

**DEVELOPMENT OF AUTOMATED GUIDED VEHICLE FOR MATERIAL
HANDLING AUTOMATION FOR INDUSTRY 4.0**

Submitted in partial fulfillment of the requirements for the award of

Bachelor of Engineering degree in
Mechatronics

By

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**DEPARTMENT OF MECHATRONICS
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SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

Accredited with grade “A++” by NAAC

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APRIL 2024



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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the Bonafide work of **ASHWIN C (40090002)** and **ALLEN MATHEW (40090701)** who carried out the project entitled **"DEVELOPMENT OF AUTOMATED GUIDED VEHICLE FOR MATERIAL HANDLING AUTOMATION FOR INDUSTRY 4.0"** under our supervision from November 2023 to April 2024.

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1.

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ACKNOWLEDGEMENT

I am pleased to acknowledge my sincere thanks to the Board of Management of **SATHYABAMA** for their kind encouragement in doing this project and for completing it successfully. I am grateful to them.

I convey my sincere thanks to Dr. **B. Kanimozhi, M.E., Ph.D.**, Head of the Department, Department of Mechatronics Engineering for providing me necessary support and details at the right time during the progressive reviews.

I would like to express my sincere and deep sense of gratitude to my Project Guide **Dr. J. Senthilkumar, M.E., Ph.D.**, for his valuable guidance, suggestions and constant encouragement paved the way for the successful completion of my project work.

I also express my thanks to all Teaching and Non-teaching staff members of the Department of Mechatronics Engineering who were helpful in many ways for the completion of the project.

ABSTRACT

Industries are currently embracing automation in all aspects of employment. Industries are attempting to cut back on labor costs and human processing time. The suggested effort will aid in handling the materials effectively. Specifically, for selecting the raw materials from the warehouse, transporting them on a vehicle, and bringing them to the machine shop. This kind of vehicle can be used to cut processing costs and labor costs. The UGV transports the raw materials from the warehouse to the workshop where the machining operations are carried out. The system's brain, which regulates the movement of the vehicle and arm actuation, is the ARDUINO UNO R3 ATMEGA 328P controller. The gripper is located at the end of the robotic arm, which has five servo motors. The three-wheeled vehicle is useful for moving things from one location to another. The black line that the car must move on is located using three IR sensors. The black line is detected using sensors 1 and 2. whenever it senses the need to drive the car forward, left, or right. The workshop or storage is indicated by the third sensor. The third IR sensor signals that the robot has arrived to the storehouse, at which point the vehicle stops and the ARDUINO UNO R3 activates the arm to imitate carrying the cargo. It is driven to the workshop without any human intervention by the vehicle, which starts up autonomously. As a result, the suggested project is helpful for efficiently moving and transporting both raw materials and finished goods while consuming less time. The robotic gripper arm, three-wheeled autonomous vehicle, ARDUINO UNO R3 controller, motor driver, three infrared sensors (IR), and single-mode power supply (SMPS) are all included in this

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CHAPTER – I

INTRODUCTION

1.1 INRODUCTION

The Automated Guided Vehicle (AGV) is a general one that incorporates all vehicle structures fit for working without driver action. Robotized guided vehicles have found colossal present day applications. AGVs are right now found in a wide scope of adventures, with the principle constraints on their usage basically coming about due to the segments of the items to be transported or spatial thoughts. Various employments of AGVs are really feasible, yet the purchase and execution of such systems is for the most part established on money related examinations. In an ordinary conveyance community, human prosperity administers the productivity. The AGV is uncommonly versatile in light of remote correspondence. Its ability to talk with various autonomous vehicles gives a predictable action. Persevering coordination between vehicles passes on money saving viability. The introduction of unmanned vehicles onto a stockroom floor effects influences security. With the guide of natural sensors, the AGV can recognize inquiries in its accident way. Computerization abstains from vehicle car over-burdens and their potential for disasters.

In general, all the products are produced for the specific applications that have to be useful. All the products are created by the fundamental material. That material is known as „Raw material“. Without raw materials, there are no products [1]. These raw materials maybe different kinds based on applications. These raw materials are converted into useful products by the industries. There are lots of labors or workers for machining these raw materials. Also, there are many workers used for transporting these materials [2]. There are many rooms such as storehouse or warehouse, different workshops, and also some inventories for holding or carrying the finished or partly finished goods [3]. A lot of workers cause the high labor cost for the owner of the industry. Some workers have to work there for machining these raw materials that are inevitable [4].

But many workers used for transporting should be avoided because it reduces the

labor cost. The proposed project may be useful for transporting materials from one place to another place without human intervention [5].

The proposed project is made simple and efficient one by introducing Automation there. The traditional process of transporting the raw materials as well as finished products involves at least 2 or 3 workers in that field. Because one person should take the materials from the storehouse and then another person should load this material to the vehicle which carries that materials and another person should drive the vehicle to the appropriate places such as Lathe section, Cutting section, Drilling section, Milling section, Painting section, Assembly section, Cleaning section etc. So the manual method of having many processes involving human and takes large time and also sometimes accident occurs due to carelessness and distractions in the human mind [6]. This is not a cup of cake for everyone. Hence new entrepreneurs will not take up this business. Henceforth, the primary intention of this research work is to automate the material handling process using low-cost automation techniques. To design and fabricate a low-cost Unmanned Guided Vehicle (UGV) for material handling in industries for handling both the raw materials and the finished goods with the help of Robotic Arm with Gripper at its ends by using Arduino UNO R3 controller [7]

1.2 MANUAL HANDLING TECHNIQUE

In manual handling technique, all the materials are carried and transported solemnly by the workers and not using any vehicle for carrying those materials. This method is the very ancient method for material handling in the world. This method prevails still in the small industries such as fireworks, match boxes industries etc. and also this method costs high due to lots of humans are required for handling those materials are heavy and a lot if any. [8]

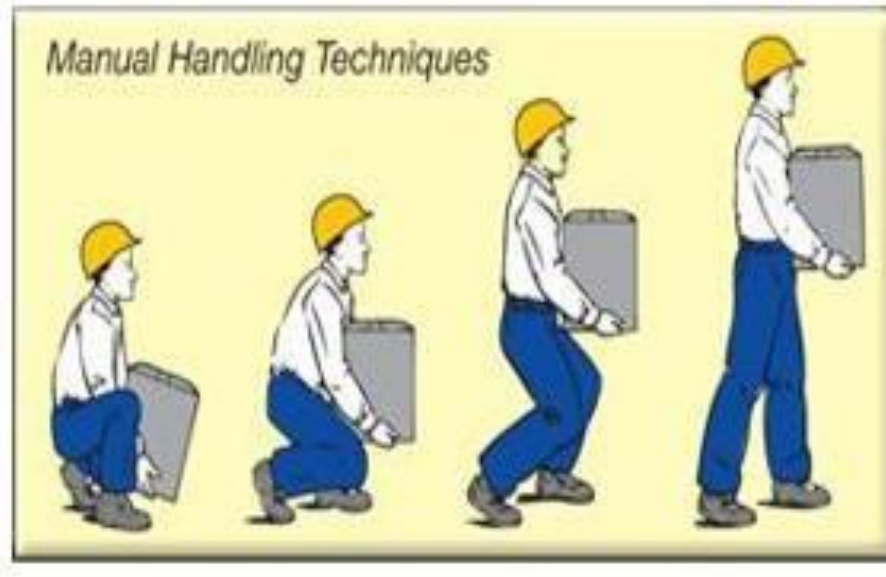


Fig.11: Manually Handling Technique [8]

1.2.1 Manual cart(Transporter)Technique

Manual cart technique possesses an approach in which materials are taken out from the storehouse with the help of humans and then they place these materials in the vehicle which carries and transports it to the destination such as work shop set. One transporter who drives the vehicle which carries the materials that has to be machined. If he lose his control, it leads to an accident.[9]



Fig 1.2: Manual cart(Transporter)technique [9]

1.2.2 Forklift & Conveyor technique

These techniques involve some lift or crane type mechanism for lifting the products which are bigger in sizes and does not carry the human. This method is mostly used in Automotive and automobile industries such Audi, Ferrari, Lamborghini industries, particularly in the lifting of the engine components such as engine head, the whole crank case, flywheel and hood of the vehicle and more are lifted by implementing this way of procedure. [10]



Fig.1.3: .Fork Lift & Conveyor Technique [10]

And also this technique not only lifts the materials but also transports it to its next section. But this forklift method used in the only vast area in industries and also it is an expensive one. By analyzing the existing methods instigated in material handling, the following drawback have been identified as follows:

- The existing system takes more time to lift the materials that have to be machined.
- It involves many human labors which in turn results that high labor cost.

