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Automated Navigation of Guided Vehicle for Warehouses

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Abstract: For the reduction of pollution and shortage of oils, nowadays there is a high demand on the part of manufacturers for their shipping warehouses in an effective manner without any havoc. Human error has been a negative effect on various factors such as safety, efficiency, and quality. These difficulties can be eliminated or reduced with the introduction of a Microcontroller Based Guided Vehicle (MBGV) – a driverless, intelligent forklift which uses an optical path to traverse a warehouse in a quick and safe manner. This vehicle employs a microcontroller and a rechargeable battery for doing the shipping operation in an automated manner without any need for fuel. Since there is going to be a fuel depletion in the world in the coming days, this automated vehicle can be an alternative solution for the above purpose. This paper deals with the existing different types of automated vehicles available, their selection, principle of operation of the proposed model, merits and demerits of this Automated Guided Vehicle and its plan of future work.
Keywords: Light Dependent Resistor (LDR), DC Motors, Servo motor, Predictive control, Microcontroller Based Guided Vehicle (MBGV), Automated Guided Vehicle (AGV).

I. INTRODUCTION

In this paper, the requirement for trolleys and conveyers to deal with transfer of materials in big industries is totally eliminated. For the above requirement an automated Guided Vehicle has been implemented & controlled by a microcontroller. Generally the power from fuel is used for the existing methods of handling material. In the future there is going to be a depletion of fuel in the world due to various reasons. This automated guided vehicle can be employed to avoid this type of fuel depletion thereby reducing the requirements of manpower. In this vehicle, a microcontroller is used to control the path of vehicle in an automatic manner. The power is supplied to the Guided Vehicle by a rechargeable battery. The DC motors used to apply movements to guided vehicle are driven by power previously stored in the battery. The microcontroller controls the velocity (speed of rotation) of DC motor. The available types of guided vehicles and conveyers use petrol or diesel as fuel for their operation. Large amount of fuel will be consumed by these types of vehicles for a specified period. This guided vehicle employs a rechargeable battery which can easily detachable and replaceable and employed for charging while the vehicle is under idle operation. The microcontroller can be programmed to decide the path for the vehicle which can be changed if needed.

The DC motor at the wheel shaft of guided vehicle provides the drive of straight line movement. The rechargeable battery on the sheet metal provides the current supply. It also supplies the already stored energy to the D.C motor. The straight line movement of the guided vehicle is taken care by the D.C motor (12 V/ 2A) and monitored by the Light Dependent Resistor (LDR) sensors. The Loading/Unloading materials and the position of the station can be sensed by the microcontroller with the help of IR sensors. As per the sensor signal received, the microcontroller provides information to DC Motor to move it forward and backward.

