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# AUTONOMOUS WITH GPS BASED CONTROLLED MOBILE ROBOT FOR MATERIAL HANDLING IN WAREHOUSE

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**Abstract.** The Autonomous Guided Vehicles (AGVs), that relied on tracks and specially defined paths or were to be overseen by operators, AMRs have evolved. PNO AMRs: using a rich set of sensors and artificial intelligence and machine learning, with computation on board for path planning, to interpret and navigate the environment, with no wired power or tethers of any kind. Since AMRs are indeed assemblies of cameras and sensors, if there is a sudden obstacle such as a fallen box or a group of people, the navigation techniques related to collision avoidance should slow down or stop in order to reroute their path across that thing and move forward with the rest of their task. Autonomous mobile robots become increasingly important in modern intralogistics. Automatic or semi-automatic goods transport by driverless platform trucks saves much more noticeably and increases the efficiency of warehouses and logistics hotspots. As they are of low heights, they will pass under rack transporters and trolleys and lift pallets from transfer racks and take them to a defined destination on their own. They perceive and avoid any obstacle to be independently able to reach their destination. Either QR codes attached to the floor or laser-assisted natural feature navigation act as orientation for the AMRs. In contrast, intralogistics is still largely characterized by standard process features, in which goods are transported anyway back to accurate positions along short and medium-length routes. Autonomous mobile robots give significant support to these processes. They relieve workers from monotonous transport tasks and reduce distances for walking, thereby increasing handling capacity and decreasing error and accident rates. They take up no more space than the load to be transported and also maneuver extremely well in most tight spots, thanks to their compactness and mobility. Integration into established process sequences is especially easy: for example, integration into the warehouse without any problems with other automated components.

**Keywords:** Automotive, Electronics, FMCG, Healthcare, Hospitality, Pharmaceuticals, and Warehousing.

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## 1. Introduction

The AMRs, or Artificial Intelligent Mobile Robots of find-path or problem of path planning forms. Navigation simply means a procedure or activity of designing and directing a route or path, and this must be properly done by an autonomous robot so that the robot can move from one location to another without losing or hitting anything else. The three general navigation. Of these three, the issue that seems one of the simplest ones in navigation is path planning. Path planning gives the capability to choose and identify an adequate path that the robot [18]. Now, robotics is one modern science and technology of intellect. Robotics was successfully developed in large scales of fields, theoretically and practically. For years and now, technological progress brings. From cleaning rooms, waiting on food, opening doors and to efficiently wait on humans, robots can do everything indoors. Robots are already quite an important addition to the medical world: waiting on patients, performing delicate surgeries with great precision, controlling medical equipment, and taking well-educated patients [11]. In case the system is realized on a vision basis, then the performance and efficiency ability of the system would be strengthened with regard to it. Oriented objects necessary for tasks in arm. IP algorithms take quite much processing time because of this reason: all this has to be done in such a way that object recognition may successfully be implemented [10]. Explores development of an AMR for material handling in warehouses, utilizing GPS-based control to enhance navigation and operational efficiency. The robot integrates GPS technology to enable precise positioning and route planning within complex warehouse environments. Equipped with real-time tracking capabilities, the robot navigates autonomously, manages obstacles, and executes material transport tasks with high accuracy.

**Table 1: Application of Autonomous Mobile Robot**

S.No	Capabilities	Description
1	Warehousing and logistics	Goods Transport: AMRs are used to move goods within warehouses, reducing the need for human labour in repetitive tasks
2	Manufacturing	Material Handling: AMRs transport raw materials and components between different stages of the production process
3	Healthcare	Patient Transport: Autonomous Mobile Robots can transport patients within hospitals, especially in large facilities.
4	Security, surveillance	Patrolling: AMRs can autonomously patrol large areas, such as industrial sites, warehouses, or campuses, to detect and report security breaches.