1.3 ENACTMENT OF PROPOSED METHOD

The proposed system entirely focused on, to reduce the humans for materials handling. The primary motto is to automate the entire material handling process. The process is automated by using sensors and actuator connected to Arduino UNO R3 controller. This proposed work is not only picking or lifts the raw materials from the storehouse but also transports to the other sections and drops there and also again picks the finished or semi-finished good from the workshop to other painting section or any. This research is mainly concentrated on the requirement of small and medium scale enterprises, to offer them with high reliability, high efficiency and the most important efficiency and less time consumption.

1.4 AUTOMATED GUIDED VEHICLE

An automated guided vehicle or automatic guided vehicle (AGV) is a mobile robot that follows markers or wires in the floor, or uses vision or lasers. They are most often used in industrial applications to move materials around a manufacturing facility or a warehouse. Automated guided vehicles increase efficiency and reduce costs by helping to automate a manufacturing facility or warehouse. The AGV can tow objects behind them in trailers to which they can autonomously attach. The trailers can be used to move raw materials or finished product. The AGV can also store objects on a bed. The objects can be placed on a set of conveyor and then pushed off by reversing them. Some AGVs use forklifts to lift objects for storage. AGVs are employed in nearly every industry, including, pulp, paper, metals, newspaper, and general manufacturing. Transporting materials such as food, linen or medicine in hospitals is also done. An AGV can also be called a laser guided vehicle (LGV) or self-guided vehicle (SGV). Lower cost versions of AGVs are often called Automated Guided Carts (AGCs) and are usually guided by specific lines magnetic tape. AGCs are available in a variety of models and can be used to move products on an assembly line, transport goods throughout a plant or warehouse, and deliver loads to and from stretch wrappers and

roller conveyors. AGV applications are seemingly endless as capacities can range from just a few kgs to hundreds of tons. The Aim of the project is to design and fabricate such a AGV There are many definitions of AGVs, different according to points of view. Wikipedia, the free encyclopedia, defines AGVs as: “A robot that been used highly in industrial applications to move materials from point to point”

The American Society of Safety Engineers (ASSE) defined AGVs as: a. Machines without drivers that can move along pre-programmed routes, or use sensory and navigation devices to find their own way around. b. Vehicles that are equipped with automatic guidance systems and are capable of following prescribed paths. Or Driverless vehicles that are programmed to follow guide path

1.5 APPLICATIONS FOR AGVS

Automated guided vehicle systems are used for tasks that would typically be handled by forklifts, conveyor systems or manual carts, moving large volumes of material in a repetitive manner.

AGVs are used in a variety of applications. They're often used for transporting raw materials such as metal, plastic, rubber or paper. For example, AGVs can transport raw materials from receiving to the warehouse or deliver materials directly to production lines. AGVs consistently and reliably deliver raw materials needed without human intervention, ensuring that production lines always have the materials they need without interruption.

In addition to transporting raw materials, AGVs are used in work-in-process applications and with finished goods to support production or manufacturing lines. According to Investopedia, the term work-in-process describes “partially completed goods, which are typically turned from raw material to finished product in a short period of time,” such as manufactured goods. In work-in-process applications, AGVs move materials or parts from the warehouse to production lines or from one workstation to another, providing

repetitive and efficient movement of materials throughout the manufacturing process. Without AGVs, manufacturing processes may come to a halt when processing lines run out of materials. Manufacturing is then delayed while a human worker retrieves the necessary materials from storage and transports them to the production line.

AGVs are also used in inbound and outbound handling for replenishment and for picking. For example, AGVs may be used to transport inventory from receiving to storage locations or from long-term storage locations to forward picking locations to replenish stock. Moving inventory from long-term storage to forward picking locations ensures that adequate inventory is accessible to pickers, making the order picking process more efficient. AGVs such as collaborative mobile robots assist in the picking process by guiding warehouse associates through tasks and transporting picked orders to packaging and shipping workstations.

1.6 AUTOMATED GUIDED VEHICLE BUILT WORLDWIDE

Some of the Automated Guided Vehicles (AGVs) that are well known are discussed in brief.

1.6.1 Mobile Post Distribution System (Mops)

MOPS or Mobile Post Distribution System (Tschichold, Vestli, Schweitzer, 1999) is a research AGV developed at the Institute of Robotics in Zurich, Switzerland. It is used to transport mail around the Swiss Federal Institute of Technology in Zurich. MOPS is powered up by rechargeable batteries which give it a 4-hour active life, weighs around 90kg and can carry up to 50 kg of postal payload. It is also capable of hot-swapping its own batteries pack, thus ensuring 24h availability.

The MOPS provide services of picking up boxes with incoming mail at the ground floor of the five floor building, which is sorted by human first, delivering them to the secretaries' offices, subsequently bringing back the outgoing mail to the ground floor station. It is also capable of switching floors by sending an infrared signal to the building's lifts. As the building is open to the public, protection against

theft of the mail is provided by motorized blinds over the pigeon-hole mail points, which can be opened by the robot and by authorized staff.

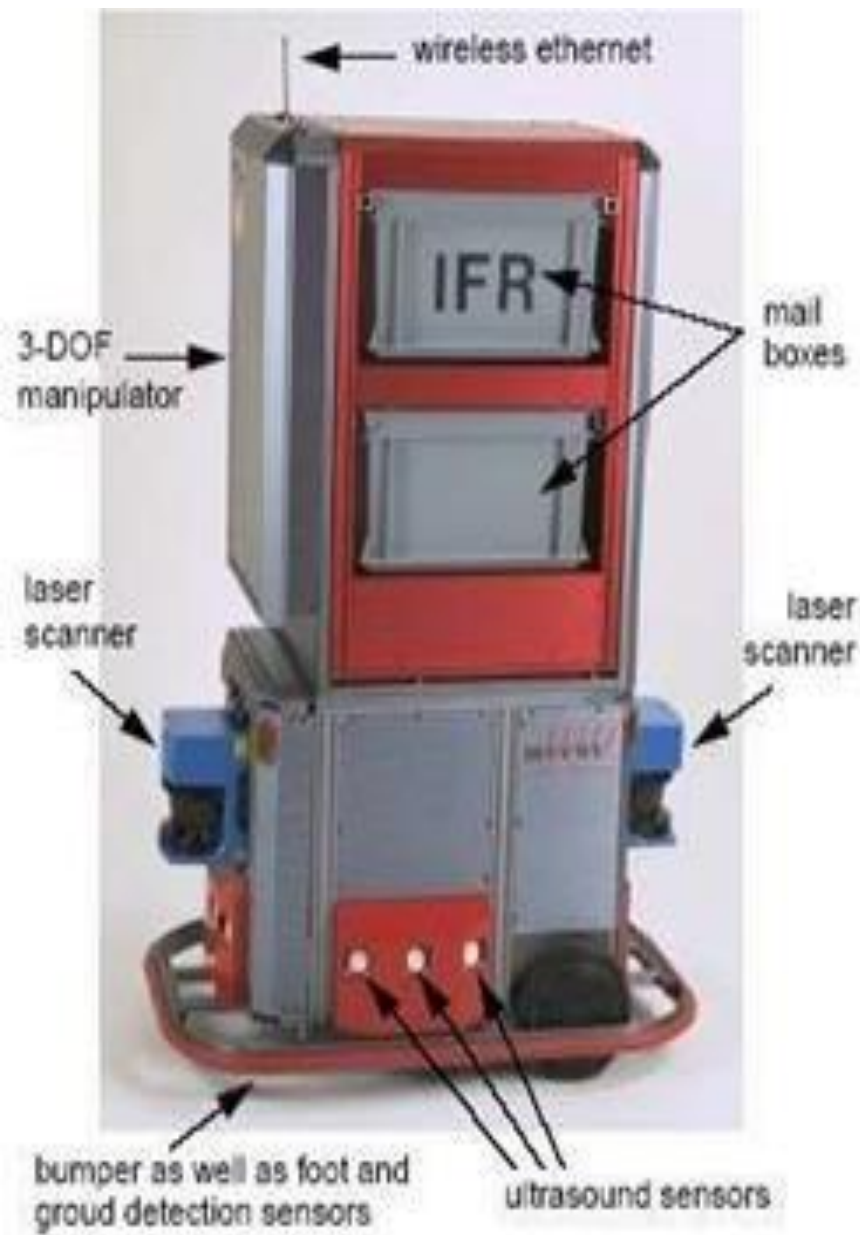


Fig 1.4: The Mobile Post System MOPS

1.6.2 Park shuttle AGV's of Amsterdam's Schiphol Airport



Fig 1.5: The Park Shuttle AGVs of Amsterdam's Schiphol Airport.