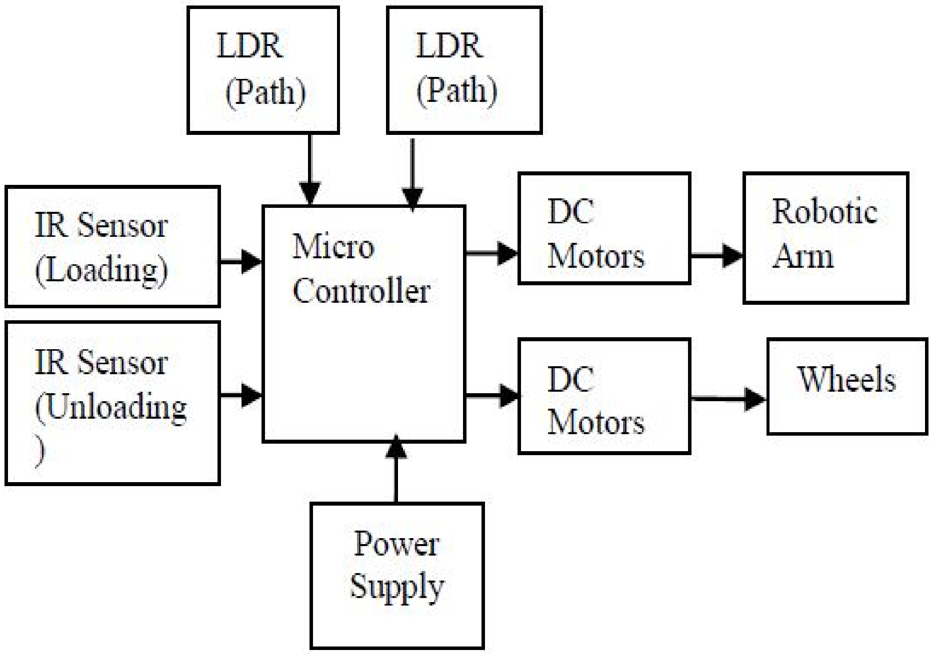

Figure 1: Block Diagram of the Guided Vehicle

The control, navigation and interaction with the working environment of Automated Guided Vehicle (AGV) are indispensable processes for material handling in a Flexible Manufacturing System [1].The selection of type of appropriate vehicle is important to go for designing an AGV system. The first type of vehicle for consideration is a Deck AGV, which can be referred as Load-carrying AGV [2]. This type of vehicle employs different mechanisms of deck-top used to carry and transfer the concerned load. Generally the top of the vehicle carries the load through a customized deck mechanism. The deck acts as a mechanism for movement of the load during transfer to pick-up and deposit stand. These stands use handshake sensors to communicate with the vehicle during the transfer of load. The advantage of this type of vehicle is the capacity to carry multiple units of load, thereby increasing the efficiency of the system. This merit can also reflect in decreasing the number of vehicles needed for the system. When interfacing with pick-up and deposit (P&D) stand, the deck AGVs are parallel to the travel aisle direction and therefore aisle contention can be minimized during the transfer of load while interfacing with pick-up and deposit stands [3].

The second type of vehicle is a forked AGV [4], [5]. Typical forked vehicles employ standard fork truck masts and integrate forks into their design. The connection between the AGV and load is made through the container fork pocket. The Pick-up and deposit points shall be mounted on the floor or at a height above the floor. The key advantage of this type of AGV is its flexibility to interface with existing storage rack systems. Generally these types of vehicles may need a more number of sensors when compared to other types of AGV [6]. The capacity to store and retrieve multiple units of load and its integration with typical pallet platforms are the other merits of this forked type AGV. Generally the forks are made tapered for the applications of roll handling so that product damage can be minimized and varying roll diameters can be accommodated [8].

The third type of vehicle is referred as a load-towing vehicle. The design of a tow-train AGV is almost similar to that of standard tow tractors [7]. The connection between the AGV and load is made through a coupling device. The Pick-up and deposit (P&D) points can be mounted in a parking location on the floor for automatic transfer of load. In conjunction with the load towing, there are a number of designs available for the carts and dollies used for AGV and are generally tuned to the application. The coupling designs either automatic or manual are used for the interface between the vehicle and trailing equipment. The capacity to tow a long train of carts is the additional advantage by which the number of vehicles is decreased to meet requirements of the system [9]. The above types of vehicles may have many variations but the optimal design solution depends upon the nature of application. The important consideration is designing a system flexible with one universal vehicle type.

II. DESIGN AND CONTROL SYSTEM

The controller to be used for the MBGV system needs to satisfy certain requirements such as stability under a specified environment. The aim of the work is the control of electric vehicle where the ground forces to shipping.

Generally the MBGV employed in a model warehouse is built to scale. The key work is to identify the pallets inside the warehouse. An external input generated by an infrared remote control will notify the MBGV whether a pallet is entering or exiting the warehouse. The vehicle follows the high contrast lines for transferring the warehouse to reach the destination. When the four pair line follower module detected an intersection, the MBGV will determine whether to turn or go straight by using an algorithm that incorporate the vehicles for current location and direction.

At the first instant, the remote control gives information about the entry of pallet to the warehouse. The MBGV targeted the pallet from the incoming dock and put it at one of various docks at the warehouse other end. The guided vehicle provides information to another independent vehicle about the new position of the above pallet. The next instant permits for a pallet to be moved out of the warehouse. The guided vehicle along with Automated Storage & Retrieval System (ASRS) will provide a confirmation regarding the location of a pallet at any dock before transiting it to the outgoing dock [10]. During the forward transit, the guided vehicle determines the movement of any object in the forward path using IR sensors. On detection of any object, the guided vehicle will make a delay in travel for the obstruction to be removed. During the reverse transit, the bump sensors will monitor the probability of a rear collision by which the vehicle will be disabled.

