Design and Development of an Automated Guided Vehicle

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Abstract – *AGV'S are specifically used in operation with focus on field of distinct manufacturing in industries, where transportation of material is purposefully repeated. AGVs importance is proved in a very little time period as it quickly and safely moves material through operations. Automated Guided Vehicle (AGV) are used in industries like FMCG, Textile, Paper, Cement, Chemical and pharmaceutical. The control system manages the operations performed by the vehicle. Control system design includes the design of a Printed Circuit Board (PCB), its simulation and fabrication. Programming is done on the controller on the PCB which has the proper instructions to be followed by the vehicle for navigation, transportation and detection of external objects. The vehicle is designed in such a way that it is versatile and can be easily re-programmed whenever required and can also adapt itself to the real-time applications. It is a combined circuitry of Controller, sensors, Direct Current (DC) electrical motor. The AGV moves from one point to other point using the DC electrical motor with a driver or controller that control the speed of the motor. Sensors are used to detect their path (guided wires, strips) as a route in carrying the loads and also for detecting objects nearby to avoid collisions. Hence these robots work autonomously to transfer work pieces between various assembly lines in a plant.*

Key Words: **Guided Sensors, Multiple sources multiple destinations, Navigation, Actuator.**

INTRODUCTION

AGV (Automated Guided Vehicle) machines are widely used to autonomously transport work pieces between several assembly stations by following special guide wires or colored strips. As the current system scenario at plant, it indicates that the management of empty bags is done manually and as a result it does not match with time line criteria in plant. So we come up with a new idea to overcome the flows of the current system. The entire system can be autonomous just by replacing few processes with emerging technologies. By this we can achieve excellent connectivity of empty bags from ground floor to go down to Roto Packer. The Company makes two unique evaluations of bond Portland Pozzolana Cement (PPC - 43 review) and Ordinary Portland Cement (OPC 53 review). The offer of the two sorts of bond to purchasers is accessible in two plans i.e. either by non-trade buy (more than 1000 concrete sacks of 50 KG) or trade buy. For that cement industry requires various types of sacks for a solitary item (either PPC or OPC). So four kind of bag handling is required and hence go down is divided into sections, so as to accommodate all types. These four categories are listed as follows: a) Portland Pozzolana Cement trade category bags b) Portland Pozzolana Cement non-trade category bags c) Ordinary Portland cement trade category bags d) Ordinary Portland Cement non-trade category bags.

Concept

We have come up with a new idea of an Automated Guided Vehicle (AGV), AGVs are driverless technologies which are so accurate in transferring and handling materials from one source to destination or point to point. According to the proposed concept the robot will replace all the manual work carried out at bag go-down without affecting the bag handling process. In order to accumulate bags on automated bag placer machine, they need to be pre-processed first. Figure1 depicts the conceptual layout of whole proposed system where we have divided the project into two stages. Stage I represents the part where a truck loaded with bundles of empty bags is unloaded manually and they are transferred to the semi-circular shaped bins situated near the silo. In this bin concept, four different color-coded bins will be made at ground floor, colour code represents the bifurcation for storing different types of bags. At the time of unloading the worker has to manually put the bags on trolley and stack them, as go down gets vacant the worker will drag the trolley to the lift and it gets elevated through AC motor mechanism. The worker has to press same color-coded button situated at control panel manually near the elevator, which provide a particular command to control unit which further communicates the movement of loaded bags automatically, AGVs are in synchronization with lift. Stage II, where the elevator comes up and it is aligned with the floor level of go down and AGV then navigates to enter the lift.