The Park Shuttle (FROG Navigation Systems) is an automatic navigating vehicle which provides transportation for passengers. It is a people mover system. There is no driver onboard, instead a computer and an electronic navigation system do the driving. This Park Shuttle has a safety system of sensitive and intelligent sensors. The sensors scan the area in front of the vehicle and will decelerate or stop the vehicle when an unknown obstacle is detected.

An additional safety feature is provided by the bumper system that brings the vehicle to an immediate halt when it is impressed. In addition, the vehicle has emergency stop buttons (both inside and outside) that can be operated by the passengers. The speed is limited to 40 km/h obtain a good ride quality. 8 The Park Shuttle vehicle runs on four rubber tires. Traction is provided by an electric motor powered by a rechargeable battery. Up to 100 km can be covered on one

battery-load. It has a capacity of 10 passengers, 6 seated and 4 standees. It is easy to get into and out of the vehicle (wheelchair accessible) and provides good all-round visibility. Inside the vehicle is a console on which the passengers can indicate their destination.

Each vehicle is also fitted with an information display that announces the stop at which the vehicle has arrived. The maximum load is 800 kg. The maximum vehicle weight is monitored by means of weight sensor.

1.6.3 Line Following Robot

Line following robot is generally a wheeled mobile robot. The method of line following varied depending on the number of sensors available and the type of line to be followed. There are four methods identified including edge following, line search, line trap, and cross- over. These four methods are different in number of sensors that used and also the results that will be obtained are different. With only one light sensor, the robot will have to know where the line is, or spends time searching to find it. Whereas with two light sensors, the robot is possible to remember which direction the line went. With more sensors, the result that will be obtained would be more excellent and the robot will be more intelligent.

Table 1.1 Line Following Method

Method	Characteristics
Edge following	Stay on the edge of the line
Line search	Stay on the line
Line trap	Keep the line between the sensors
Cross over	Move back and forth over the line

1.6.4 Kerwin's Line Following Robot

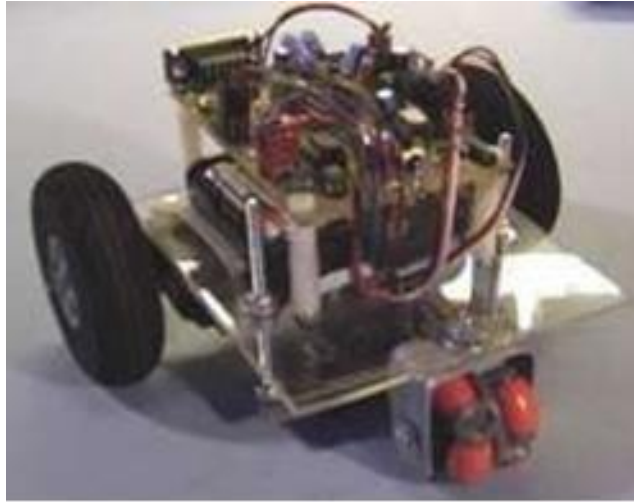


Fig 1.6: The Kerwin's line following robot using three matched IR transmit/receive pairs

The Kerwin's line following robot (ranch bots) is a design with Futaba S-148 servo motors mounted to the bottom of the plexiglass. It has three wheels with the front wheel is the omni-directional wheel. The sensor system consists of an array of three matched IR transmit/receive pairs mounted on a circuit board that can be raised or lowered to fine tune the sensitivity. It uses the Atmel microcontroller as the controller part. The microcontroller takes input from sensor array and drives the servo motors in response.

1.7 HOW AGVS WORK

AGVs are self-propelled vehicles with movement guided by software and sensors. Most AGVs move along defined pathways, but as mentioned, AMRs typically have more advanced technology with dynamic navigation capabilities.



Fig.1.7: How AGV Working

1.7.1 AGV navigation

AGV navigation may be guided using one or more of the following mechanisms:

- Magnetic guide tape — some AGVs have magnetic sensors and follow a track using magnetic tape.
- Wired navigation — some AGVs follow wire paths embedded into the facility floor. The wire transmits a signal that AGVs detect via an antenna or sensor.
- Laser target navigation — with this method, reflective tape is mounted on objects such as walls, fixed machines and poles. AGVs are equipped with a laser transmitter and receiver. The lasers reflect off of the tape within the line of sight and used to calculate the object's angle and distance from the AGV.
- Inertial (gyroscopic) navigation — some AGVs are controlled by a computer system with the aid of transponders embedded into the facility floor to verify that the AGV is on the proper course.

- Vision guidance — No modification is required to the infrastructure for vision-guided AGVs. Cameras record the features along the route, and AGVs rely on these recorded features to navigate.
- Geo Guidance — Like vision-guided AGVs, no infrastructure modifications are required for AGVs that use geo guidance. Geo guided AGVs recognize objects in their environment to establish their location in real-time to navigate throughout the facility.
- LiDAR — LiDAR (Light Detection and Ranging) is a sophisticated navigation technology utilizing sensors that transmit laser pulses to measure the distance between the robot and objects in its environment. This data is compiled to create a 360-degree map of the environment, allowing robots to navigate the facility and avoid obstacles without the need for any additional infrastructure. 6 River Systems uses LiDAR navigation technology to enable their AGVs to navigate a warehouse without requiring changes to infrastructure as well as to adapt to new environments should the layout of a warehouse floor change.

1.7.2 AGV steering

AGV steering is controlled by differential speed control, steered wheel control or a combination of the two:

- Differential speed control — This is the most common type of steering control used by AGVs. Differential speed control uses two independent drive wheels. Each drive wheel is driven at a different speed to turn. To go forward or backwards, the two drives are driven at the same speed. The simplest steering control option for AGVs, differential speed control doesn't require additional steering motors or mechanisms. It is commonly used for AGVs that operate in tight spaces or for those that operate near machines. It is not used for towing applications, as it can cause a trailer to jackknife while turning.
- Steered wheel control — This type of steering control is similar to the steering control in a car or truck. In steered wheel control, the drive wheel is the turning wheel. Steered wheel control is more precise than differential speed control and

offers smoother turning. It is often used for towing applications and may also be operator-controlled.

- **Combination steering** — This is a combination of differential speed control and steered wheel control. AGVs using combination steering have two independent steer/drive motors on diagonal corners of the AGV and swiveling castors on the other two corners. AGVs using combination steering can turn in any direction like a car and also drive in differential steering mode in any direction.

1.7.3 AGV traffic control

Traffic control measures include zone control, collision avoidance or a mix of both:

- **Zone control** — Simple to install and easy to expand, zone control is a commonly used traffic control method for AGVs. A wireless transmitter transmits signals in defined areas, and the AGV contains a sensor that receives the signal and transmits it back to the transmitter. If the area is clear, a “clear” signal is sent that allows the AGV to enter or pass through the area. If another AGV is in the area, a “stop” signal is sent that alerts other AGVs attempting to enter that the area is not clear. In this case, the waiting AGVs will stop and wait until the first AGV moves out of the zone and a “clear” signal is sent by the transmitter. Another way zone control can be used is by equipping each AGV with its own transmitter, allowing it to send a “do not enter” signal to other AGVs approaching the zone.
- **Collision avoidance** — AGVs using collision avoidance zone control are equipped with sensors that transmit a signal and wait for a reply to determine if an object is in front of it. These sensors may be sonic, which work like radar, or optical, which uses infrared sensors. Both work in a similar manner. Bumper sensors are another type of collision avoidance sensor. Many AGVs are equipped with bumper sensors as a fail-safe. Bumper sensors stop to avoid a collision when they sense physical contact.
- **Combination control** — AGVs that use combination control are equipped with both collision control sensors and zone control sensors in order to offer more robust collision prevention in all situations. For instance, an AGV may use zone control as

its primary traffic control system but also have collision avoidance sensors as a backup in case the zone control system malfunctions.

