Design and Modeling of Automated Guided Vehicle Systems using Arduino

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***Abstract* - The Automatic Guided Vehicle (AGV) refers a type of system that can be used in production as well as in other industries. This system includes a battery operated remote sensing locomotive (carrier) on which a small lift is provided, specific path over which it moves, sensors for sensing the obstructions on the path of the carrier. The main focus of this study is to make AGVs with the convenient materials, simple and applicable routing system and more importantly reducing the cost and increase the flexibility. In this paper is to build a prototype of an Automated Guided Vehicle (AGVs) model that can move on a flat surface with its four driving wheels. The prototype is able to follow line on floor with the Arduino mega microcontroller as it main brain that control all the navigation and responses to the environment. The ability to follow line on floor is an advantage of this prototype as it can be further developed to do more complicated task in real life. To follow the line, the microcontroller is attached to a sensor that continuously reflects to the surface condition. It has also been attached with an ultrasonic sensor for the detection of object. In this paper implicates of designing and fabrication of the hardware and circuitry. AGV is therefore suitable for automating material handling in batch production and mixed model production.**

Keywords: **AGV, Design, Arduino**

I. INTRODUCTION

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. AGVs 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 AGV.

Han and McGinnis [1] developed a real time algorithm in which material handling transporters are considered. Sabuncuoglu and Hommertzheim [2] investigated the performance of machine and AGV scheduling rule against the mean flow time criterion using a simulation model. And also the importance of material handling and they compared several AGV dispatching rules the importance of material handling and they compared several AGV dispatching rules. Various vehicle dispatching rules in relation to a specified schedule and on a particular layout in relation with the design phase investigated by Mahadevan and Narendran[3].Maxwell and Muckstadt [4] investigated by introduce 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.

Kim et al. [5] proposed a deadlock detection and prevention algorithms for AGVs. It assumed that vehicles reserve grid blocks in advance to prevent collisions and deadlocks among AGVs. Wuwei et al [6]. 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. Lin and Wang [7] proposed a fuzzy logic controller for collision avoidance for AGV. Wu et al. [8] 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. Alves and Junior [9] 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. Gaskin and Tanchoco [10] developed the first integer programming model for material flow path design. Afentakis [11] states the advantages of the loop layout as simplicity and efficiency, low initial and expansion costs, and product and processing flexibility

II. OBJECTIVE OF PRESENT WORK

- The AGV is a productivity increasing feature in a factory.

- Ability to add sensors to detect the payload conditions and adjust the lifting time.
- Basic functions like line following, collision avoiding and Flexibility of path
- Reduce manpower and Increase productivity.
- Eliminate unwanted fork trucks and Reduce product damages.
- Maintain better control of material management and Suitable to transfer frames

III. COMPONENTS USE IN AGV

Chassis: AGV's chassis is made of a 2.5 millimetre thick rectangular sheet metal (300×500) mm at the bottom. Figure 1 and 2 shows the Chassis and Assemble part of AGV's.

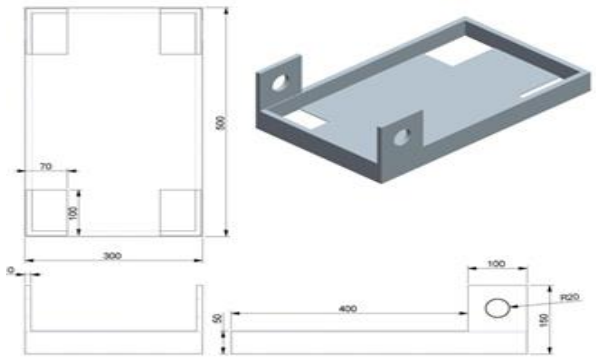


Fig. 1. Chassis of AGV's

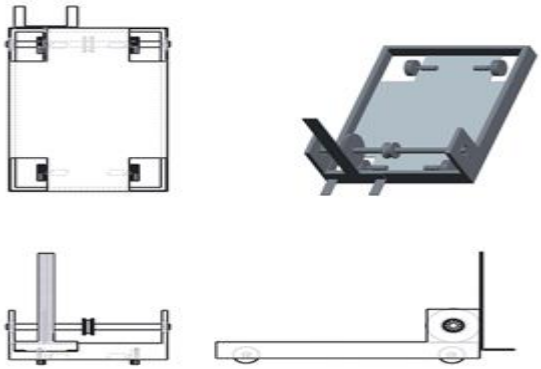


Fig. 2. Assemble part of AGVs

Electrical tools

D C Motor: 10 RPM Side Shaft 37mm Diameter High Performance DC Gear Motor is suitable for AGV systems. Motor runs smoothly from 4V to 12V and gives 10 RPM at 12V.

