Design and Modelling of an Autonomous Automated Guided Vehicle with Intelligent Navigation Control System

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Abstract— Design and modeling of an autonomous AGV with intelligent navigation and control system is an implementation of automated guided vehicles which are used to navigate goods from one place to another. This paper shows the methodology which can maximize the performance of an AGV. We have also mentioned the algorithm to avoid obstacles in the way of an AGV and also to find the shortest path to the destination. This methodology not only reduces the cost but also increases the efficiency from previously proposed AGV. The proposed AGV will decrease the chances of accidents and mistakes. We are going to increase the working speed of AGV as it will not need to stop its work due to some external obstacles. We have used Kalman filter and PID to increase the accuracy of AGV. The A* algorithm is used to find the shortest path by avoiding obstacles to reach destination in minimum time. We have used directional sensors to get information about current position and destination of AGV. The highly accurate directional sensor will help AGV to easily calculate the position of it at any point.

Index Terms— AGV(automated guided vehicle), LASER(light amplification by stimulated emission of radiation), P(proportional), PD(proportional derivative), PI(proportional integral).

I. INTRODUCTION
Automated guided vehicles (AGVs) is a kind of autonomous robot which increase efficiency and reduce costs for helping in manufacturing facility or warehouse. The first AGV was invented by Barrett Electronics in 1953. The AGV can tow objects with them in trailers. 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 motorized rollers (conveyor) and then pushed off by reversing them. 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[1]. AGVs are actual vehicles that can take materials/tools from one location to another using a variety of different paths based on traffic in the area and programming that is done that will direct the AGV down the path that will get it to its location the quickest. Since AGVs are unmanned, they can run 24 hours and 365 days a year. Throughout requirements for the AGVS must also be examined closely when determining the route the vehicles must travel. If a company can minimize the time spent moving between two locations and the time it takes to load vehicles, the number of vehicles will decrease, and the number of paths for the vehicles will decrease in quantity. A carefully planned route can lead to an efficient, cost effective implementation of an AGVS.

Types of AGV
1. Based on load carrier
   a.)Tow
   b.)Unit load
   c.)Fork

2. Based on navigation
   a.)Fixed path
   I) wired
   II) Guide Tape
   III) Magnetic spots
   b.)Free path
   I) Gyroscopic Navigation
   II) Vision Guidance
   III) Laser Guided

• WIRED
A slot is cut in to the floor and a wire is placed approximately 1 inch below the surface. This slot is cut along the path the AGV is to follow. This wire is used to transmit a radio signal. A sensor is installed on the bottom of the AGV close to the ground. The sensor detects the relative position of the radio signal being transmitted from the wire. This information is used to regulate the steering circuit, making the AGV follow the wire.

• GUIDED TAPE
AGVs (some known as automated guided carts or AGCs) use tape for the guide path. The tapes can be one of two styles: magnetic or colored. The AGC is fitted with the appropriate guide sensor to follow the path of the tape. One major advantage of tape over wired guidance is that it can be easily removed and relocated if the course needs to change. Colored
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- In wired AGVs, the breakage in wire makes impossible to follow route, if the path has to be changed lot of labor work is needed [3].
- In laser guided AGVs, considerable amount of time is required for adjusting the position of the reflectors to prevent the reflected light from being blocked [4].
- The installation cost and expansion cost is high of laser guided AGVs [5].
- Gyroscopic Navigation needs evenly plane surfaces, & the gyro changes its value abruptly & hence it has to be used with magnetic markers [6].
- In the Vision Guidance for the image processing the 360 degree image of the surroundings has to be fed to the system which needs lots of memory [7].

II. PROPOSED METHODOLOGY

- To overcome all the demerits we have a new concept of autonomous automatic guided vehicle.
- This autonomous AGV can have a lot of manoeuvrability & application.
- This autonomous will also have ability to avoid obstacles & will be equipped with better handling ability.

III. BLOCK DIAGRAM

- The Autonomous AGV will be working on a maze-like surface which will be used for the navigation purpose. This maze structure can be a pattern of two colours or more made up of vinyl which can be easily pasted over floor. This pattern would be used for navigating freely. Autonomous AGV will be provided with A* algorithm to find a path from one place to another. If in case the desired route is again obstructed by some other material it will re-calculate the path to the destination. Ultrasonic sensors will be placed to three sides of the autonomous AGV to avoid accidents. The AGV will decelerate first & would finally stop if the object is too much close to the AGV & will avoid collision.