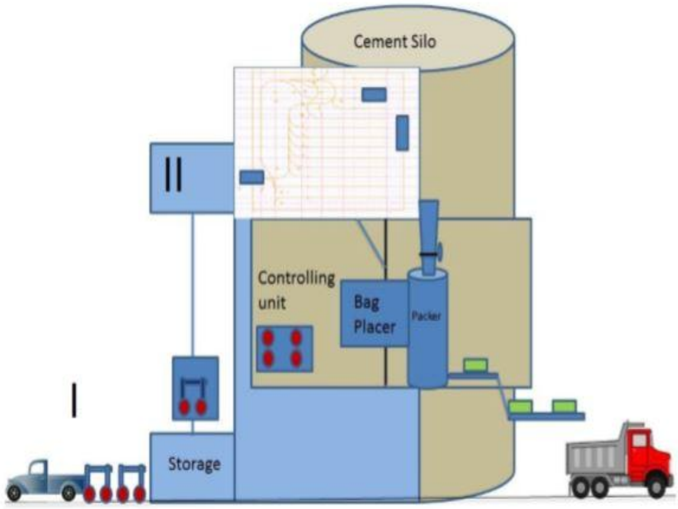

Fig 1. Conceptual layout of proposed Systems.

It uses linear actuator mechanism to hold or drag the trolley (Figure 2). Once the AGV holds the trolley properly it then uses its guided path to reach the destination and drags the trolley following the signals received from the sensor. Further when bags are to be sent to the packaging floor the same process of Stage II is repeated. Vector image of proposed AGV is shown in Figure 3.

Fig 2. AGV Engage with Trolley

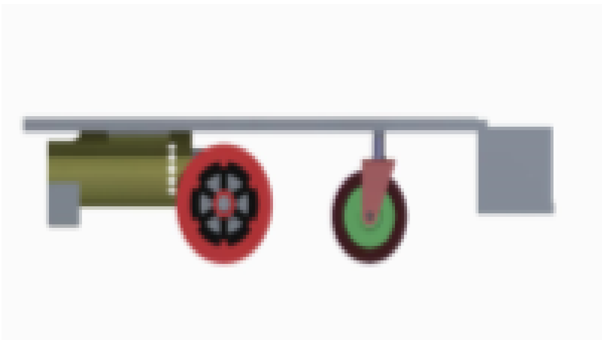

Fig 3. Vector Image of AGV

Navigation Mechanism

AGVs worldwide are a best example of transporting heavy loads inside the peripherals of a company. Our AGV concept is unit load concept which has to transfer bundled bags inside the premises. World wide a lot of navigation techniques are used for AGV movement. Techniques used are Laser triangulation, Inertial Magnetic tape, Magnetic grid, Wire, Optical. Sometimes if there is a need, two or more techniques may be cascaded in one system. The different types of techniques are shown in figure 4. AGVs (some known as mechanized guided trucks or AGCs) utilize tape for the guide way. The tapes can be one of two styles: attractive or shaded. The AGV is fitted with the proper guide sensor to take after the way of the tape. One noteworthy preferred standpoint of tape over wired direction is that it can be effortlessly expelled and migrated if the course needs to change. Shaded tape is at first more affordable, yet does not have the upside of being inserted in high activity zones where the tape may end up plainly harmed or messy.

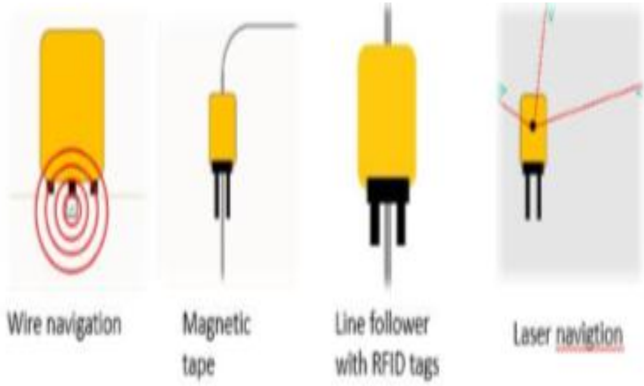

Fig 4. Types of Navigation Mechanisms used in AGV.

An adaptable attractive bar can likewise be implanted in the floor like wire however works under an indistinguishable arrangement from attractive tape thus stays unpowered. Another favorable position of attractive guide tape is the double extremity. Little bits of attractive tape might be put to change conditions of the AGV in view of extremity and succession of the labels. Using magnetic guided tape is beneficial because they are not affected by dust. The layout designed in the Creo software is shown below in figure 5, a pictured form or top view of magnetic tape laying can be seen. It also defines the path for AGV.