**Table 2: Challenges for Autonomous Mobile Robot**

S.No	Challenges	Description
1	Combining technology	It is difficult to make ultrasonic sensor and GPS system to work AMR smoothly.
2	Weight limits	AMR cannot carry heavy loads, so after combining both ultrasonic sensor and GPS system.
3	Weather conditions	Extreme weather conditions it may affect AMR performance and accuracy of ultrasonic sensor and GPS system.
4	Expenses	The sensor and AMR are costly to keep working and maintain in high stress disaster scenario.

### Problem Statement

There are some problems in autonomous mobile robot one of the major problems is when the autonomous mobile robot can carry the material but it has wait until pick or place material from the conveyor belt. pick the material from the autonomous mobile robot it consumes more time and cost in the industrial plant. It is inflexible it cannot move the object or material which is fallen in its way until someone pick the object. It has some problem in navigation and operational efficiency.

The solution for the problem above statement is our project to create a robot which has pick and place robotic arm attached to the autonomous mobile robot. so that autonomous mobile robot can complete the job with less time and less cost is needed and it is flexible it uses its robotic arm to move the harmless object from its way than to take another route using GPS.

## 2. Literature Survey

[1] **Andreas Locklin, et.al (2022)**. The paper reflects an approach to manufacturing where the schedule is the base, incorporating data obtained. Manufacturing execution system. Such an approach is still valid in the case of warehousing and might be integrated with the Warehousing Execution Systems or Warehouse Control System. The rest of the paper are divided into- presentation of approaches to human motion trajectory prediction. In that sense, primarily schedule-based approach is presented along with realization requirements. For an operational level, the realization is based on the Festo MES4.

[2] **Khurshid, et.al (2021)**. For instance, new I4.0 tools like will enable companies to configuration. Handling logistic itself position in more significant terms. However, like this AMR-based automated logistics system along with other types of robotics formed by new technology in the Industry 4.0 era is left open for further research. Nowadays, robots in logistics systems are utilized towards commanding material flow the most common type of robots used in logistics is known as AGV or AMR.

[3] **Che-Wen Chen, et.al (2021)**. It also brings in RGBD camera and 2D LIDAR to reduce localization error. Major contributions of this thesis are virtual wall placement at dangerous settings of the path-planning function that can let among different. Moreover, it's a classical method; inside the VSLAM algorithm developed in this dissertation, there will exist two state-of-the-art technologies: object detection technology and the OCR technology associated with extracting acquired stored enables an idea about the traversed space.

[4] **Kasim M, et.al (2021)**. This is the first release of a project originally developed at Philadelphia University-Jordan. The major goals for the design and implementation of this project include reliable, low-cost communication running on a mobile phone that guides a mobile robot in performing safe and efficient operations in hazardous environments. The mobile robot is set to perform routine scanning, monitoring, and control work. A navigation algorithm for real-time obstacle avoidance is attached to a mobile robot with the intent of using it on a data acquisition system that uses a microcontroller.

[5] **Shuliang Zhang, et.al (2021)**. Based on the above analysis, this paper develops a novel indoor mobile robot positioning method hybrid based on laser radar and ultrasonic sensors. Positioning with laser radar is mainly used in the process, but some inevitable problems arise due to the sensing capability of the sensor being restricted. Even though the method is furnished with accurate positioning information, it does not fit very well for one operation to be carried out, and it requires cooperation with other sensors in order to upgrade positioning accuracy filter fusion model.

[6] **Chee-Henn Chng, et.al (2020)**. This is a very efficient framework that allows hundreds and thousands of relief to be achieved, through providing congestions when the robots are moving with higher speeds of sorting. Paper introduces a decision-module in the architecture above, to be sent across the server and the client instead of relying on the traditional server/client architecture.

[7] **R. Siegwart, et.al (2019)**. This dimensional model of AMR should be proposed. Based on that, part two inferred a novel locating method which can improve usage to counteract the problems induced by the merge of multi information. In the third, this paper integrates and approach to complete ground AMR navigation involving several obstacles. Every section in this paper adopts MATLAB to simulate. The final outcome of this paper is that indeed it provides some results where it can easily be seen that the combined algorithm is better than the other two.