1.8 BENEFITS OF AGVS

AGVs offer numerous benefits in warehousing and manufacturing.

1.8.1 Increase efficiency and productivity

Because they operate autonomously, AGVs increase efficiency and productivity, and they're predictable and reliable for repetitive tasks. AGVs eliminate unnecessary walking and also eliminate the physical labor of transporting materials. They set the pace for workers, as well, keeping associates on-task. AGVs like collaborative mobile robots guide associates through each task, reducing human error, which helps to improve order picking accuracy and minimize loss and misplaced products. By leveraging AI to optimize routes and prioritize work, collaborative mobile robots improve resource utilization.

1.8.2 Consistent costs

AGVs are typically acquired on a per unit or per rental period cost basis, so there's less fluctuation in costs compared to human labor, which can fluctuate based on market conditions and demand.

1.8.3 Flexibility

Some AGVs offer the flexibility of easily changing routes (compared to others which require re-routing guide wires or other infrastructure to adjust a vehicle's route).

Automated guided vehicles are a scalable solution, as well, with the ability to add additional units based on demand.

1.8.4 Less space required

Compared to other automation solutions, such as conveyor systems, AGVs require less space. Some AGVs are smaller compared to traditional warehouse equipment, such as forklifts, which allows for floor layouts with narrower aisles and better space utilization.

1.8.5 Improved safety

Finally, AGVs are a safe automation solution for warehouses, distribution centers and manufacturing facilities. AGVs are equipped with sensors to avoid collisions. Advanced AGVs like AMRs have intelligent routing capabilities that enable them to plan the most efficient path through a warehouse or facility, reducing aisle congestion and preventing injuries.

Automated guided vehicles are uniquely designed to automate tasks for which humans are not necessary. They automate long walks in warehouses, set the pace for workers, and eliminate the physical rigors of a traditionally physically demanding job. Chuck by 6 River Systems is a flexible, scalable and cost-effective solution for warehouses and distribution centers offering innovative technology designed to tackle some of warehousing's biggest challenges.

Is your operation ready for AGVs? Consult this IDC study to assess your warehouse or fulfillment center's maturity level. We can also discuss the solution that's right for you. Contact us today.

1.9 PROBLEM STATEMENT

There are many reasons which yield to the creation of Automated Guided Vehicle (AGV) around the world. Mostly the reason is to overcome the logistic problems that often occurred in the workplaces and to make improvement to the facilities provided in the workplaces. Usually the AGVs are implemented in factories, hospitals, offices,

houses, and even can be found anywhere outdoors without the people surround realized it.

In the industries or factories, the AGVs can ease the physical strain on human workers by performing tiring tasks, such as lifting and carrying heavy materials, more efficiently with no signs of fatigue creeping in. They can carry far more than human workers, and their movements can be tracked electronically at all times. Their movements can be timed to feed or collect products or materials from the work cells in the factories. Besides that, in the hospitals thousands of staff spends a portion of their day moving medical supplies, bedding, medicines and other equipment around large hospitals. By using the AGVs, the strain on the workers can be ease as well as the hospital's system would be more smart and systematic without any bad complaint from the patients and people. AGVs also capable of both cutting cost and releasing more staff hours to tend and care for patients. Therefore it is very significant that the valuable knowledge on AGV construction is studied and be further implemented from the result of this project. It is due to its advantages to our own living and technology. We have pleasure in introducing our project AGV, which is equipped by microcontroller, motor driving mechanism, lift mechanism and battery. The power stored in the battery is used to drive the DC motor that causes the movement as well as lifting power to AGV. Battery assembled on the AGV is easily replaceable and detachable, used for recharging the battery, while the AGV is under roof.

1.10 PROJECT AND ITS SCOPE

The objective and scope of this project is to create an AGV model that can follow a trail of line on a flat surface horizontally. This AGV model is using microcontroller to control all navigation and lifting functions during its operation. In other words, the microcontroller acts just like the brain for the model that controls all operation of the system. The model is a three-wheeled mobile robot that has the ability to follow line on floor. There are three wheels including two driving wheels controlled by two motors and a free wheel in front that is able to rotate 360°. With three wheels, both driving wheels

are always in contact with the surface, because of the robot's steering relies on both its driven wheels being in contact with the surface at all times. This project consists of four main stages, which are theoretical design, mechanical fabrication, electronic hardware design and as well as algorithm design in assembly language. The matter to be considered is how the robot can follow the trail of line continuously. It is also important to choose the most suitable microcontroller, actuators, and sensors to achieve the project objectives.

1.11 MARKET SURVEY

A market survey is an important requirement for initiating any successful business. The objective of a market survey is to collect information on various aspects of the business. This survey is a tool through which we can minimize risk. After the market survey, the results must be analyzed in order to finalize a business plan. We are implementing automatic guided vehicle, which replaces the normal transporting methods. So that we want to consider all the sections related to this work such as problems arising while installing. So we conducted a market survey by personnel interview techniques was used with the measure emphasis on personal interview method. Interviews were conducted through the structure questionnaire, Also we go through people who work in large industries such as production plant, supply station etc. The following questions are mainly taken for questionnaire: Area of applications? i.e. inside/outside/both Types surface of flooring? Weights of loads max? Distance to transportation? From the data which we got from the market survey we are well know about the things what the market needed, and what modifications should be taken to the system. And we analysis the data and make objectives want to goal

CHAPTER-II

LITERATURE REVIEW

Automatic Guided Vehicles (AGVs) have played a vital role in moving material and product for more than 50 years. The first AGV system was built and introduced in 1953. It was a modified towing tractor that was used to pull a trailer and follow an overhead wire in a grocery warehouse. By the late 1950's and early 1960's, towing AGVs were in operation in many types of factories and warehouses.

The first big development for the AGV industry was the introduction of a unit load vehicle in the mid 1970s. This unit load AGVs gained widespread acceptance in the material handling marketplace because of their ability to serve several functions; a work platform, a transportation device and a link in the control and information system for the factory.

Since then, AGVs have evolved into complex material-handling transport vehicles ranging from mail handling AGVs to highly automated automatic trailer loading AGVs using laser and natural target navigation technologies. In fact the improvement of AGVs over the last decade is deeply indebted to development of Scheduling, Algorithm and Steering methods. The problem of scheduling of AGVs and the other supporting equipment has been extensively studied by Basnet and Mize and Racham and Steck e currently providing the most up-to-date and comprehensive reviews in this area.

Han and McGinnis have developed a real time algorithm in which material handling transporters are considered. Schriber and Steck e have shown how the additional consideration of the material handling system and limited buffers degrades the system performance. Sabuncuoglu and Hommertzheim have highlighted the importance of material handling and they compared several AGV dispatching rules. They have also shown how the buffer capacity can affect the performance of the system. Flexibility, which is a distinguishing feature of FMSs, has received an extensive amount of attention. Routing flexibility (i.e., alternative machines and processing routes) has been considered by Wilhelm and Shin,

Chen and Chung, and Khoshnevis and Chen . These studies have indicated that dynamic routing (i.e., a path determined dynamically during schedule generation) performs better than a preplanned routing.

Rachamadugu et al. Have proposed a quantitative measure of sequence flexibility and have shown that perfect sequence Flexibility improves system performance. Similar observations have been made by Lin and Solberg. In most work to date, tools, pallets/fixtures and their availability are not modeled adequately. A static allocation of tools is usually assumed in these studies.

However, some researchers have considered a limited tool magazine capacity and the changing of tools from central tool storage. One purpose of this thesis is to develop an algorithm that can be used to investigate the research issues discussed above. This algorithm should not only consider the major elements of FMSs but also generate high quality schedules in a reasonable amount of time. In this thesis, the basic structure and characteristics of such an algorithm is described.