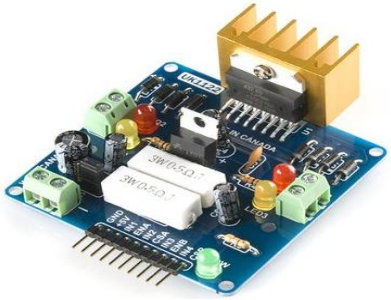
MOTOR DRIVER CIRCUIT: 8V-28V, 5Amp Dual DC Motor Driver with Current Sense can drive 2 DC motors with current up to 5Amps. It can work between 8 to 28V DC and gives current sense output for each motor. Motor driver has 6-pin removable XY connector on the power side and separate 6 pin 2510 relimate connectors for logic connections of each motor driver section.

SSR RELAY: solid state relay is an electrical switch comprising solid state or electronic components. Solid state relays can operate for many millions of turn on/turn off cycles with no deterioration in performance.

INFRARED SENSORS ARRAY: it is used in any type of fast line following application. Interfacing is too easy since it gives TTL outputs. Tested for speeds up to 3.5 m/s on curved line (Using PID). Each sensor in array can be individually set by pre-set so any colour/distance can be set to sense the line.

ULTRASONIC SENSOR: AGV's used HC SR-04 Ultrasonic Sensor. It provides 2cm - 400cm distance measurement function, with accuracy of 3mm.The modules easy pin configuration makes it suitable for interfacing in any embedded application.

Figure 3 shows Electrical tools are used in AGV's (a) Motor Circuit Driver (b) SSR Relay (c) Ultrasonic Sensor (d) Display Unit (e) Infrared Sensors Array



(a) Motor Circuit Driver

(b) SSR Relay

(c) Ultrasonic Sensor

(d) Display Unit

(e) Infrared Sensors Array

Fig.3 (a) Motor Circuit Driver (b) SSR Relay(c) Ultrasonic Sensor (d) Display Unit (e) Infrared Sensors Array (Electrical tool used in AGV's)

IV. SOFTWARE TOOLS

Arduino Mega

The Arduino Mega is a microcontroller board based on the ATmega1280. It has 54 digital input/output pins (of which 14 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. Figure 4 shows that assemble part of electrical tools in AGV's.