[8] **Ching-changwong, et.al (2019)**. These techniques pushed much discourse regarding this topic feature detection really into the methods to be used in such approaches to study object detection. These techniques are actually able to pick out the objects, considering both those which are textured as well as those which just so happens to be texture-less, took detection results in order to perform of performing the pick-and-place operation.

[9] **Guo-Sheng Cai, et.al (2019)**. It better demonstrated localization accuracies of the mobile robot. In this contribution, the author shows an EKF-based method for positioning and applies it to some experiments using ROS. Estimation for the robot after measuring with a prediction through by the GPS. Therefore, the first thing that we are getting is a more accurate information about the pose being considered and secondly, that we do not increase the cumulative error by many folds.

[10] **H.S Hewawasam, et.al (2019)**. It is basically a comparative study mainly which has been sought in the search of this research by first glancing the performance of these filter terms of the demonstrated experiment of test, showing it outperforms almost all the metrics in of object, commonly general 12 benchmarks of dynamic objects.

[11] **Jiatong Bao, et.al (2018)**. It attempts to integrate resources to solve the problem of autonomous outdoor navigation on a slow mobile robot platform. Independent planning of enclosure may be performed using open online satellite maps. The robot would have been driven in a sequential manner, where it moves in a manner toward its destination. Simplified detection of the calculation of the also movement because considered low-speed vehicles have to move through the above pedestrian environments.

[12] **Jacobus Theunissen, et.al (2018)**. Above all, mainly RFID will be applied for the implementation of shop floors in paper offers, which is an offer in most of the vehicles. However, it will be used for networking purposes and Arduino Mega boards will be applied.

[13] **Ahmed Alaa Mahfouz (2017)**. Development of functional justifications of a service robotic system in warehouses for materials handling. The development to the production line for materials handling in warehouses. The use of robotic systems for materials handling has economical justifications so too few plants would benefit from this innovation. This problem is based on many phases, as development a logistic robot, and then adds measurement and manipulation capabilities. This paper handles the first phase, platform that in a well-known environment. The different modules of mobile robot navigation in a well-known environment have been summarized, and the proposed method for path planning, along with some of the experiments designed.

[14] **Aniruddha Singhal, et.al (2017)**. Introduced the streamlined this encompasses onboard 5 Simultaneous localization and mapping algo rhythm to reach a destination. Autonomy in every is implementing the apart from

obstacles avoidance capability is the crux of this work. Particularly, this paper centers three implementations, using as the implementations within but while one relies on a cloud robotics engine.

**[15] Murat Koseoglu, et.al (2017).** They Designed an AMR that can maneuver in a partly known environment. An AMR can sense the parameters of its environment and its location in that environment. It will allow an AMR to formulate a navigation plan and optimize this plan using some specific planning algorithm. In other words, an AMR has no predetermined navigation plan. Besides map building, sensor data may also be exploited by an AMR for the construction of the environment map and positioning itself in the built termed enables a very sensitive navigation plan to be built which the programmer can revise and improve dynamically.

**[16] Pratiksha Andhare, et.al (2016).** They stated toward the acknowledgement as well as the inspection of small parts to a greater extent. So, it enables have a vision into the things are. It can be used for different industrial purposes palletizing is said job arranging objects any particular fashion. Palletizing is basically the main contribution of robotics. These are oriented hence random objects. The vision system is supposed to first recognize the objects and then sort them.

**[17] Humbert, et.al (2015).** This paper shall first introduce the influence of the cooperation or non-cooperation should then be drawn out effects. Third, a software interface representing in a realistic3D environment the robotic cell. Advanced software has been developed, allowing the simulation of shall be generated in order to minimize the proposed. Software is also 7 modular, allowing simulations.

