Control System Design Analysis on Automated Guided Vehicle (AGV)

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ABSTRACT

An Automated Guided Vehicle (AGV) as a tool to increase flexibility in planning the distribution of goods such as moving an assembled engine to a room. Engine Test for benchmarking on the machine. Automated Guided Vehicle (AGV) is a vehicle that is controlled automatically using a navigation system whose movement pattern control will follow a predetermined path. Writing this report aims to understand the working principle and analyze the control system of the AGV. Movement performance on AGV is controlled by RFID tags, such as stop, start, field change on radar, speed change, and auto-fill. The magnetic stripe is one part of the navigation system. The AGV will follow a track made of adhesive magnetic tape affixed to the floor. The control system on the AGV consists of two main controls controlling the AGV, namely PLC as a performance control and signaling on the AGV and CIZON controller as the primary navigation control on the AGV.

Keyword: -*Automated Guided Vehicle (AGV), Industrial Robot, Line Follower Robot, Radio Frequency Identification (RFID)*

1.INTRODUCTION

The application of automation technology in the industrial world is very much at this time. The application of technology is intended to make it easier for humans to complete work. In logistics, efficiency and effectiveness are fundamental things that must be appropriately managed. Suppose these two things are not handled properly. In that case, it will result in more significant costs incurred, and the processing time in logistics also runs longer, so the quality of distribution services to customers or users will decrease. To overcome this problem, industry and warehouses have used a robotic technology called AGV (Automated Guided Vehicle) to optimize material handling systems and as an alternative to solve the issues related to distribution system problems. PT. Hino Motors Manufacturing Indonesia (HMMI) is a manufacturing company that uses AGV to optimize material handling systems, such as moving the assembled engine to the Engine Test room to benchmark the machine [1]. In the manufacturing process, the AGV is a vehicle with hardware, software, sensors, and actuators responsible for directing the movement according to the planned route.

2. THEORETICAL FOUNDATION

2.1 Automated Guided Vehicle (AGV)

Automatic Guided Vehicle (AGV) is generally used to identify vehicles capable of moving and performing specific tasks independently without operator assistance. Different AGVs are used in almost every finished goods manufacturing industry to carry a wide variety of products (usually using pallets). The functions performed by the AGV are similar to those of human-driven lift trucks [2]

Fig. 1. Automated Guided Vehicle

Automated guided vehicles (AGVs) are self-driven vehicles. Early types of AGVS were introduced around 1954. They are used to transport material from one location on the facility floor to another without any accompanying operator, and are widely used in material handling systems, flexible manufacturing systems, and container handling applications. With the advance of technology, more sophisticated machines are available, which considerably reduce machining and internal setup time [1]. The aim of production planning includes along with fast production, efficient transportation of material between the workstations and in and out of storage. Flexible material handling systems are required to perform an efficient routing of material with random handling capability. The use of AGVs increases flexibility, since the flow path can easily be selected from number of alternative paths, or, can be reconfigured to accommodate new locations. The design of material handling guide path has a significant implication on the overall system performance and reliability, since it has a direct impact on the travel time, the installation cost, and the complexity of the control system software.

3. RFID (Radio Frequency Identification)

Radio Frequency Identification (RFID) is a general term for non-contact technology that uses radio waves to identify people or objects automatically. RFID uses radio frequencies to read information from a small device called a tag or transponder (transmitter and responder). The RFID tag will recognize itself when it detects a signal from a compatible device, namely an RFID reader (RFID reader) [2]. RFID systems, tags, or transponders are generally attached to an object. Each tag can carry unique information, including serial number, model, color, place of assembly, and other data about the object When this tag passes through the field generated by a compatible RFID reader, the tag will transmit the information contained in the tag to the RFID reader so that the object identification process can be carried out.

