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Hassle - Free Load Carrying Using Automated Guided Vehicle

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Abstract - In today's rapidly evolving world, where efficiency and sustainability are paramount, businesses are seeking technologies that not only save time and drive profits but also align with their sustainable goals. In response to this demand, a prototype of an Automated Guided Vehicle (AGV) is developed.AGVs are versatile robotic platforms designed to navigate predefined paths while handling heavy loads of materials. The AGV system addresses these needs by utilizing cost-effective RFID tags and an RFID reader for efficient load tracking and navigation. Additionally, it incorporates two infrared (IR) sensors for path detection, an L298N motor driver for precise motor control, an Arduino microcontroller as the central processing unit, and an HC-05 Bluetooth module for wireless communication.By integrating these components, along with feedback control loops and path planning algorithms, The AGV is observed to be an efficient load carrier and can navigate reliably in dynamic environments. Above all, this solution not only saves time and enhances profitability but also promotes sustainability by optimizing resource utilization and minimizing manual intervention.

Key Words: AGV(Automated Guided Vehicle),RFID(Radio Frequency Identification) tags, RFID (Radio Frequency Identification)reader, IR sensors, L298N Motor driver, Microcontroller.

1.INTRODUCTION

AGVs (Automated Guided Vehicles) are wireless and autonomous vehicles that operate without the need for an onboard driver [1, 2]. They are employed to efficiently transport loads from one location to another. Introduced in the mid-20th century, around the 1950s, AGVs have evolved from wire navigation to today's advanced laser navigation systems [1, 2, 3, 7, 9]. These robotic platforms carry loads either on their beds or on attached trailers [1, 2, 7, 9].The AGV prototype involves a combination of modern hardware elements with sophisticated control algorithms, and this shows how innovation and technology coexist [2, 3, 4, 5, 7, 8]. The AGV is a well-balanced combination of various engineering specialties, including electrical, electronics, mechanics, and computers [5, 7, 8]. The AGV project aims to change traditional load-carrying techniques with the help of automation [3, 7]. The goal of the AGV prototype is to reduce human efforts in carrying heavy loads, improve inventory control, and expedite material handling processes in buildings. Additionally, it can minimize delay, facilitate smooth operations in facilities, and offer adaptability to diverse circumstances or demands. Therefore, beyond their transportation capabilities and their ability to navigate autonomously, AGVs contribute to reducing operational costs and increasing productivity in various industries [1, 3, 5, 7, 9]. In order to navigate to a specific position, both IR sensors and RFID technology play a key role, as these two components help in the navigation of the AGV.. Thus, Hassle-Free Load Carrying Using Automated Guided Vehicle is designed to increase efficiency by incorporating RFID technology, IR sensors, and also making the AGV move by taking inputs from the mobile app.

2. Design of Automated Guided Vehicle

The design of the prototype began by making the outer body and the top load-carrying bed of the AGV from foam board because of their lightweight and durable properties. The chassis is crafted from wood because of its natural shock-absorbing qualities, which help safeguard sensitive components from vibration-induced damage. The front portion of the AGV body involves a curved design because the curved fronts help the vehicle move forward by reducing air resistance.

On the upper surface of the chassis bed, an HC-05 Bluetooth module and an Arduino Uno microcontroller are placed, both operating at 5 volts. The Arduino has 14 digital I/O pins, with 6 for input and 6 for output in the form of PWM signals. The Bluetooth module is connected to the Arduino's RX pin and motor driver. Situated next to the Arduino is the L298N motor driver. It's linked to the Arduino's analog pins. The motor driver operates within a voltage range of 5 volts to 35 volts. It receives PWM signals from the Arduino as input and controls the direction and speed of the four DC motors, which are mounted underneath the AGV to drive its wheels.

For power, the AGV utilizes three 3.3V battery cells positioned near the motor driver. Two IR sensors positioned at the front bottom of the AGV are connected to the power pins and to the digital pins 6 and 7 of the Arduino to navigate it along its set path. Additionally, an RFID reader is placed at the bottom of the AGV and connected to the digital pins of the Arduino board to detect the respective RFID tags placed on the designated path. It functions at 3.3 volts and has a working frequency of 13.56 MHz. A switch is located at the backside of the AGV for power control and operation.