**[18] Hsien-I Lin, et.al (2015).** The number of possibly involved objects has got infinite shapes. When the objects are unrestricted, then it is very challenging to attain absolutely autonomous vision-based robot due to the above fact. But keeping in mind the above point, then estimation abilities for a toward robot operation could be attained. Therefore, in our paper we shall mention the system which makes easier the construction process by the user and gives him the opportunity to choose the features interpretable for the construction of so-called predictive models. The proposed GUI is adoptable to the potential users without a particular background of knowledge.

**[19] Woosik Lee, et.al (2015).** This paper will discuss the multi-GPS receiver system that can be achieved by developing low-cost GPS receivers like LS20031 and also for such proposed systems. This may be further divided into two steps explained below: Testing the performance of each sensor through error modeling with the aim of achieving the maximum accuracy in position estimation from EKF. Finally, we introduce relative results of improvement in accuracy from viewpoint to authenticate the proposed methodology. Paper, essentially, we concentrated on.

**[20] Farhad Aghili, et.al (2015).** Estimation of three-dimensional attitudes and positions of a robot through the optimally fused data sources consisting of two RTK GPS measurements. It is done using signal of services suffers from a notorious problem known as signal robustness problems due to the susceptibility of their signal to various sources. That measurement noise covariant matrix cannot be known beforehand due to their variation from one point to another. It will be calculated online in real-time with the extracted data. The algorithm is always "tuned".

### 3. Materials Required

#### Arduino



**Fig 1:** Arduino AT mega 328

Arduino ATmega328 offers a number of interfaces with the computer, other Arduino or other microcontrollers. Arduino ATmega328 has four hardware UARTs that give 5V TTL serial communication. The Arduino AT mega 328 is an integrated development environment (IDE) based microcontroller board that uses on the other hand, the central core processor is going to be the most important control unit for the robot since it will take inputs from the GPS, sensors, and also the motor control with working on the robotic arm.

## GPS Module



**Fig 2:** GPS Module (NEO-6M)

This module has actual real-time GPS data, for instance, latitude and longitude that will enable the robot to go to specific places it is instructed to do so within the warehouse. NEO-6M chip receives signals from over one GPS satellite and other satellite constellations such as GLONASS, Galileo, and Bei Dou. These are satellites which can be available to provide information to an object of accurate timing as well as to the precise orbital data.

## Ultrasonic Sensors



**Fig 3:** Ultrasonic Sensors (HC-SR04)

It detects the obstacles that are in the way of the robot. Arduino uses this information to avoid collision by changing the path of the robot. Trig (Trigger) pin: This is used to trigger ultrasonic pulses. The sensor initiates a burst of ultrasonic when it is set HIGH for  $10\mu\text{s}$ . In this circuit, an echo pin will send a pulse ultrasonic, that goes high and stays high until the sensor receives an echo back; once it does, it will make the pin low. Most ultrasonic sensors determine their range of operation sound send receive again between the sensor and the object itself, that is, proximity sensor.

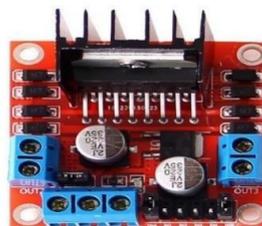
## DC Motors With Wheels



**Fig 4:** DC Motors with Wheels

Provides movement for the robot. The motors are controlled by the Arduino to move the robot towards the destination. A DC motor is such a device in which, whenever suffers some force. This force is known as the Lorentz force responsible for the turning of the armature of the motor.

## Motor Driver



**Fig 5:** Driver (L298N)

Interfaces between the Arduino and the DC motors, allowing the Arduino to control motor direction and speed. This module allows you to independently manage two motors of up to 2A each in both directions.

## Battery



**Fig 6:** Battery Pack (12V, 7Ah Lead Acid or equivalent)

The project consists of a 12V, 7Ah lead-acid battery or its equivalent. This battery is chosen for its capacity to provide sufficient power to run the mobile robot, including its motors sensors, and control systems, over extended periods. Lead-acid batteries are durable, cost effective, and provide steady voltage, which is crucial for maintaining consistent performance of the robot. The 7Ah rating indicates the amount of current the battery can supply over time ensuring that the robot can handle intensive operations like navigation and pick-and-place tasks without frequent recharging. An equivalent battery type, such as a lithium-ion battery with similar voltage and capacity, may also be considered for its lighter weight and longer life cycle.