Kim et al. Proposed a deadlock detection and prevention algorithms for AGVs. It was assumed that vehicles reserve grid blocks in advance to prevent collisions and deadlocks among AGVs. A graphic representation method, called the "reservation graph," was proposed to express a reservation schedule in such a form that the possibility of a deadlock can be easily detected. A method to detect possible deadlocks by using the reservation graph was suggested.

Maxwell and Muckstadt first introduced the problem of AGV flow system design. While their main concern is vehicle routing, they also address material flow path and station location design issues. The flow network they used, known as conventional configuration, is composed of unidirectional arcs. Gaskin and Tanchoco developed the first integer programming model for material flow path design. Given a fixed network of aisles and fixed pickup and delivery stations, the

model assigns direction to arcs to minimize the total trip distances of loaded vehicles. Goetz and Egbelu developed an alternative model, where the station locations no longer are fixed but restricted to the nodes on the boundary of the cells. Sun and Tchernev provide a comprehensive review on the models developed for conventional configuration.

Afentakis states the advantages of the loop layout as simplicity and efficiency, low initial and expansion costs, and product and processing flexibility. Loop layout has been studied by many researchers including Bartholdi and Platzman , Sharp and Liu ,Kouvelis and

Kim , Egbelu , Banerjee and Zhou , and Chang and Egbelu. Bozer and Srinivasan initiate the concept of tandem configuration as a set of no overlapping, bidirectional loops, each with a single vehicle.

Another problem in steering issues is to schedule several AGVs in a non-conflicting manner which is a complicated real-time problem, especially when the AGV system is bi- directional. In fact, many conflicting situations may arise such as head-on and catching-up conflicts when the AGVs or the guide-paths are bidirectional and if no efficient control policy is used to prevent them. Several conflict-free routing strategies have been proposed and can be classified into two categories:

- ✓ Predictive methods: Aim to find an optimal path for AGVs. The conflicts are predicted off-line, and an AGV's route is planned to avoid collisions and deadlocks.
- ✓ Reactive methods: the AGVs are not planned and the decisions are taken in a real- time manner according to the system state.

These methods are based on a zone division of the guide-path and consider them as non-sharable resources. Predictive methods give good performance, but are not very robust since they do not take into account real time problems. However, reactive methods are very robust but the resulting performances can be poor because the decisions are taken by considering a very short-term time horizon. In this report due

to specification of the whole plan (presence of only one AGV) a kind of predictive method is proposed.

In early 1990s Fuzzy logic came through to control and manipulate whole of the material flow in manufacturing floors. The main indication of employing this system on AGVs was the ability of controlling multiple AGV in a same time without collision. However, only simulation results are presented. Senoo et al used experimental results of a three wheeled mobile robot to discuss the stability of a fuzzy controller. It is also stated that fuzzy control was implemented in order to achieve reduction of steer energy, while maintaining better steer angle when compared with PI control.

Fuzzy logic has found useful applications in control among other areas. One useful characteristic of a fuzzy controller is its applicability to systems with model uncertainty and/or unknown models. Another useful characteristic of a fuzzy logic controller is that it provides a framework for the incorporation of domain knowledge in terms of heuristic rules.

Wuwei et al. They presented the new navigation method for AGV with fuzzy neural network controller when in the presence of obstacles. Their AGV can avoid the dynamic and static obstacle and reach the target safely and reliably.

Wu et al. used fuzzy logic control and artificial potential field (APF) for AGV navigation. The APF method is used to calculate the repulsive force between the vehicle and the closest obstacle and the attractive force generated by the goal. A fuzzy logic controller is used to modify the direction of the AGV in a way to avoid the obstacle. Lin and Wang proposed a fuzzy logic controller for collision avoidance for AGV.

They combined fuzzy logic with crisp reasoning to guide an AGV to get out of trap since memories of path and crisp sequence flows are handled by non-fuzzy processing. Their designed AGV was able to avoid collision with unknown

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obstacle. Alves and Junior used a step motor to turn the direction of the ultra-sonic sensors, so that each sensor can substitute two or more sensors in mobile robot navigation. Perhaps Sugeno has done one of the pioneering researches in mobile robot navigation using fuzzy logic control. The fuzzy control rules, which he defines for the controller, were derived by modeling an expert driving action. He made a computer model of a car in microcomputer to find fuzzy rules. The speed of the designed car was constant; then, the control input to the car is only the angle of the steering angle

Mehdi Yahyaei has design a AGV using fuzzy logic system and a rotational ultra sonic sensor to steer the AGV to avoid collisions and obstacles. He also employed a programmable logic control (PLC) as the processor which makes the AGV to be ultimately fitto the industrial environments.

The first Automated Guided Vehicle was acquaint with the world in 1950s and the first large advancement for the AGV business was the presentation of a unit load vehicle in the mid 1970's. Suman Kumar Das, M.K. Passan Right now kinds of aides methods for AGV's are examined. The sorts are Wire Guided Vehicle, Magnetic Guided Vehicle, Rail Guided Vehicle and Laser Guided Vehicle. In Wire Guided Vehicles wires are simply utilized for the transmission of radio sign to direct the vehicle along the way chose. A space is sliced in to the floor and a wire is put around 1 inch underneath the surface. This space is cut along the way the AGV is to follow. This wire is utilized to transmit a radio sign. A sensor is introduced on the base of the AGV near the ground. The sensor distinguishes the overall situation of the radio sign being transmitted from the wire. This data is utilized to direct the controlling circuit, causing the AGV to follow the wire.

Hee-Woon, et al Right now recognition and situating is proposed. AGV ought to explore the way accurately which is requested by the administrator, and it ought to likewise maintain a strategic distance from the obstructions coming in the middle of for example in a distribution center if a laborer goes over the way of AGV, it ought not slam into the specialist, it is possible that it should pass by the specialist by finding another way breaking down the encompassing or it should stop for some

time and hold up until the laborer passes. Now and again a minimal effort camera is added to catch the ongoing pictures to figure out the encompassing to keep away from crashes. By the blend of profundity data from the picture taken by the camera and 2D facilitate framework would be useful to ascertain the constant separation along AGV's, gear and articles precisely to decrease position mistake. Lothar Schulze, Sebastian Behling and Stefan Buhrs Right now improvements and consequences of research are examined. Segments of AGV are vehicle, stationary control framework, fringe framework parts and on location framework segments. Vehicle is the fundamental control component of the AGV and plays out the real transportation task which is requested. Stationary control framework is the organization of transportation request. Enhancement of calendars and the board of multi AGV framework is overseen by stationary control framework. Fringe framework parts speak to the partner to different on board gear of the vehicle, for example battery stacking stations and burden move systems. On location framework parts are the parts of the site's basic plan that affects the AGV, for example the ground, doors, lift, etc.

Himanshu Dudeja, et al, Right now sensors and their working is clarified. The fundamental sensors of AGV are attractive guide sensors, normally known as MGS1600 and Motor controller sensors known as FBL2360 and 2CHBLDC. The MGS1600 is an attractive guide sensor fit for recognizing and revealing the situation of attractive field along its flat hub. The sensor is proposed for line following automated applications utilizing an attractive tape to shape a track direct on the floor. FBL2360 has various wellbeing highlights which are joined into the controller to guarantee solid and safe activity.

CHAPTER-III

AIM AND SCOPE

AIM

In our project we are eliminating the need of man power in travelling and moving heavy objects in industries. For this purpose, we are designing Automated Guided Vehicle controlled by microprocessor controller. In this busy 21st century people need all their work to be automated and manpower free. To avoid this type of problems and reduce manpower requirement we need other type of automation is called automatic guided Vehicle. The microcontroller is used to control the vehicle path automatically as assigned. The rechargeable battery is supplying power to the automated guided vehicle. The vehicle is capable of carrying weights according to its size.