The Arduino is programmed using the Arduino IDE.

The path of the AGV can be designed according to specific requirements, and RFID tags can be strategically placed to designate delivery points for the load.

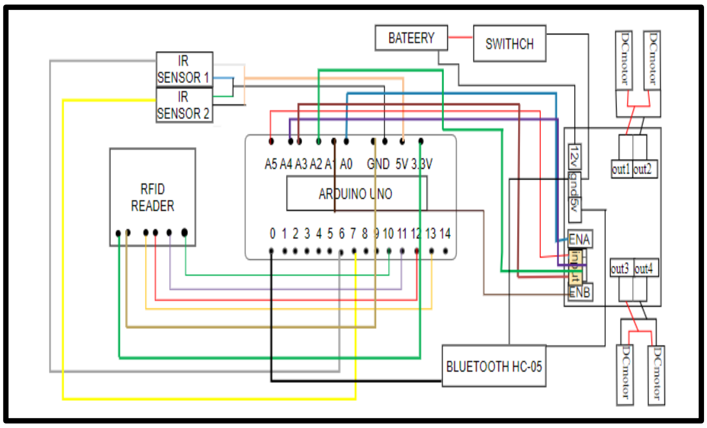

Fig -1: Circuit Diagram

2.1 METHODOLOGY

The working of an AGV begins by giving commands through a mobile phone to go to a specific RFID chip position. Here, the AGV works wirelessly by receiving commands from mobile devices with the help of Bluetooth. The Arduino's RX (Receive) pin 0 is connected to Bluetooth, which receives commands from the mobile phone and forwards it to the microcontroller ATmega328P, which decodes the command and executes it according to the preprogrammed instructions.

To navigate to that specific position, AGV relies on the black-tape guidance method. AGV uses two IR sensors, the left IR sensor and the right IR sensor, which help AGV be on its path by emitting infrared light and subsequently measuring the intensity of the light reflected to them.

While moving on the predetermined path, the RFID reader, which is positioned at the bottom of the AGV, receives the command from the Arduino and starts looking for the required chip by reading the RFID chips placed in various positions on the path by emitting radio waves of a particular frequency, and the chips that come into contact with the frequency transmit data back to the RFID reader. The RFID reader then forwards this information to the Arduino.

According to the data received from the IR sensors and RFID reader, the Arduino Uno sends input to the L298N motor driver, which then controls the movement of the AGVs motors, making them move forward, backward, turn, and stop based on sensor inputs and control algorithms set up on the Arduino board.

In this way, the AGV reaches the respected RFID chip position and stops.

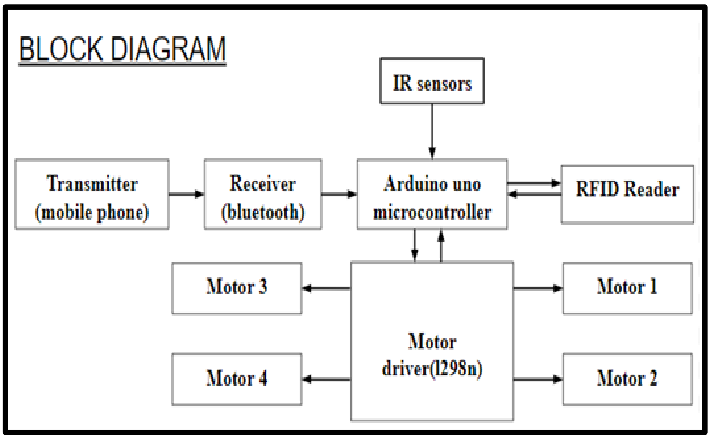

Fig -2: Block Diagram Of Automated Guided Vehicle

2.2 EXPERIMENTATION RESULT AND DISCUSSION

Firstly, the operation begins by turning on the AGV and entering the command in our mobile phone app to instruct the AGV to go to a particular chip location.AGV receives the command and starts moving along the predetermined path; at the same time, the RFID reader starts reading the RFID chips placed at different locations on the path by emitting a radio frequency of a particular range.

