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DESIGN AND FABRICATION OF AUTOMATED GUIDED VEHICLE WITH SCISSOR LIFTING MECHANISM

Ankur Pawar[*1], Nakul Ramrakhyani[*2], Akarsh Shetty[*3], Rohit Shinde[*4]

[*1,2,3,4]Pillai College Of Engineering, Department Of Mechanical Engineering, Mumbai University Of Mumbai, Maharashtra, India.

ABSTRACT

Automated Guided Vehicle (AGV) is the widely used transport system in the industry that can manage many types of loading raw material and finished products in the manufacturing process. AGV is mobile robots that navigate automatically by following the markers or lines created on or on the floor. The main purpose of Automated Guided Vehicle in the industry is to improve the transport time of the manufacturing process, can reduce human labor, and manage to handle a heavy load. The control system of an AGV is the main part that reacts as a brain to the AGV navigation system. In industry, an AGV is commonly controlled by Computer Integrated Manufacturing System (CIMS) in the manufacturing process. Computer Integrated Manufacturing (CIM) is the manufacturing approach that the entire production process was controlled using computers. This project is a basic design and development of an Automated Guided Vehicle with a Scissor Lifting Mechanism. The mechanical part of the AGV was built as the same minimum size as a standard AGV in industry and the control system of this AGV was using the Arduino and line follower type for navigation of the AGV.

Keywords: Automated Guided Vehicle, A.G.V; Computer Integrated Manufacturing, C.I.M.; Computer Integrated Manufacturing System, C.I.M.S.

I. INTRODUCTION

AGVs are autonomous vehicles that can make decisions decentralized, such as path planning and collision avoidance, using onboard computing. This operation may need to be delegated to a more powerful central processor. Localization and routing of AGVs in a real plant might be challenging. Correct equipment must be installed in the plant, which takes time and money, and inefficiencies might develop if the AGVs do not grasp the dynamic environment. AGV guidance technology can be separated into two groups: fixed and free route guidance methods. Fixed route methods rely on a laid-out path that the AGV will sense and follow. Such examples include magnetic and optical tape. Free route methods store coordinates which the AGV uses to identify its current location. Such examples include GPS and vision guidance. Fixed route systems like magnetic tape are inflexible since any modifications necessitate re-taping, which has a significant maintenance cost despite the inexpensive material cost. They give accurate AGV positioning and some decision-making capabilities, but other methods are needed to track an AGV's precise location. The cost of free route methods is high, and they might be polluting the environment. They are less expensive to install and can locate the AGV, but they are less reliable and accurate. Free route solutions, such as GPS, provide AGV paths with flexibility and ease of customization.

This project is about designing an Automated Guided Vehicle (AGV) by taking into account three parts: designing and building an AGV prototype, developing an AGV control system, and improving the motion of the AGV by using a suitable controller and improving the design that may cause problems with the AGV's motion. This project consists of several components, from designing and measuring each dimension to modeling and the control system, which includes a computer wiring system and software programmed to ensure that the AGV runs smoothly. And a basic controller is used to regulate the motion in this project, which is powered by a DC motor. The controller is implemented for a line following robot to analyze the controller.

II. METHODOLOGY

In our project, we have selected the paint strip method for our convince so to move our project ahead. To bring in motion the concept that we used in our project is based on the phenomenon of light. We know that white color reflects almost all of the light that falls on it, whereas black color absorbs most of the light. In our AGV we are using Arduino. IR transmitters and receivers which are also called photodiodes are used for sending and receiving light. IR transmits infrared lights. When infrared rays fall on the white surface, it's reflected and