OBJECTIVE

- The main objective of this project is to design and prototype of an AGVs model with two driving wheels and two free wheels, infrared sensors, microcontroller, etc that has the ability to follow line on the floor with the help of microcontroller for material handling.
- To follow the line, the microcontroller is attached to infrared sensors that continuously reflect to the surface condition to avoid obstacles in the path and then the microcontroller gives the commands to the gear motor so that the vehicle can move accordingly.
- The minimum number of gear motor allows the AGV to minimize the power. Therefore, AGV is the future of material handling in the industry.

CHAPTER-IV

MATERIALS AND METHODS

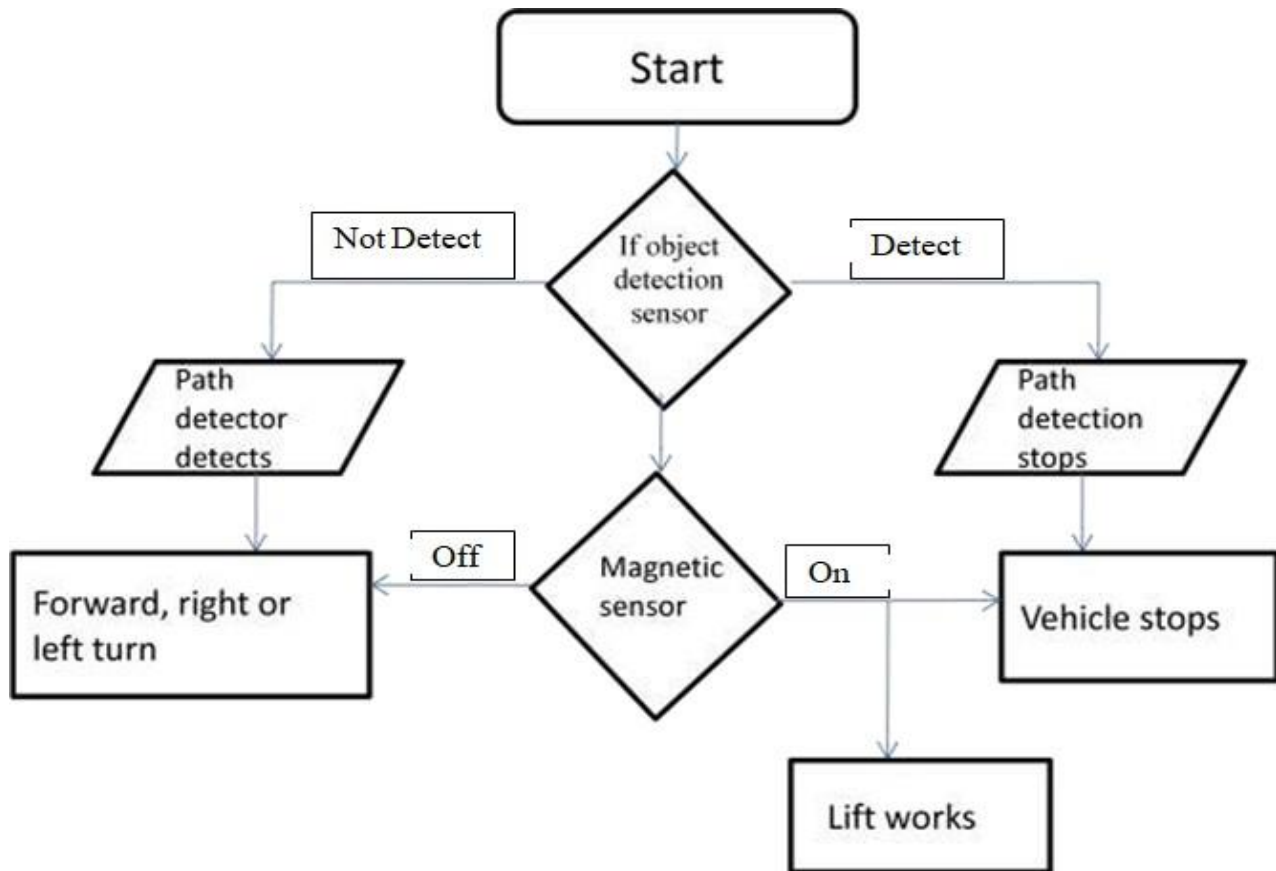


Fig. 4.1: Methodology

4.1 DESIGN OBJECTIVES

In nowadays AGV has a greater influence in the production field. Why we prefer this system is mainly because of its accuracy to transport goods, avoiding accidents at industrial zone, decreasing production overall cost etc.

In our project the important factor is that, we give an additional functions to AGV, i.e. we provide a lifting mechanism to take loads from station to station. The

lift will actuate at those particular stations using sensors. Also we provide a sensor which detects the objects in the paths to avoid collision with those objects, by stopping the vehicle and moves after the when object leaves the path.

4.2 DESIGN CONSIDERATIONS

In design problems many decision variables arise. The impact of decisions on mutual interactions and performance might be difficult to predict. It might be hard to decide on one thing without considering other decision variables. At least the following tactical and operational issues have to be addressed in designing an AGV system

- Flow path layout
- Traffic management: prediction and avoidance of collisions and deadlocks
- Number and location of pick-up and delivery points
- Vehicle requirements
- Vehicle routing
- Vehicle scheduling
- Battery management

A flow path layout compromises the fixed guided paths on which vehicles can travel to the various pick-up and delivery points of loads. Traffic management is required to avoid collisions and deadlock situations in which two or more vehicles are blocked completely. To ensure that loads are transported in time, sufficient vehicles should be available and the right vehicle should be dispatched to the right load.

This layout is usually represented by a directed network in which aisles intersections and pickup and delivery locations can be considered as nodes. The arcs represent the guide path the AGVs can travel on. Directed arcs indicate the direction of travel of vehicles in the system. The layout of this flow path directly influences the performance of the system. In our project we just mark two stations only. One loading and one unloading station. The carrier moves in the loop which connects these two stations.

In controlling and designing AGV systems the problem of prevention of AGV collisions and deadlocks should be addressed. By attaching sensors on AGVs, physical collisions can be avoided. An AGV should have the ability to avoid obstacles and the ability to return to its original path without any collisions. We had fabricated only one AGV. So the traffic management has only less important in our case. But while using more than one carrier we should take care about them.

To determine an optimal AGV's system, capable of meeting all requirements, many factors have to be taken into account. Several of these factors are:

- Number of units to be transported
- Points in time at which units can be or need to be transported
- Capacity of the vehicle
- Speed of the vehicle
- Costs of the system
- Layout of the system and guide path
- Traffic congestion
- Vehicle dispatching strategies
- Number and location of pick-up and delivery points

If AGVs use batteries, frequent battery changing might be required. McHaney (1995) presents an overview of AGV battery technology. The time required for replacing or charging batteries can impact the number of vehicles required. Simulation results from McHaney (1995) indicate a significant increase in the number of AGVs required while incorporating battery management issues in the simulation study compared to neglecting these issues in the studies. Furthermore, the time required for charging batteries impacts throughput, congestion and costs.

4.3 COMPONENTS OF AGV

1. MECHANICAL PARTS

The Mechanical components includes,

1. Chassis
2. Steering system
3. Lift mechanism

Chassis

Act as a frame for attaching other components carry the load of other components and the payload.

Act as sacrificial component to prevent damage of expensive payload in case of accidents

Steering System

Steering system is for steering the AGV. The two individual motors are directly

attached with the wheel for steering

Lifting Mechanism

Lifting mechanism is one of the main part of AGV, the lifting surface moves upward and downward at specified stations. And carry the load during load transfer.

2. ELECTRICAL COMPONENTS

Electrical components include the motor and the power supply unit for the motor unit.

4.3 ELECTRONIC COMPONENTS

Electronic components provide sensing, logical decision and control of the vehicle. It includes microcontroller, which is the brain of the vehicle for the decision logic, the motor driver as both sensing and control of motor, regulator ICs, LCD Display unit, sensors for sensing the path, position of loading and unloading stations, detect object in the path etc.

SOFTWARE COMPONENTS

Computer is used for making and implementing program for the microcontroller, using embedded computer programming language. For this project we use Arduino Uno microcontroller board based on the ATmega328 .The Arduino Uno can be programmed with the Arduino software.

4.4 MECHANICAL PART

CHASSIS

The chassis is fabricated from Acrylic sheet. This is done for ease of fabrication, and to reduce the overall weight. It was designed in Catia; part of fabrication was

outsourced due to unavailability of precision cutting tools. The chassis was designed to take a static load of 3kg.