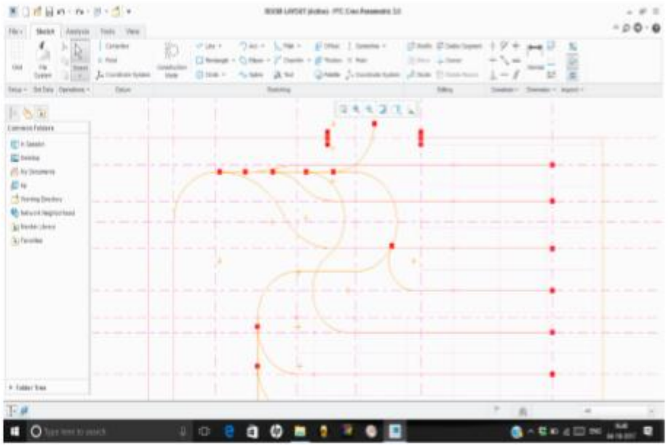

Fig 5. Magnetic Guide Tape Layout.

Magnetic Guide Sensor

The MGS1600GY is a magnetic guide sensor equipped for identifying the position of a magnetic field along its pivot. This sensor is expected for line following automated applications, utilizing a magnetic tape to shape a track guide on the floor. The sensor utilizes advanced digital signal processing to precisely quantify its horizontal separation from the focal point of the track, with millimeter resolution. Tape position data can be yield in numerical arrangement on the sensor's RS232 or USB ports. The position is additionally reported as a 0 to 3V voltage output and as a variable PWM output. The sensor will identify and also manage 2-way forks. It is instructed to follow left or right track utilizing the commands issued via serial/USB ports, accessible through its CAN bus interface. The sensor identifies and reports the position of magnetic markers that might be situated on the left or right side of the track. The sensor has four LED marker lights for simple observing and diagnostics. The sensor includes high performance, basic scripting language that enables clients to add modified functions to the sensor. A PC utility is given for sensor configuration, capturing and also plotting the sensor information on a strip graph recorder, and visualizing in real time the magnetic field as it is observed by the sensor. This sensor has amazing features useful for automated applications like, 100 Hz refresh rate, recognizes and measures position of magnetic track along flat pivot, 10mm to 60mm operational height, CAN interface up to 1Mbit/s, Wide range 4.5V to 30V DC operation. The other benefits of magnetic line tracking is since they are absolutely inactive, magnetic tracks are easy to lay and alter. They are dirt immune and can be made absolutely imperceptible under cover, tile or other deck cover. Figure below shows sensor.

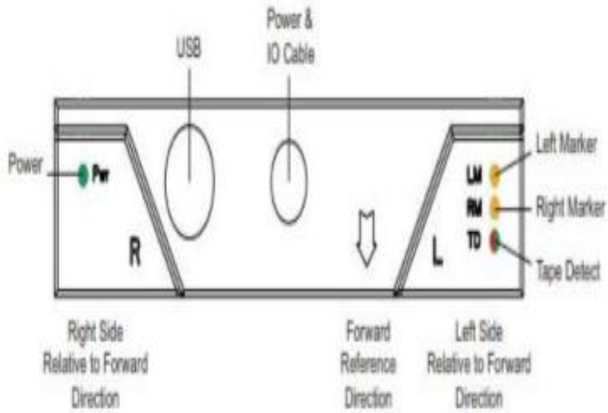

Fig 6. Magnetic Guide Sensor

Magnetic Tape Selection and Installation

The sensor is calibrated for factory use with 25mm or 50mm wide tape from Roboteq, however might be utilized with tape from different providers too. Just unipolar tape can be utilized, where one side is all of one magnetic polarity. In the default setup, the sensor expects South on the best side for the track and North on the best side for markers. The sensor can be designed to work with tape of inverted polarity. The sensor won't work with tape if it alternates its polarity. To decide the tape orientation, point compass towards the best (non cement) side of the tape. The north guiding needle will be pulled in toward the south side of the tape, and the south guiding needle will be pulled in toward the north side of the tape.