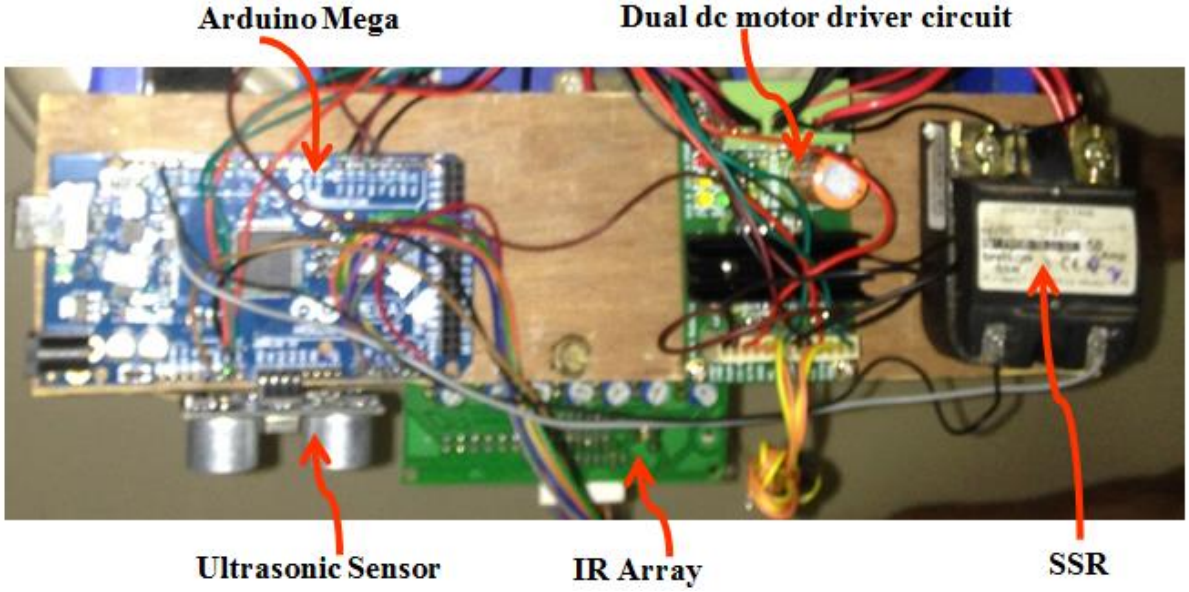


Fig. 4 Assembly of AGV's

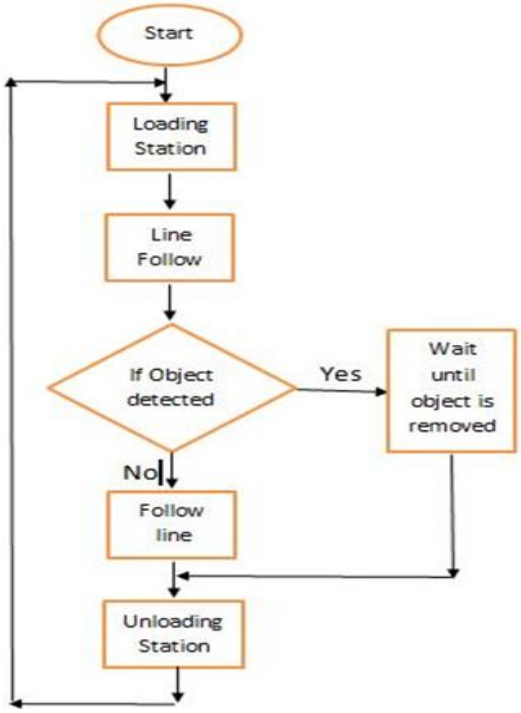


Fig. 5 Flow Chart of AGV's

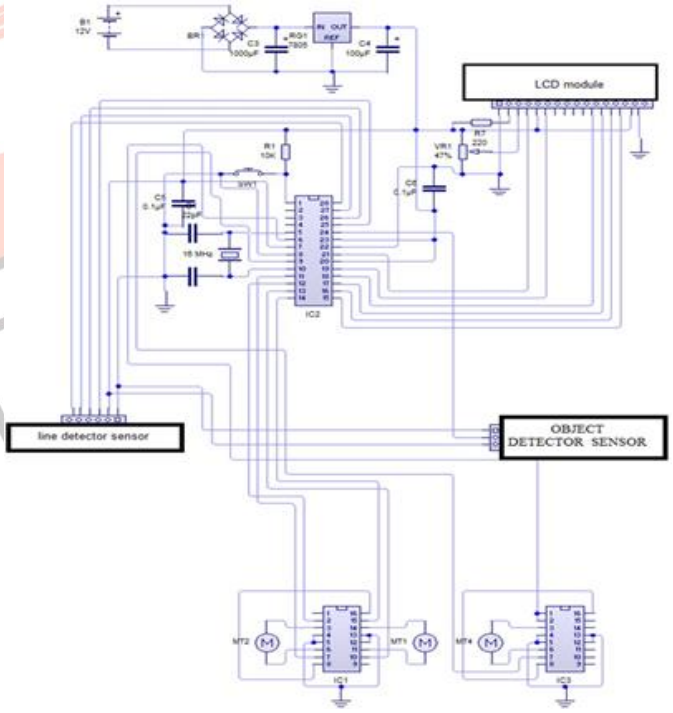


Fig. 6 Circuit diagarm of AGV's

Figure 5 shows that flow chart of automated guided vehicle. According to this working flow chart we have to interface electronics devices with the micro controller, the connections with the microcontroller has been shown here in the circuit diagram given in figure 6.

V. DESIGN AND MODELING OF AGV

The movement modeling is design by AGV. Movement Modeling highly depends on the size of the area, expected direction ability, position of stations and allocated path between them. Furthermore, it becomes much more vital if the area is small with restricted moving space so that the vehicle should be designed to move and make U-turns, sharp turns, curve turns and of course handling deviations.

Design of AGV author has calculated torque of motor, speed, force and angular velocity. Physically Power is the rate of doing work. For linear motion, power is the product of force multiplied by the distance per unit time. In the case rotational motion, the analogous calculation for power is the product of Torque multiplied by the rotational distance per unit time. For the designing AGV author has also consider the following factor designing of shaft, design of pinion, selection of pulley and selection of bearing.

Figure 7 shows the 3-D model of AGV. It shows all the component of AGV. Figure 8 shows actual prototype model of AGV.