The Top part of chassis has lots of drilled holes which serves as holes for bolting other parts and reduce the weight of the chassis. The Holes are arranged in a zigzag linear arrangement so that the decrease in strength of chassis is not considerable.

The flange which holds the motor was designed using Aluminum and is bolted to the chassis. So that the driving motors can easily accommodate below the chassis. The chassis incorporates hole for attaching front globe wheel, and also for attaching the lift structure

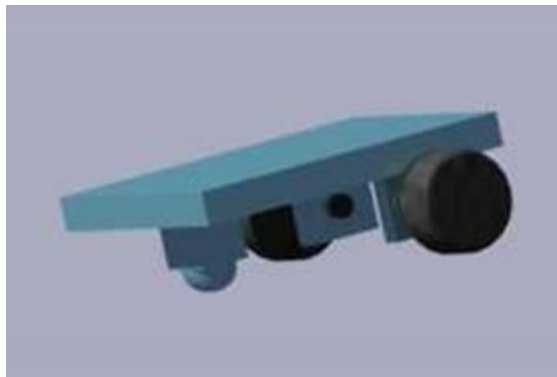


Fig 4.2: Chassis of AGV

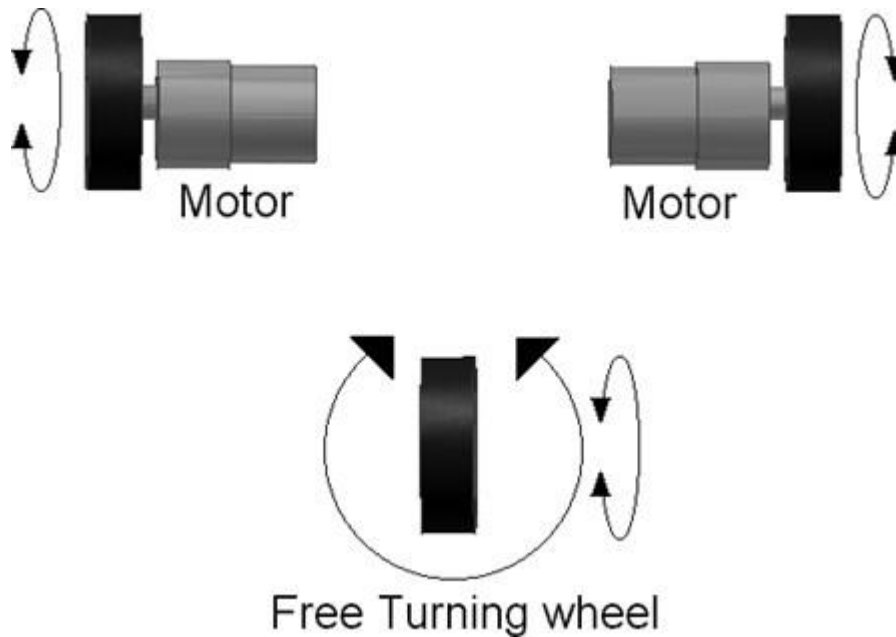
Table 4.1 Technical Data of Chassis

Features	Data
Length	300mm
Breadth	160mm
Height	62mm
Material	Colored Acrylic sheet, Aluminum
Maximum load	

4.5 STEERING SYSTEM

The steering system used in the model is of differential type. A differential wheeled vehicle is a vehicle whose movement is based on two separately driven

wheels placed on either side of the body. It can thus change its direction by varying the relative rate of rotation of its wheels and hence does not require an additional steering motion. It allows the turning center to be on the vehicle body thus the ability to rotate on the point



If both wheels rotate at the same speed and in the same direction, the robot will move in a straight line.

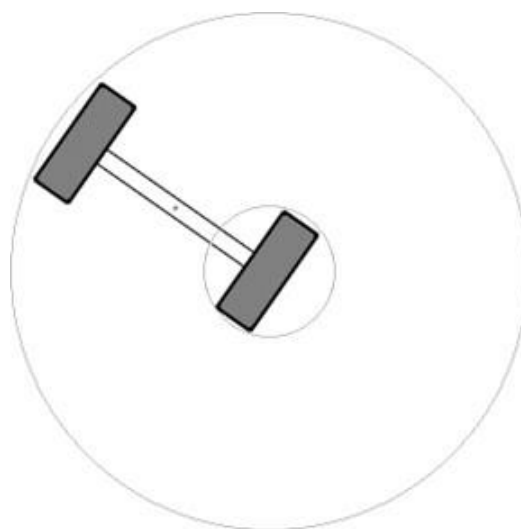


Fig 4.3: *Small radius turning*

If one of the wheels is stopped, while the other continues to rotate, the robot will pivot around a point Centre approximately at the mid-point of the stopped wheel.

Table 4.2 Steering Specifications

Feature	Data
Wheel Base	180mm
Wheel Diameter	70mm
Track Distance	170mm
Material	Rubber and plastic
Turning radius	190mm

4.5 LIFTING MECHANISM

The lift is the main component of this AGV. The lift takes and gives loads at specific stations. The vehicle under stands the stations using sensors. Lift is attached in the front portion of the chassis. The power for lift is transmitted from a motor using a threaded shaft.

The lift consists of mainly two plates. One is centrally drilled and tapped. Second plate is attached with the lower one, using bolts, at a distance. The shaft of the motor drilled axially and made internal threads using tap. Both the plates moves in between two guide ways. The threaded shaft is passed through the centrally tapped hole of lower plate.

During the rotation of shaft the lower plate moves up or down. And the upper plate moves according to it. The time for the rotation is limited for few seconds. It can be adjusted by making changes in the microcontroller program. A magnet is attached above the upper plate, which helps to hold the items to be lift, which have magnetic behavior.



Fig 4.4: *Lifting using threaded shaft*

In order to reduce the overall cost and weight of the AGV, we used acrylic sheets for the manufacturing of lifting surfaces, Aluminum C channels for the guide ways in between the plates moves are used for the fabrication.

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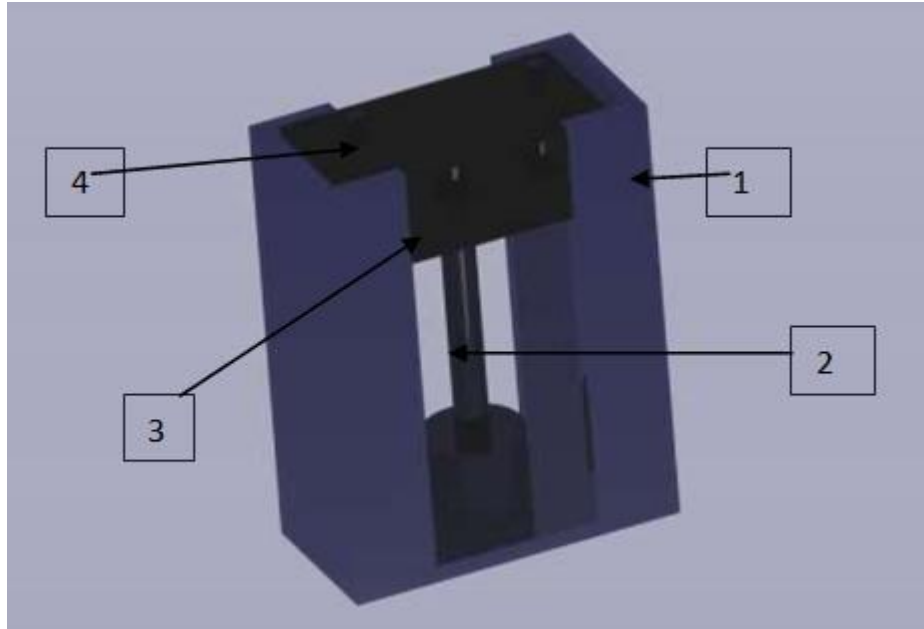


Fig 4.5: Structure of lift

1. Guide ways
2. Threaded shaft
3. Lower plate
4. Upper plate

4.6 ELECTRICAL COMPONENTS

4.6.1 DC Motor

100 RPM DC Motor with Gearbox generally used for robotic applications are used for the driving mechanism, steering mechanism and lifting mechanism. We can adjust it to desired RPM using gear box. Very easy to use. It is excellent for line tracking robotic application.