III. MODELING OF VEHICLE

In order to guarantee the speed-up time, the electric motor is required to have large torque output under low speed and high over-load capability, and in order to operate at high speed, the driving motor is required to have certain power output at high-speed operation.

The straight line motion of the guided vehicle is taken care by the D.C motor (12 V/ 2A) and monitored by the Light Dependent Resistor (LDR) sensors.. The Loading/Unloading materials and the position of the station can be sensed by the microcontroller with the help of IR sensors. As per the sensor signal received, the Microcontroller provides information to DC Motor to move it forward and backward. The hardware requirements of the system are – Microcontroller, IR Sensors, Light Dependent Resistors and DC Motors. The software requirements of the system are – Keil IDE Compiler and Embedded 'C' language.

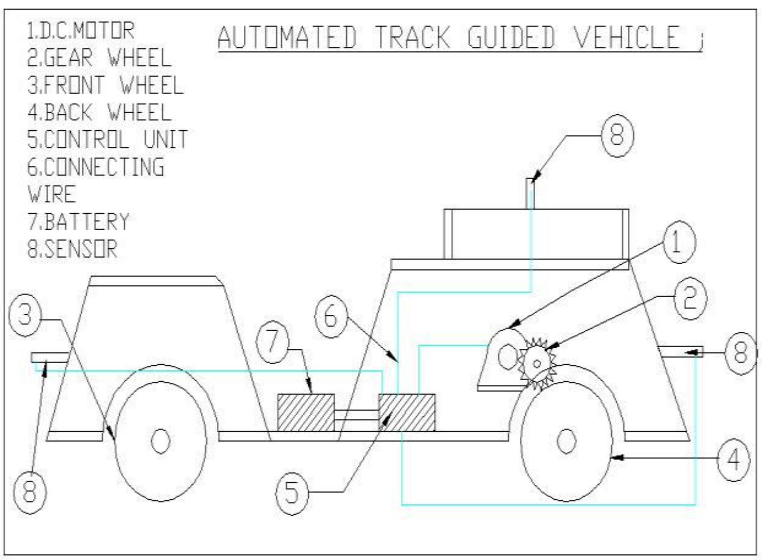

Figure 2: Schematic Diagram of MBGV

IV. EXPERIMENTAL RESULTS AND PROTOTYPE

To illustrate the behavior of the MBGV system and in order to confirm the findings of the previous section, the bilateral controller was designed. The set of hardware designed of Figure 3 shows the gripper in contact with the environment without time delay. The results demonstrate the excellent position and force tracking of the proposed MBGV system under ideal conditions (without time delay). The product is assembled with all relevant sensors and the progress is shown in the Figure 3.

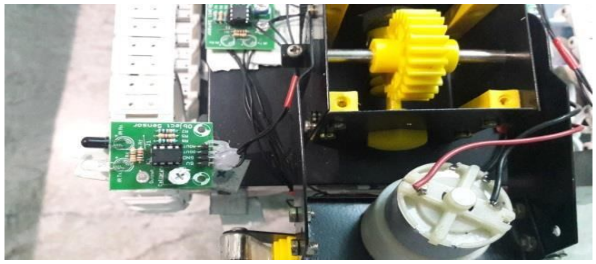

Figure 3: Snapshot of the System

IV. CONCLUSION

An Automated Guided Vehicle (MBGV) is presented. The developed algorithm is based on memorized path and kinematics determination of the movement. The vehicle position and deviation are calculated from rear wheels rotation measurement. The steering and driving command are determined from this deviation. Localization of MBGV by Kaman filtering algorithm is presented. Overall structure of designing MBGV is described. The control of MBGV motion is implemented by using Proportional Integral Derivative (PID) control scheme. Displacement axis and steering axis are separated to implement the motion control.