## Servomotor



**Fig 7:** Servomotor

Controls the movement of the robotic arm or gripper to pick up and place materials. Produces torque and voltage and current it receives. It works by using a feedback signal from a position sensor to compare the current position of the load to the desired position or velocity set by the user.

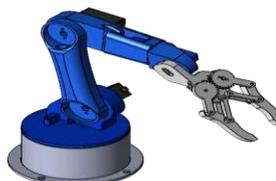
## Robot Vehicle Body



**Fig 8:** Chassis for the Robot

The chassis refers to the load-bearing framework in any artificial object. It provides the desired structure to the object at its time of construction and, simultaneously, while it functions. In essence, it forms the body of a robot that maintains all the elements inside the robot, such as the motors, Arduino, and sensors. The drivetrain is stored in the chassis, which makes the robot move by combining either wheels or tank treads, and any other way. In some places, a chassis is also known as the frame of the robot.

## Robotic Arm



**Fig 9:** Robotic Arm

Made pick-and-place movements by physically transferring materials from one location to another. The work pieces in the process are accessed by setting the location of the robotic arm, which then performed a task by way

of the end-effector. Robotic arms also must be programmed to perform manufacturing tasks. Frequently, a controller along with a teaching pendant are used for this purpose. Sometimes, manual motion is applied in the programming of some robotic arms. It is a 3D printed DIY kit - the 6DOF, bionic robotic arm.

### Jumper Wires



**Fig 11:** Jumper wires

Attach ordinary by putting jumper wire on the circuit. Connect various electronic components such as sensors, motors, and modules to Arduino. These are essential in building circuits.

### Enclosure/Frame for Electronics



**Fig 13:** Enclosure/Frame for Electronics

This protects the electronics (Arduino, GPS, motor driver) from dust, impact, and environmental elements as well. It also helps to make their mounting and organization more manageable.

## 3. Existing System

The AMRs for material handling in warehouses typically involve human-operated forklifts. Some semi-automated systems use predefined paths or tracks for robots, but they lack flexibility and require significant infrastructure changes. GPS-based autonomous mobile robots (AMRs) offer a more efficient solution by navigating the warehouse using GPS coordinates and sensors. However, these systems can face challenges with GPS signal accuracy, especially indoors, and require additional technologies, like LiDAR or camera-based localization, to complement GPS. The current systems are limited in dynamic decision-making and adaptability to changing environments.

## 4. Proposed System

An autonomous GPS-based mobile robot designed for efficient material handling in warehouses. The robot navigates using GPS and integrated sensors to map the warehouse environment, avoiding obstacles and selecting optimal routes. It utilizes a real-time control system to manage the picking, transporting, and placing of materials, improving accuracy and reducing human error. The robot can be programmed to handle various tasks such as inventory management and restocking, with the ability to operate continuously. This system aims to enhance productivity, reduce labour costs, and ensure a safer working environment by automating repetitive and strenuous tasks.

## 5. Conclusion

The designing and functionality of the pick and place robotic arm with AMR are presented. The designing and fabrication have been carried out on the robotic arm coupled with AMR. Designing of the manipulator has also been performed. The torque exerted at each of the joints was calculated for different loads. Accordingly, based on the torque, the power is estimated. The servo is chosen at each joint with the required torque kept in mind.

Satisfactory numbers of experimentation are done on the pick and place robotic arm with AMR producing satisfactory outcomes. The higher torque-rated motors might be applied to provide power to the joints so even in the absence of electric current to the motors, the position of the robotic arm will be maintained. The AMR also carries with it a set of applications that include object detection and collision avoidance by attaching ultrasonic sensors and the GPS system to it.

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