Fig 4.6: DC Motor with Gear box

Table 4.3 Motor Specifications

Feature	Data
Supply voltage	12V DC
Speed	100 RPM with gear box
Shaft Diameter	6mm
Weight	125gm
Torque	12Kgcm
No-load current	60mA(Max)
Load current	250ma(Max)

4.6.2 Battery

The power required for the entire working process is given by a Rechargeable valve Regulated Lead-Acid battery. The power from the battery is split it into two and one part is given to microcontroller, display unit, driving unit and other part is given to lifting motor.



Fig 4.7: Battery

Table 4.4 Battery Specification

Features	Data
Speed	100rpm
Voltage	12V DC
Torque	12Kg-cm
No load current	60mA
Load current	250mA

4.7 ELECTRONICS COMPONENTS

4.7.1 Microcontroller

A microcontroller (μ C, uC or MCU) is a small computer on a single integrated circuit containing a processor core, memory, and programmable input/output peripherals. Microcontrollers are designed for embedded applications, in contrast to the microprocessors used in personal computers or other general purpose applications.

We use AT mega 328 in our AGV. The Atmel®AVR® ATmega 328 is a low-power CMOS 8-bit microcontroller based on the AVR RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega8 achieves throughputs approaching 1MIPS per MHz, allowing the system designed to optimize power consumption versus processing speed.

The reasons for using ATmega 328 are:

- Low cost

- Easy to program

- High-performance, Low- power Fully Static Operation

- High Endurance Non-volatile Memory segments

- Power-on Reset and Programmable Brown-out Detection Internal

- Calibrated RC Oscillator External and Internal Interrupt

- Sources High stress value

- Five Sleep Modes: Idle, ADC Noise Reduction, Power-save, Power-down, and Standby

I/O and Packages

23 Programmable I/O Lines

28-lead PDIP, 32-lead TQFP, and 32-pad QFN/MLF

Operating Voltages

2.7V - 5.5v to 4.5V - 5.5V

The Microcontroller is programmed with the required program to accept the data from the sensing unit, interpret it, and give responses to the driving and lifting mechanism in very small time interval.

4.7.2 Motor Driver

It is an electronic circuit which enables a voltage to be applied across a load in either direction. It allows a circuit full control over a standard electric DC motor. That is, with an H- bridge, a microcontroller, logic chip, or remote control can electronically command the motor to go forward, reverse, brake, and coast.

A "double pole double throw" relay can generally achieve the same electrical functionality as an H-bridge, but an H-bridge would be preferable where a smaller physical size is needed, high-speed switching, low driving voltage, or where the wearing out of mechanical parts is undesirable. The term "H-bridge" is derived from the typical graphical representation of such a circuit, which is built with four switches, either solid-state (e.g., L293/ L298) or mechanical (e.g., relays).

In our AGV we use the driver IC L293d. There are two driver ICs are provided in the design, because three motor are in the AGV. One driver circuit is connected to the two motors of driving mechanism. And second one is used for the motor which is incorporated with the lift.

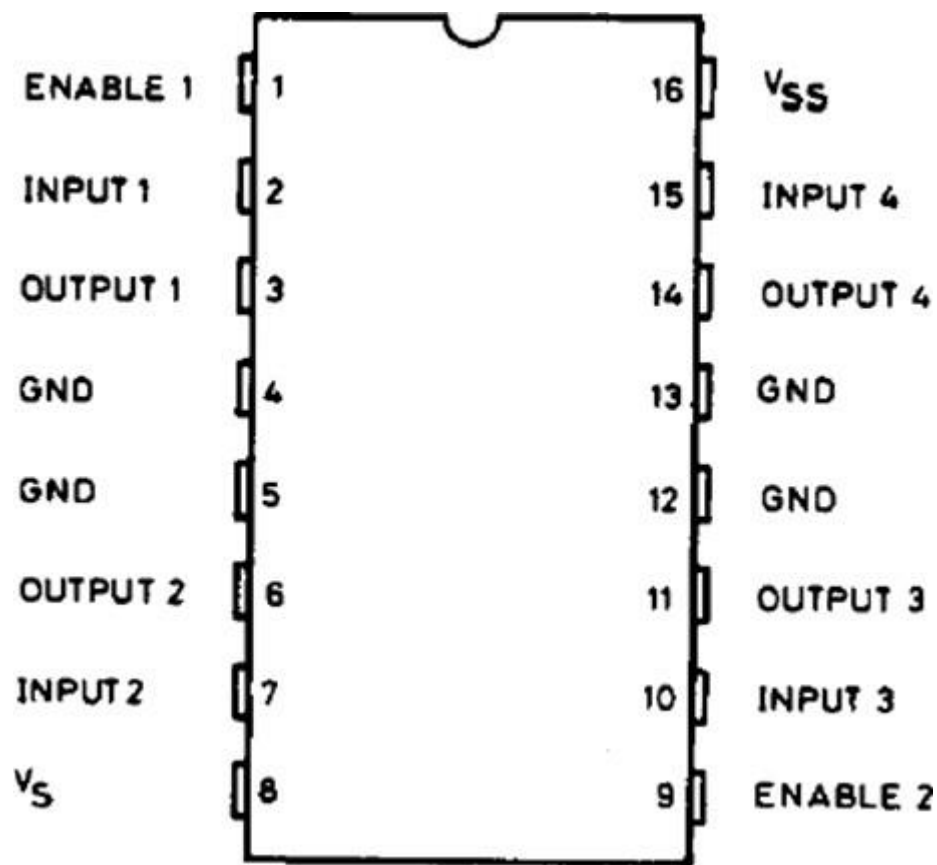


Fig 4.8: Motor Driver (L293D)

4.7.3 Regulators

Mainly two types of voltage regulators are used in the design. One is variable and the next is not. The non variable belongs to 78 series. And variable is LM series. The main supply is 12V. But we need only 5V. It is made possible using these regulators

7805 Regulator

It is the one of the important electronic part. The motor, driving IC, microcontroller etc need only 5V for their operations. Before the supply is given to these circuits it is given to the 7805 voltage regulator. It reduces the voltage from 12V to 5V.

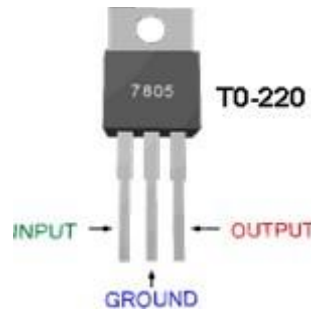


Fig 4.9: 7805 Regulator

4.7.4 Infrared Sensors

IR Sensor is one of the important parts. Path detection and obstacle detection is done with the help of IR Sensors. There are five IR Sensors are in our AGV. Out of them four are used for path detection and the rest of one is used for obstacle detection.

IR sensor have a transmitter and a receiver port.

The strength of signal reached at the receiver port after the reflection of light is used to detect the path. Path is marked in the black background by white lines. Sensor detect the white line by the strength of IR wave. The reflected wave from white line has high strength than that of from black. TSOP1730 are used in the design.

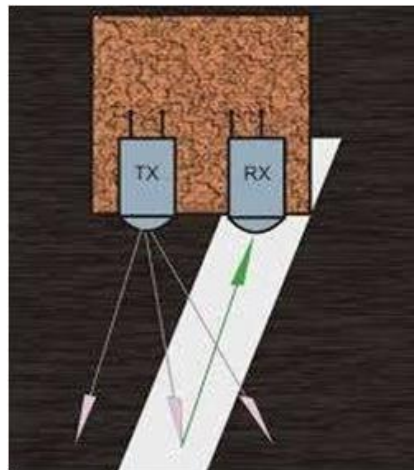


Fig 4.10: IR for Path Detection

CHAPTER-V

CONCLUSION

The AGV is a productivity increasing feature in a factory. During the manufacturing of this AGV we will find many of intelligence that can be given to it. We will provide the basic functions like line following and collision avoiding. And the main function, transportation of goods from station to station. The second phase of our project is to be fabricate the prototype model and testing to be done.

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