This paper proposes the localization system for estimation of MBGV. The position and orientation are estimated by Kalman filtering in state-space model. The position and orientation of MBGV are measured and used for simulating the localization system. It is concluded that the vehicle can reach from the initial position moved along with generated path with accurate location. The tests reveal a smooth movement and convenient deviation. The first prototype working, the next research steps will be development of a correction system to correct none detected errors. It will also be necessary to develop the fleet management strategy and software. Future work is planned to increase the accuracy of the system by equipping more sensors for observation technique. Treatment of dynamic model of vehicle is also planned for the next step.

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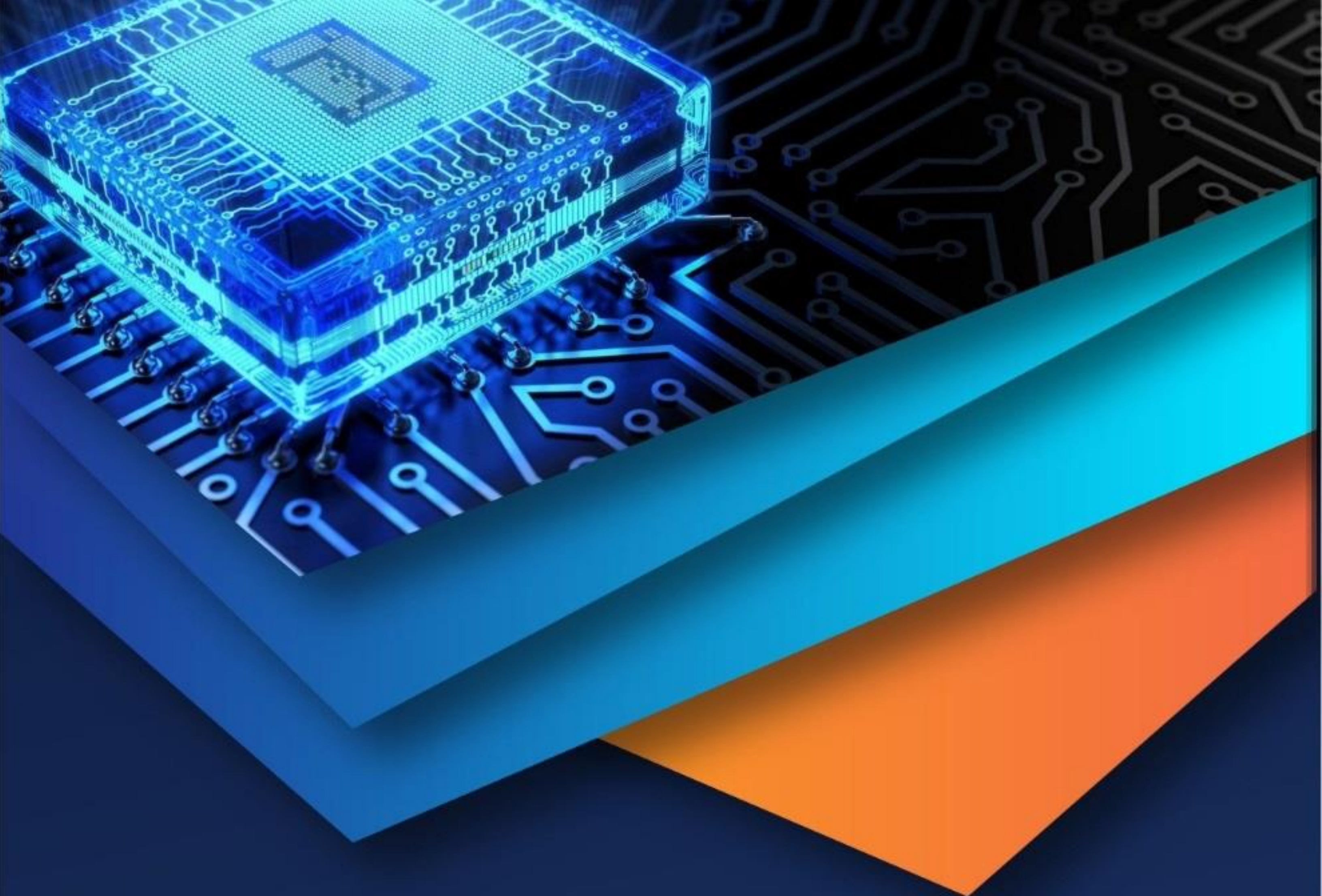

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