED to alarm the customers if the robot is blocked by them. Additionally, the IR sensor is able to locate the destination by searching for the IR signal transmitted by the IR beacon, so that the robot can move in the right direction.

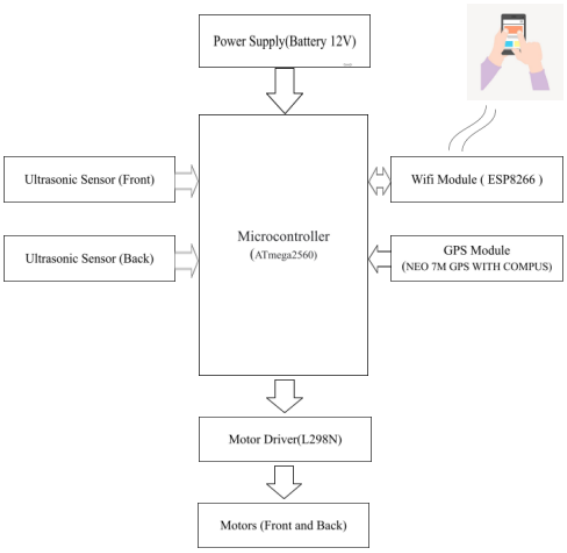


**FIGURE 1. Block Diagram**

### *5. Ardunio Uno*

Arduino is a tool for making computers that can sense and control more of the physical world than your desktop computer. It's an open-source physical computing platform based on a simple microcontroller board, and a development environment for writing software for the board. Arduino can be used to develop interactive objects, taking inputs from a variety of switches or sensors, and controlling a variety of lights, motors, and other physical outputs. Arduino projects can be stand-alone, or they can be communicating with software

running on your computer. The boards can be assembled by hand or purchased preassembled; the open-source IDE can be downloaded for free. The Arduino programming language is an implementation of Wiring, a similar physical computing platform, which is based on the Processing multimedia programming environment which is shown in the fig.


**FIGURE 2. Arduino Uno**

### 6. *Pin Configuration*

The Arduino Uno can be powered via the USB connection or with an external power supply. The power source is selected automatically. External (nonUSB) power can come either from an AC-to-DC adapter (wall- wart) or battery. The adapter can be connected by plugging a 2.1mm centre-positive plug into the board's power jack. Leads from a battery can be inserted in the Gnd and Vin pin headers of the POWER connector.

The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts. The power pins are as follows: VIN. The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin. 5V. this pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 12V), the USB connector (5V), or the VIN pin of the board (7-12V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage your board. 3V3. A 3.3-volt supply generated by the on-board regulator. Maximum current draw is 50 mA. GND. Ground pins. IOREF. This pin on the Arduino board provides the voltage reference with which the microcontroller operates. A properly configured shield can read the IOREF pin voltage and select the appropriate power source or enable voltage translators on the outputs for working with the 5V or 3.3V.

## 3. SOFTWARE DEVELOPMENT

Microcontrollers depend on a host computer for developing and compiling programs. The software used on the host computer is known as an integrated development environment, or IDE. For the Arduino, the development environment is based on the open-source Processing platform which is described by its creators as a programming language and environment for people who want to program images, animation, and interactions. The Arduino programming language leverages an open-source project known as Wiring. The Arduino language is based on good old- fashioned C. If you are unfamiliar with this language, don't worry; it's not hard to learn, and the Arduino IDE provides some feedback when you make mistakes in your programs.

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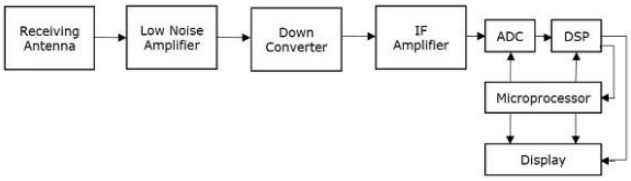


**FIGURE 3. Block Diagram Of GPS**

### 8. *Three Elements Of GPS*

Space (Satellites): The satellite moves around the earth, transmitting signals to user on geographical position and time of the day.

Ground Control: The Control Segment is made up of Earth-based monitor stations, master control stations and ground antenna. Control activities include tracking and operating the satellites in space and monitoring transmissions. There are monitoring stations on almost every continent within the world, including North and South America, Africa, Europe, Asia and Australia.

User equipment: GPS receivers and transmitters including items like watches, smartphones and telematic devices.

### 9. *Reading Digital Compass*

The digital compass is used to read the current heading angle of the robot. We know the target angle from the GPS module, but the robot needs to know which direction it is pointed at, so the digital compass plays an important role to direct the robot towards the target path. The digital compass communicates with the Arduino Microcontroller using I2C serial communication. We have used HMC5883L.h library to read the compass [15]. These digital compass modules are not accurate and they need to be calibrated before using in any project. The HMC5883L.h library has a build in calibration example sketch which we used to read the X and Y axes offset values. The main program takes into account these offset values and calculates the current heading angle.