The two IR sensors, which are placed at the bottom of the AGV, are helping it navigate along its predetermined path .If the chip that responded was not the respected chip, the AGV moved forward, and on arriving at the required chip position, the AGV stopped.

It is observed that the AGV is able to identify the required chip and be able to carry the load efficiently, even if there is a curved path involved to reach the required chip location.

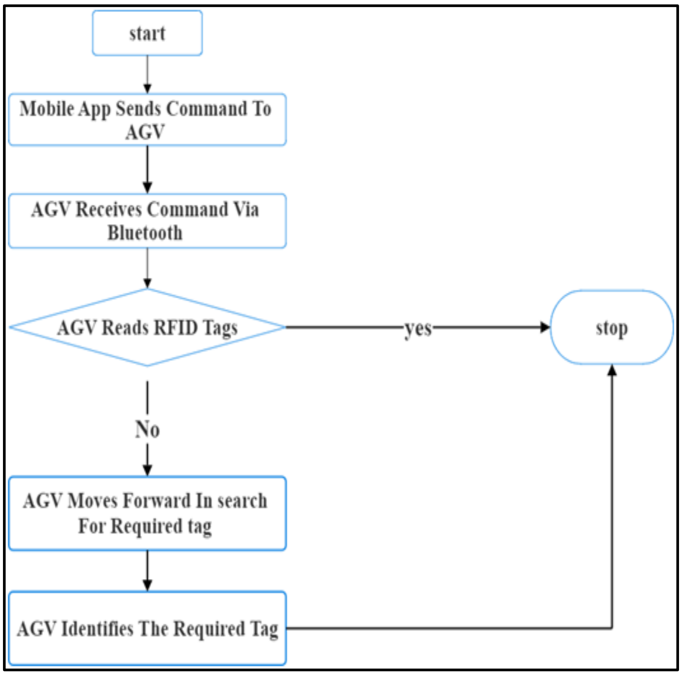

Fig -3: Flow Process of Automated Guided Vehicle

2.2.1 CALCULATIONS

To calculate the velocity of AGV when carrying different loads over a fixed path length.

The fixed path is of length 2m and considered pay loads from no load to 2000 g.

Table -1: Observations

DISTANCE (meters)	TIME (seconds)	PAYLOAD (g)
2	51.60	0
2	39.79	500
2	38.88	1000
2	37.28	1500
2	36.88	2000

Table -2: Observations

S.NO	PAYLOAD	SPEED(m/s)
1	0	0.038
2	500g	0.050
3	1000g	0.051
4	1500g	0.053
5	2000g	0.054

Speed=Distance/Time

The calculations are performed to find the velocity of the AGV at different load conditions over a fixed path length, and on performing the calculations, it is observed that as the load increases, the time taken by the AGV decreases and the speed of the AGV increases. This is because as the load increases, the vehicle attains better stability and traction, which in turn helps the AGV follow the predetermined path without any slipping. As a result the AGV is traveling at higher speed and taking less time to travel.

3. CONCLUSION

The paper provide insights about the Hassle-Free Load Carrying Using AGV (Automated Guided Vehicle)prototype , which aims to replace traditional load-carrying techniques to meet the demands of our fast-moving world by using modern technologies such as the RFID reader, RFID chips, L298N motor driver, IR sensors, Arduino Uno, and HC-05 Bluetooth module. To develop a real model, it is advisable to select a fabricated material that is durable, versatile, and easy to work with. Additionally, there is a need to multiply the components and increase their power capacity so that the AGV can handle and transport loads carefully.

Therefore, the AGV developed holds immense potential across various industries, from manufacturing and logistics to the educational and healthcare sectors, as it increases efficiency, saves time, aims for sustainability, brings profits,and improves the quality of life by automating physically demanding tasks and freeing people to engage in more meaningful activities.

3.1 FUTURE SCOPE

Future implications of the model include the integration of advanced technologies such as artificial intelligence and machine learning, through which both the accuracy and speed of an AGV can be achieved and, at the same time, it can be trained to work in different environments. AGV can also integrate with kinetic energy harvesting systems such as regenerative braking and piezoelectric materials. In this way, the AGV could become even more versatile, sustainable, and adaptable to a wide range of applications.

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