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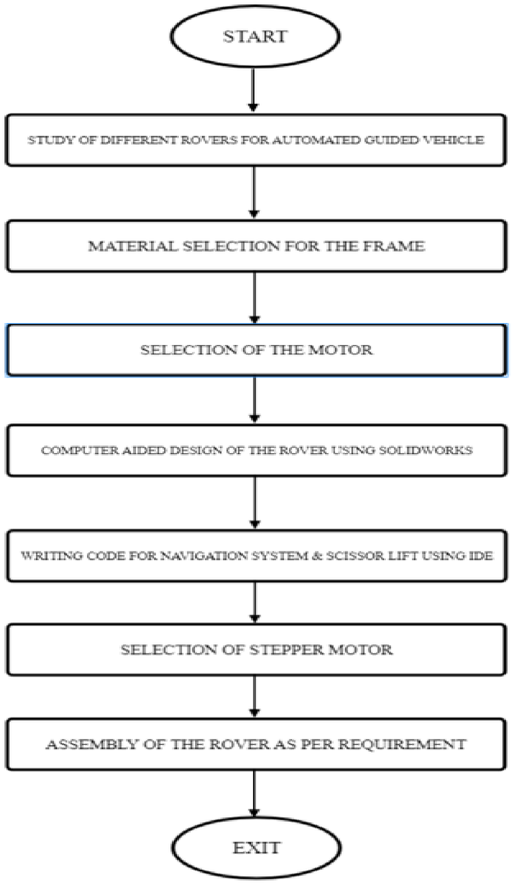
caught by photodiodes which generate some voltage changes. When IR light falls on a black surface, light is absorbed by the black surface and no rays are reflected, thus the photodiode does not receive any light or rays. So, when our AGV senses a black line it sends a signal to Arduino. Then Arduino drives the motors according to the Sensor's output. we are using two IR sensors namely the left sensor and the right sensor. when both (Left and Right) sensors sense white then our AGV moves forward. If the left sensor comes on the black line, then our AGV turns the left side. If the right sensors sense the black line, then the robot turns the right side until both sensors come to a white surface and when the white surface comes our AGV will move forward again. If both sensors come on the black line, then the AGV will stop.

Plan of Work



III. MODELING AND ANALYSIS

1. Previous Model

Figure 1: 3D Model of A.G.V.

This is the previous iteration of our model. This model was used as a reference for making the next iteration of the model. We made many holes and slots in this model because we thought this might decrease the weight of the model but it reduced the integrity of the model. We also had to make some adjustments in the dimensions of the model. It also had double the amount of scissor links which reduced the integrity of the worktable.

2. Final Model

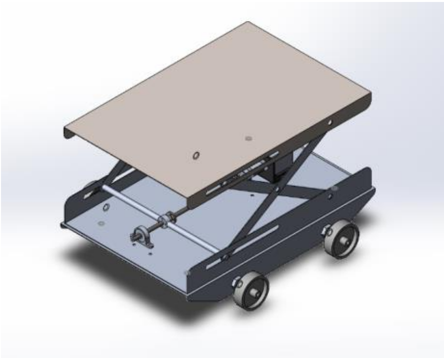


Figure 2: 3D Model of Final Design.

3. Model Details

- **Chassis**

A Chassis is the load -bearing framework of an artificial object, which structurally supports the object in its construction. This supports our Scissor lifting Mechanism. The base is made of Aluminum 3003 alloy for this model.

- **Base Table**

It is the part placed on top of the chassis which has been riveted on the chassis. This houses the lead screw assembly and all the computing components.

- **Scissor Link**

The links are used for the scissor lifting mechanism. It supports folding in a Criss-cross position. It is made up of Aluminum because of its low density.

- **Work Table**

Worktable is used to carry the load placed on the chassis. It is connected to the scissor links via bolts.

- **Lead Screw**

This lead screw is connected to the stepper motor which moves it with certain speed and step size for the motion of the scissor lift.

- **Mounting**

This is used as a guide and support for the lead screw, which helps in the smooth motion of the shaft.

- **Flexible Coupling**

The purpose of this flexible coupling is to transmit the motion from the shaft of rotating shaft to another, while tolerating at the same time a small amount of misalignment. In our case this is used to connect our stepper motor to the Lead screw.

- **Wheel**

Wheels are used to move the A.G.V. Motion of the wheel connected with the D.C. Motor helps the Model to move. Wheels with good grip are used which provides stability and friction.

4. Circuit Diagram

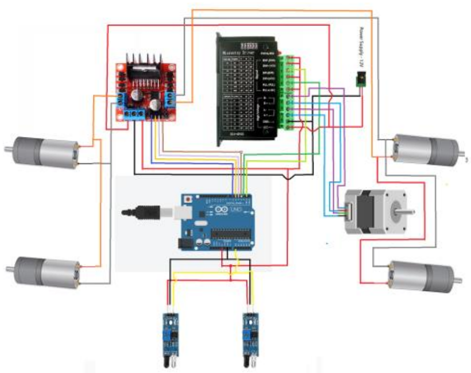


Figure 3: Circuit Diagram

- **Electronic Components**
- Arduino Uno
- L298M Motor Driver
- D.C. Motor
- I.R. Sensors
- Stepper Motor
- Micro Step Controller

5. Analytical Calculation

Stress Calculation on Base

- Weight of the Scissor lift Mechanism = 1.31 kg
- Area of Base Plate = 0.14 m^2

Stress = Force/Area

i.e., Stress at the base=Weight of the body above the base/Area of cross section of the Base

= (1.31*9.81)/0.14 = 91.79 N/m^2

Stress at Base of plate = 4.3*10^2 N/m^2

Yield Stress of Aluminum = $193*10^6$ N/m^2

Ultimate Stress of Aluminum = $228*10^6$ N/m^2

Stress at the base (91.79 N/m^2) is less than the yield stress of Aluminum (193*10^6 N/m^2),

Hence the Design is safe.