### 10. *Keypad Interfacing*

The delivery product is kept safe in a container which remains locked with a four digit password. When the robot reaches to its destination, it stops and waits for the customer to enter the four digit password that has been sent to the customer's cell phone along with the order confirmation. This four digit password would be preset by the vendor in the program. This preset password is saved in a string called "password". The customer's input password is stored in another string called "input_password". When the customer inputs the password and presses the "#" key, the "input_password" string is matched with the "password" string. If the input password matches, the servo motor turns from 0 degree to 90 degree and opens the lid of the container. If the input password does not match, the buzzer beeps three times and the customer needs to retype the input password. The "*" key clears the input password string if the customer mistakenly types a wrong key. We have used the Keypad.h library [16] to interface the 4×3 keypad and the Servo.h library to control the servo motor.

## 4. WORKING PRINCIPLE

The motor run's according to the principle of Fleming's left-hand rule. When a current carrying conductor is placed in a magnetic field is produced to move the conductor away from the magnetic field. The conductor carrying current to North and South poles is being removed. In the above stated two conditions there is no movement of the conductors. Whenever a current carrying conductor is placed in a magnetic field. The field due to the current in the conductor but opposes the main field below the conductor. As a result, the flux density below the conductor. It is found that a force acts on the conductor to push the conductor downwards. If the current in the conductor is reversed, the strengthening of the flux lines occurs below the conductor, and the conductor will be pushed upwards.

### 5. *Electromagnets And Motors*

It is created by a simple electromagnet by wrapping 100 loops of wire around a nail and connecting it to a battery. The nail would become a magnet and have a North and South Pole while the battery is connected. Now say that take a nail electromagnet, run an axle through the middle of it, and suspended it in the middle of a horseshoe magnet.

### 6. *The Commentator And Brushes*

The "flipping the electric field" part of an electric motor is accomplished by two parts: the commentator and the brushes. The diagram at the right shows how the commentator and brushes work together to let current flow to the electromagnet, and also to flip the direction that the electrons are flowing at just the right moment.

### 7. *Wheels*

A wheel is a circular component that is intended to rotate on an axle bearing. The wheel is one of the main components of the wheel and axle which is one of the six simple machines. Wheels, in conjunction with axles, allow heavy objects to be moved easily facilitating movement or transportation while supporting a load, or performing labour in machines. Wheels are also used for other purposes, such as a ship's wheel, steering wheel, potter's wheel and flywheel.

### 8. *GPS Working Principle*

GPS works through a technique called trilateration, it used to calculate location, velocity, and elevation, trilateration collects signals from satellites to output location information. It is often mistaken for triangulation, which is employed to live angles, not distances. Satellites orbiting the earth send signals to be read and interpreted by a GPS device, situated on or near the earth's surface. To calculate location, a GPS device must be ready to read the signal from a minimum of four satellites. Each satellite in the network circles the earth twice a day, and each satellite sends a unique signal, orbital parameters and time. At any given moment, a GPS device can read the signals from six or more satellites.

### 9. *Servo Motor*

A servo motor may be a sort of motor which will rotate with great precision. Normally this sort of motor consists of an impact circuit that gives feedback on the present position of the motor shaft, this feedback allows the servo motors to rotate with great precision. If you would like to rotate an object at some specific angles or distance, then you employ a servo motor. A

servo consists of a Motor, a potentiometer, gear assembly, and a controlling circuit. First of all, we use gear assembly to scale back RPM and to extend torque of the motor. Say at initial position of servo motor shaft, the position of the potentiometer knob is such there's no electrical signal generated at the output port of the potentiometer. Now an electrical signal is given to a different input terminal of the error detector amplifier. Now the difference between these two signals, one comes from the potentiometer and another comes from other sources, are going to be processed during a feedback mechanism and output are going to be provided in terms of error signal. This error signal acts because the input for motor and motor starts rotating.

## 5. RESULTS

The analysis is the numerical simulation of any particular physical event using the Finite Element Method (FEM). Engineers use it to minimise the number of actual samples and tests, as well as refine parts during the design process, in order to create better goods faster. Mathematics is needed to fully comprehend and measure any physical phenomenon, such as structural or fluid behaviour, thermal transport, wave propagation, and so on. Partial Differential Equations are used to explain the majority of these systems (pdes). Numerical techniques have been developed over the last few decades to allow a machine to solve these problems, and one of the most well-known is Differential equations can be used to explain not just natural processes but also physical phenomena in engineering mechanics. These partial differential equations (pdes) are difficult equations that must be solved in order to calculate related structural quantities (such as stresses (), strains (), and so on) in order to predict the behaviour of the investigated variable under a given load. It's important to remember that FEA only provides an approximate solution to the problem and is merely a numerical method for obtaining the real solution to these partial differential equations. Simply put, FEA is a numerical method for predicting how a part or assembly will behave under certain conditions. The robot checks if it has reached the threshold value from its destination (in our program, we set the threshold value to 3 meters). If not, the robot calculates the target angle, current heading angle and distance to destination again and the loop continues till the robot reaches to its destination.