Fig 7 Path

Servo Motor Driving Systems

A servo drive gets a motion from a control System, increases the flag, and transmits electric current to a servo motor with a specific end goal to deliver movement relative to the command signal. Typically, the command signal represents a desired velocity, but can also represent a desired torque or position. A sensor connected to the servo motor reports the motors genuine status back to the servo drive. The servo drive at that point contrasts the real motor status and the instructed motor status. It at that point changes the voltage frequency or pulse width to the motor in order to adjust for any deviation from the command status. In an appropriately arranged control system, the servo motor rotates at a velocity that very closely approximates the velocity signal being received by the servo drive from the control system. A few parameters, for example, stiffness (otherwise called proportional gain), damping (also known as derivative gain), and feedback gain, can be adjusted to achieve this desired performance. The way toward altering these parameters is called performance tuning. Although servo motors require a drive particular to that specific motor brand or model, numerous drives are currently accessible that are good with a wide variety of motors. Amalgamation of a freely configurable actuator system, an intelligent servo drive series and sector-specific components permits highest flexibility when thinking of new vehicle concept, safe and space-saving in the smallest installation space.

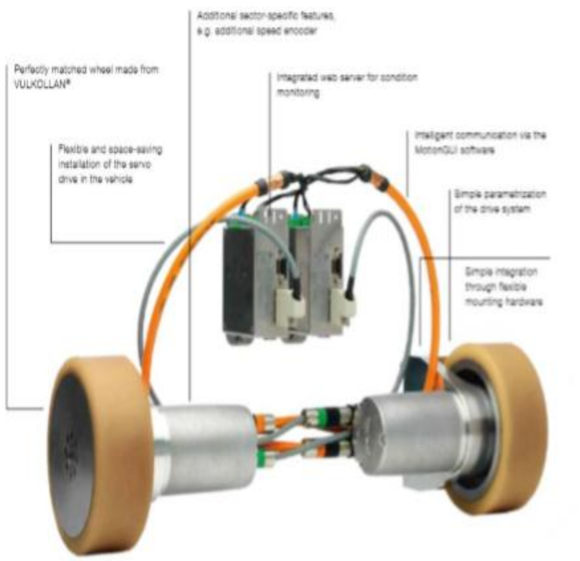

Fig 8. Servo Motor Driving System

Gripping Mechanism for AGV

Gripping systems input actuator's movement into the gripping activity at the output. The actuator can be a motor or a pneumatic or hydraulic device. The gripping activity starts when the work piece is grabbed and closes when it is discharged amid the exchange course.

Here in the proposed model we have designed a gripping mechanism for AGV to engage with trolley. A linear actuator creates motion in a straight line, in contrast to the circular motion of a conventional electric motor. They are used in industrial machinery and machine tools, in computer peripherals such as disk drives and printers, in valves and dampers, and in many other places where linear motion is required. Hydraulic or pneumatic cylinders produce linear motion. Electro-mechanical actuators are like mechanical actuators aside from that the control handle or handle is supplanted with an electric motor. Rotary movement of the motor is changed over to linear displacement. There are numerous designs of linear actuators and each organization that produces them has a tendency to have an exclusive technique. The accompanying is a summed up portrayal of an exceptionally straightforward electro-mechanical direct actuator. Typically, an electric motor is mechanically connected to rotating lead screw. This screw has a continuous helical thread machined on its circumference running along the length. Threaded onto the lead screw is a ball nut with corresponding helical threads. The nut is prevented from rotating with the lead screw. Now, when the lead screw is rotated, the nut will be driven along the threads. The direction of motion of the nut depends on the direction of rotation of the lead screw. By connecting linkages to the nut, the motion is converted to usable linear displacement. Most current actuators are built for high speed, high force, or a compromise between the two. When actuator taken into consideration for any application, the most important specifications are typically travel, speed, force, accuracy, and lifetime. Several types of motors can be used in a linear actuator system. They are dc brush, dc brushless, stepper, or in some cases, even induction motors. It all depends on the application requirements and the loads the actuator is designed to move.