- **C.A.E. on the body**

We also performed a Stress Analysis on the Worktable. (Fig 1.6) on Ansys and found the following result: -

We found max equivalent stress value as 147.38 N/mm^2.

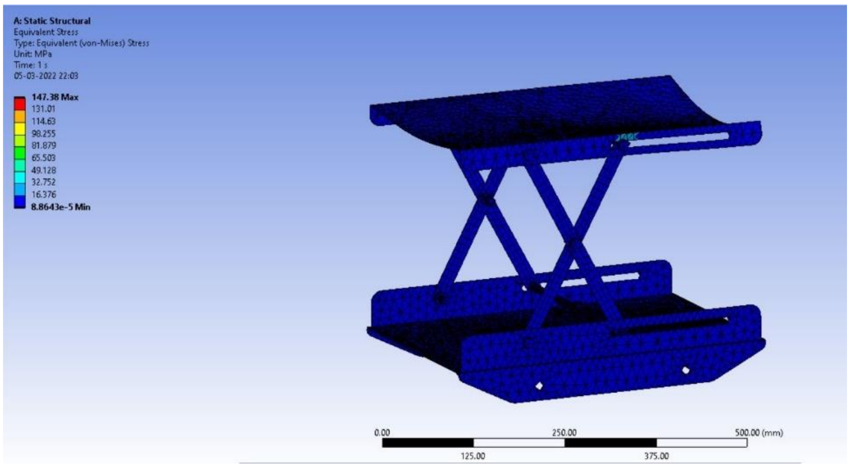


Figure 4: C.A.E of A.G.V.

IV. RESULTS

- The A.G.V. was able to follow the dedicated path.
- The Lift worked where the marker was placed.
- The Lift was able to lift 5 kg of static load without any problem.

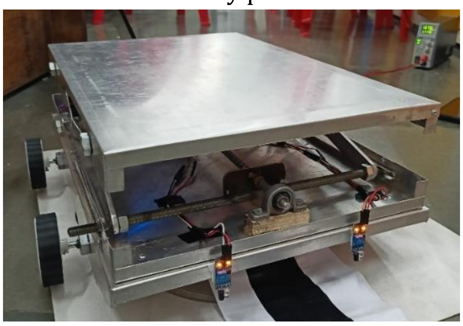


Figure 5: A.G.V. following the path.

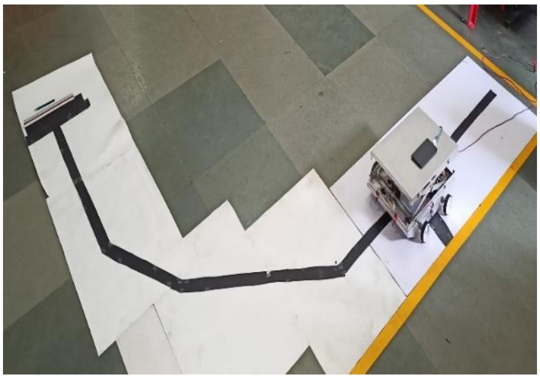


Figure 6: A.G.V. lifting on the marker.

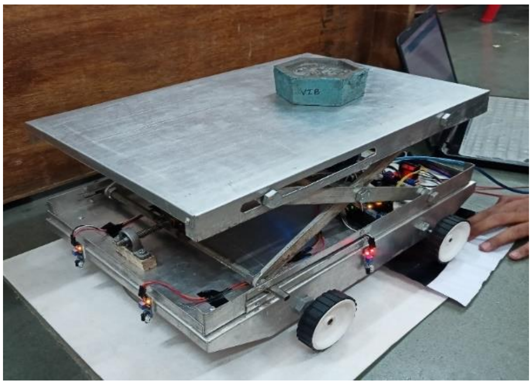


Figure 7: A.G.V. lifting a load of 3kg.

V. CONCLUSION

The paint strip method is more viable for Navigation systems. The Programming for the A.G.V.'s Navigation system is running smoothly & The Design of the chassis with the dimensions we choose is safe.

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