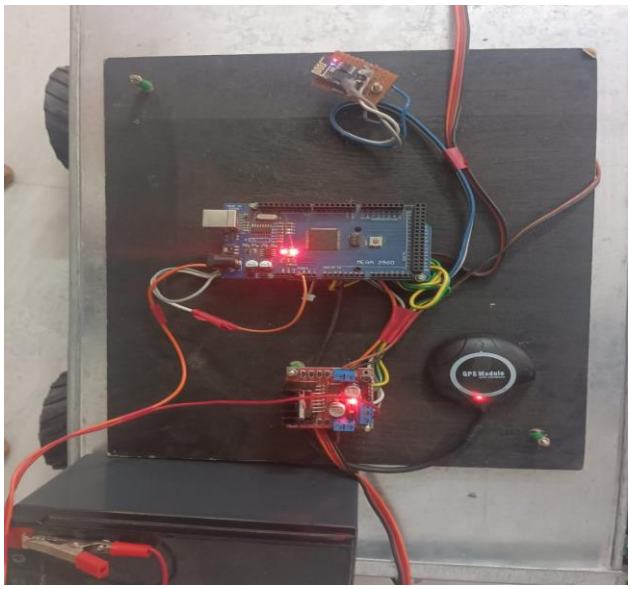

**FIGURE 4. Robot Connections**

GPS modules work the best at outside in fields or in open areas. Trees or buildings around the testing location can block the satellite signals and can cause the accuracy of the GPS module to decrease. The ideal testing location for our prototype robot should be an open field where the ground is obstacle free. But during the tests, these factors came into account and added some errors in the results. In our work we have conducted two types of experiments to determine the performance of our robot: A heading angle accuracy experiment and a trajectory completion accuracy experiment. In the heading angle accuracy experiment the actual heading angle and the current heading angle are measured and the accuracy is found from the deviation between the two data. D. J. Paul et al. showed an accuracy of the heading angle in a GPS guided object transporter robot where the performance of the robot is determined only by the direction of movement .

**FIGURE 5. Output**

However, the data from GPS modules can fluctuate sometimes, causing some error in the robot operation. While conducting the test runs we have found that, when the robot reaches approximately around the

destination point and the GPS data fluctuation occurs, the robot moves out from the trajectory and misses the destination, causing a trajectory completion failure. This matter has been taken into account in our test runs and we conducted this trajectory completion accuracy experiment to evaluate the trajectory completion performance of our robot. In this experiment, the number of successful trajectory completion attempts determine the performance of the robot. The Neo M8N GPS module readings do not vary considerably within 3 meters around a location. So, we considered a 3 meters radius circle around our destination as the threshold value from our destination. When the robot reaches within this circle, it stops as it approximately reaches the destination. While returning back to its home location from where it started, the robot receives new GPS data, so it does not follow the same route always. The four wheel drive chassis of our robot gives it enough power to carry a 500 gm to 1KG load and helps the robot to track its path accurately. One of the advantages of our robot is that, being a GPS guided delivery robot, it has no range limits as long as the GPS location is received. Starship food delivery robots are available in the market but they are only used for local delivery services within a 6 kilometers radius.

## 6. CONCLUSION

We have developed an autonomous package delivery robot prototype which can deliver up to 1KG of packages or products to a certain GPS location safely in a password protected container without any human contact. We need this system to be involved in every individual life since consumption of various product has been increased and it's difficult to fulfil the demand without the help of self-delivery robot. We can conclude the performance of the self-delivery robot is efficient. The fabricated system can result in non pollution / minimising environmental degradation due to the usage of batteries and solar panel which supplies electrical energy as source of energy and saves money. The Neo M8N GPS module readings do not vary considerably within 3 meters around a location. So, we considered a 3 meters radius circle around our destination as the threshold value from our destination. When the robot reaches within this circle, it stops as it approximately reaches the destination. While returning back to its home location from where it started, the robot receives new GPS data, so it does not follow the same route always. The four wheel drive chassis of our robot gives it enough power to carry a 500 gm to 1KG load and helps the robot to track its path accurately. One of the advantages of our robot is that, being a GPS guided delivery robot, it has no range limits as long as the GPS location is received. Starship food delivery robots are available in the market but they are only used for local delivery services within a 6 kilometers radius. The robot can deliver light weight items and is best for office buildings, hospitals and airplane for delivering the documents/ files, samples and food respectively. Self-delivery robot can also be used for food and item deliveries from restaurant and e-commerce as well. In future this robot can be developed as a google map guided robot to enhance the accuracy. A Lidar sensor based mapping can be implemented for avoiding obstacles and recognizing the surrounding environment. To accommodate more packages and heavy load, the size of the robot can be increased and powerful motors can be attached. These updates will highly improve the performance of our robot and it will become a more reliable source to bring our daily needed products to our door. The robot provides a simple user interface to the customers, which makes it smart and user friendly. Also, the lightweight construction of our robot makes it crash-safe, thus it can effectively contribute to the reduction of urban traffic, congestion and accidents.

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