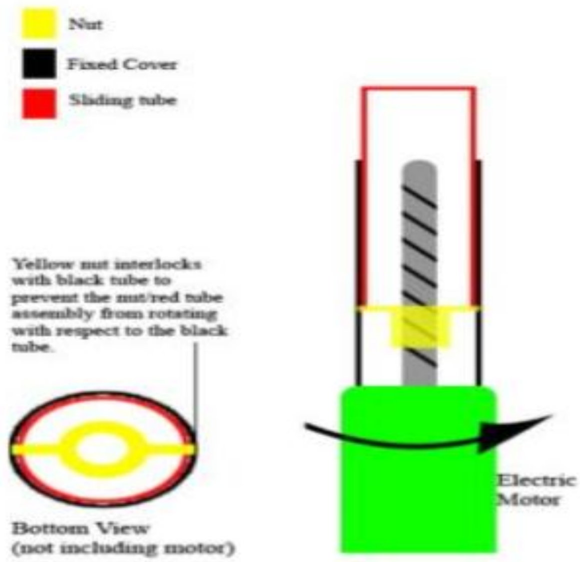

Fig 9. Linear Actuator working Mechanism

Here we designed a gripping mechanism using linear actuator. Actuator used here is an electromechanical linear actuator. The specifications of the linear actuator we take into consideration are: Max. Load: 500N, Input voltage: 12V Dc, Duty cycle: 25, Max Speed: 16.5mm/s, Stroke: 100m.

Now here we used a wedging action. The wedge action principle of these grips allows them to be tightened onto a specimen without altering the vertical position of the faces in relation to the specimen. This is accomplished by a design, which moves the grip body to close the faces. The gripping mechanism designed lays on the AGV platform and here we have 5mm plates being laid over the platform where gripping assembly is engaged. Now when the actuator expands the wooden blocks on the sides touch the edges of trolley and actuator stays expanded and they remain engaged. This is how the engagement of trolley takes place. To determine the exact expansion we have also attached a tension spring having stiffness of 0.5n/mm. The expansion of ripper is 60mm on both sides, which permits automatic locking with woods. Also there is friction surface beneath the trolley.

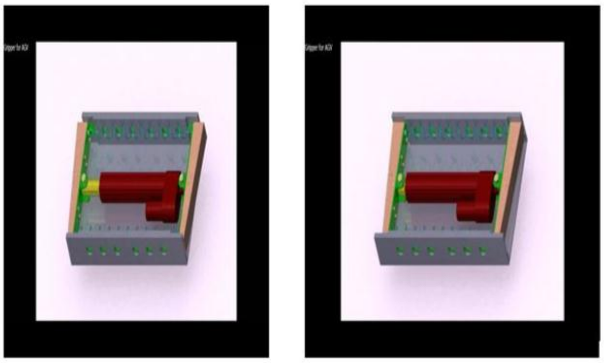

Fig. 10 Gripping Mechanism CAD Model

Simulation and Analysis

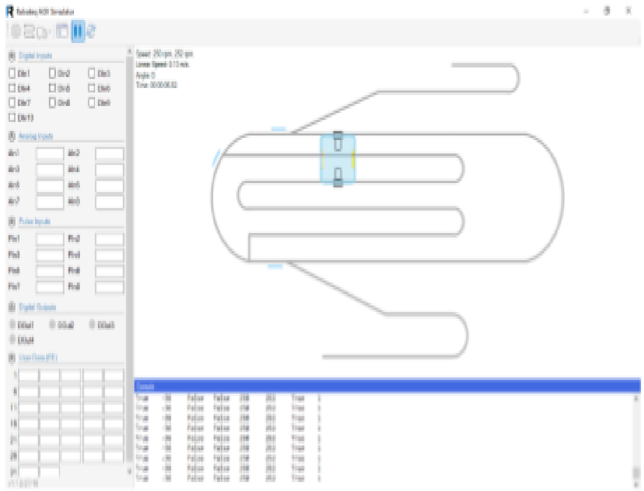

Fig. 11 Simulation of an AGV easily following the guided Path

CONCLUSION

The results of the individual and overall testing of the proposed AGV are very encouraging. One of the remark-able features of the result is its reproducibility. It gives a great tool in the hands of developer to modify the data with suitable calibration. Without this feature no AGV systems can be brought into existence.

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