IV. PID CONTROLLER

PID is used for controlling any automated mobile machines. For the navigation purpose the analog values will be used in place of digital. Before feeding it to the motor the PID will calculate the proportionate input for the proportionate output to get balanced result.

1 - Proportional Control:

This controller multiplies the current "error" by a constant called Kp. This "error" is the difference between actual output and the desired output which is fed back into the system.
system, so the error is calculated. This error is inserted into the PID controller as input, and the PID controller will calculate P, I and its D terms and commands the system to remove the error. Thus the desired output will be achieved as soon as possible with best stability.

2 - Integral Control:

The Integral term is used to multiply the current error and by a constant Ki, making a summation of all that information. When Integral term is added to the proportional term, it accelerates the process of reaching the steady state of the system. In other words, it also eliminates (or at least try to eliminate) the residual error, arriving faster to the desired result.

-Derivative Control:

The Derivative term, causes the rate of change of the error signal which is multiplied by a constant Kd. This will predict the error and hence decrease the rate at which errors produces changes in the system.

P controller (sometimes used):

In this controller we use small values of the constant Kp to get to the desired value, but its control is slow (that it takes some time to get to the desired value). If the value of Kp is increased an overshoot will occur.

PI controller (most commonly used):

It removes the residual portion of error in the steady-state case (improving transient response), but in this case it will have more overshoot, occurring system oscillation and which will lead to instability, the system will over-damp, under-damp or oscillatory. This type of control will make the system slower. By using large values of Ki, it will leave the system faster, however, increases the overshoot and decrease the margin of stability of the system.

PD controller (rarely used):

It is used to decrease the overshoot magnitude of the systems that uses integral controller and improve the stability of system. But a Derivative controller increase the noise error term and make the system process more unstable. The PD controller decreases the time to reach the desired value considerably so that the derivative gain Kd should be high. This decreases the control time, but increases the bandwidth of the system, leaving the system susceptible to disturbance or noise.

PID controller (sometimes used):

PID is combination of PI and PD. It is used to remove the system errors ratio and decrease the response time without oscillations or instabilities.

In our AGV the error is calculated using the pair of two sensors. The error is them multiplied with the constant which are derived using the PID algorithm. The values of the constants were evaluated at certain speeds & these values are always proportional to the speed & the voltage levels [8].

previous_error = 0
integral = 0
start:
error = setpoint - measured_value

integral = integral + error*dt
derivative = (error - previous_error)/dt
output = Kp*error + Ki*integral + Kd*derivative
previous_error = error

wait(dt)
goto start

A* algorithm

A* algorithm is used to find the shortest path to destination by avoiding the obstacles. It has two functions i.e., (g(x) and h(x)). The function of g(x) is used to find the real cost to reach to node x. The h(x) is also called as heuristic function is used find approximate cost from node x to goal node. The total cost of each node is calculated by

F(x) = g(x) + h(x).

A* algorithm checks it neighbor nodes every time to reach goal. It is more advantageous than dikstra’s algorithm as A* checks much less nodes than dijkstra. Thus we use A* algorithm in our proposed AGV to decrease the consumption of time. The process of plotting and efficiently traversable path between points, called nodes.

V. DIRECTIONAL SENSOR

In our proposed AGV we had used directional sensor to calculate the position of AGV, the position will be determined in the form of coordinates with value of X and Y. The AGV can find its position at any time with the help of this sensor. Mouse is used in our AGV which will give an accuracy of 360um, which means that the distance between each will node will be much less so that the accuracy will be increased. The shortest path algorithm that is A* algorithm will be applied it to reach its final destination. Ultrasonic sensor will be used to check the obstacle at any node.

VI. PRODUCT OVERCOME

- This new Autonomous AGV can move freely from any random point to any random destination. Only we have to feed the destination every time.
- The autonomous AGV can be made so flexible such that it can also be employed in restaurant where we need a waifer to serve things from one table to other. It can be also used in large ware house and manufacturing firms for transportation of heavy machineries.
- There is no need of any line or tapes to find path which will reduce its cost and increase efficiency.

REFERENCES

Design and Modelling of an Autonomous Automated Guided Vehicle with Intelligent Navigation Control System


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