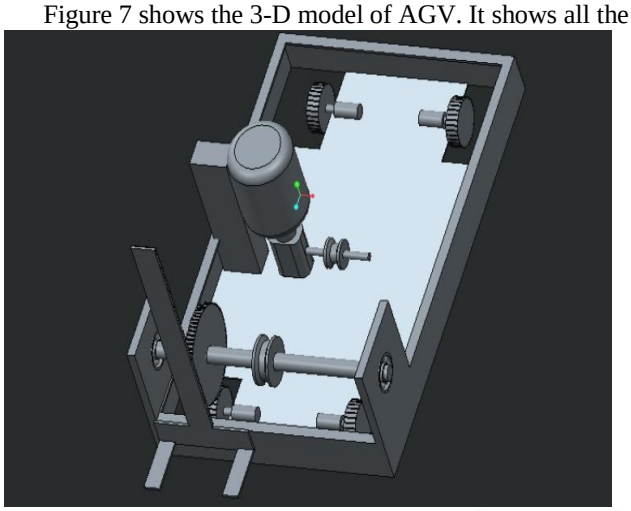


Fig. 7 3-D Model AGV

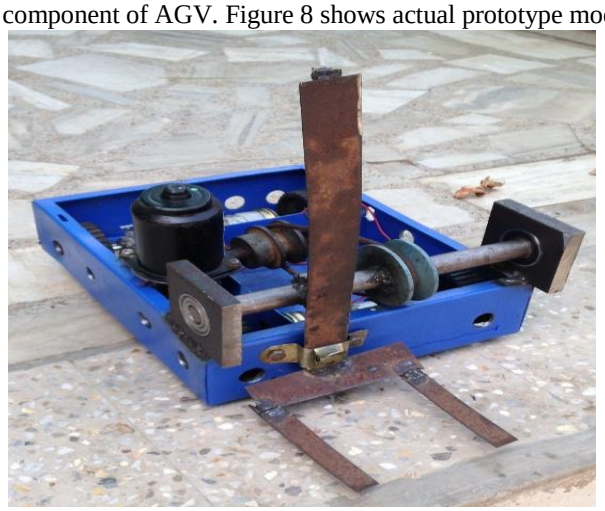


Fig. 8 Actual model of AGV

VI. DESIGNING OF TRACK

Authors have used black coloured stripped path for the line following mechanism. In which our system will try to be on the track and at some intervals we have created loading and unloading stations on which our system will load/unload the material that are provided. Width of the track is 2 cm. Vehicle will try to be on the track for that 2 sensors from the IR array are assigned to do so. When 2nd from the centre IR LED will glow at that time the vehicle will take the left turn likewise when right 2nd from the centre LED will glow than the system will take right turn. For loading and unloading the system we have deigned track of several length so that vehicle can understand it is a loading/unloading station. For that we have taken length of a black strip which covers left 4 IR LED so that system can be stop immediately and do the work assigned in the program.

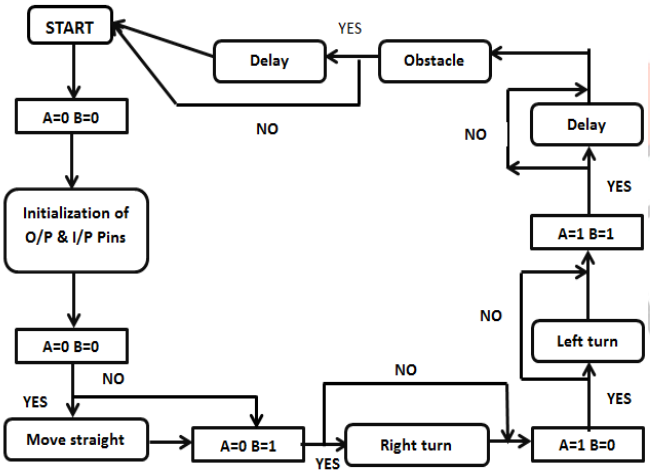


Fig. 9 Flow chart of Designing track

Fig. 10. Design Track of AGV's

VII. CONCLUSION

The AGV is a productivity increasing feature in a factory. During the manufacturing of this AGV we had found many of intelligence that can be given to it. We provide the basic functions like line following and collision avoiding and the main function, transportation of goods from station to station.

Using AGV increasing Speed of delivery, Adjustment of vehicle speed, Flexibility of path, Reduction in running cost compared to conveyer systems and ability to adjust the lifting time. Analyzing of advantages helps to motivate the fabrication of AGV in the manufacturing industries. Using prototype AGV following advantage are discover Reduce manpower, Increase productivity, Eliminate unwanted fork trucks, Reduce product damages, Maintain better control of material management, Traffic control is not needed in this system because of single carrier.

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