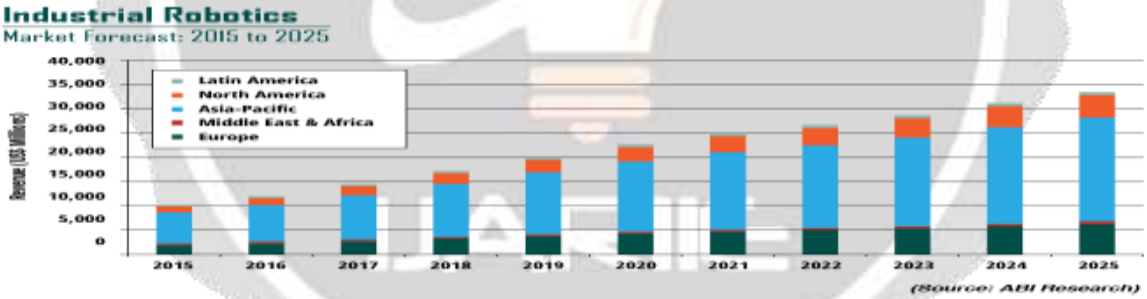

Fig -2. Industrial Robotics Chart

4.CIZON

Controller The CIZON controller is the control center of the navigation system on the AGV, which includes the navigation control system and software. CIZON is a product of Hunan CIZON Robot Co., Ltd, an AGV (Automated Guided Vehicle) manufacturer engaged in mobile robots, including several AGV navigation principles, such as AGV Magnetic guide, AGV QR code guide, AGV Inertial guide, AGV laser guide [4].

3.1 Operating System on Automated Guided Vehicle (AGV)

AGV devices, such as electromagnetic or optical, can travel along the specified guide path carrier with safety protection and various transfer functions. The AGV is battery-powered and equipped with a non-contact navigation (guide) device for crewless transport operations. Its central part is for the AGV to be monitored by the computer, according to the track and requirements, running and stopping at the specified position accurately, and completing a series of work functions

Based on Figure 3

It can be seen that the components of the AGV are:

1. E-stop button
2. SICK Laser Obstacle Scanner (Radar)
3. Safety Bumper
4. Electrical Roller
5. Roller Driving Motor
6. Magnetic Navigation Sensor
7. Pallet Proximity Sensor
8. Operation Button
9. Charging Plate
10. Play Driving Motor
11. Directional Wheels

The movement performance of the AGV is controlled by the RFID tag, such as stop, start, field change on the radar, speed change, auto-fill, and so on. The RFID coordinate information is stored in the AMS (AGV Management System) system so the AGV can report location data to AMS in real-time. The magnetic stripe is one part of the navigation system. The AGV will follow a track made of adhesive magnetic tape affixed to the floor. Magnetic sensors will measure how far from the tape's center and provide information to the motor controller, which will adjust the steering wheel to keep the vehicle in the middle of the track. Here is a picture of the RFID tag and magnetic stripe on the AGV. The AGV system is equipped with an automatic charging system, the AGV will charge the battery every circle, and there is a charging bar that will contact the charging plate on the AGV. When the battery is low, the AGV battery will be charged automatically so that the AGV can run 24 hours continuously. Two photoelectric sensors establish, communication between the AGV and the charging system.

Fig.4: Battery charging process

4. Motor: In the Motor Automated Guided Vehicle (AGV) section located at PT Hino Motors Manufacturing Indonesia, it has several servo motors and motor drivers as drivers from the AGV in the form of Driving Motor and Turning Motor sections for AGV navigation and Roller Motors as conveyors to deliver the engine pallet where all servos The motor is controlled via a servo motor driver. A servo motor, also known as a control motor, is a rotary device or actuator (motor). The engine is designed with a closed-loop feedback control system (servo), so it can be adjusted to determine and ensure the angular position of the motor output shaft. The use of servo motors on the AGV is used to move and provide the direction of the wheels on the AGV, and servo motors are also used on conveyors to deliver the engine to the engine test room for benchmarking. The Pulse Width Modulation (PWM)

technique is often used in regulating motor speed. The PWM technique works on the motor by providing a stable voltage source and a fixed working frequency, but the way to adjust the engine's momentum is by changing the amount of ton duty cycle pulses. Tons of varying duty cycle determines the motor's speed according to needs. A motor driver will control each servo motor, communicating with the PLC and CIZON Controller on the AGV.

4.1 Navigation System on AGV

The navigation system on the AGV is controlled through the CIZON controller, which is the control center of the navigation system on the AGV, which includes the navigation control system and software. An RFID tag (landmark) used to determine the position of the AGV is used on the AGV path. The RFID tag on the AGV can be installed in several ways. In most cases, the RFID Reader will be mounted under the AGV with the RFID tag mounted inside or on the floor, allowing the AGV's logic to understand its location and make decisions to stop, turn, change speed or continue straight ahead. There are several parts in the RFID localization process: RFID landmark information and action, RFID landmark defining, RFID landmark program, and RFID traffic avoidance system. Fig- 8 RFID Tag (Landmark) An RFID tag (landmark) includes two things: landmark information and landmark action. Landmark information provides information about the current landmark number (location) and relevant information about other AGV traffic. The AGV will perform the appropriate action after reading the landmarks passed during the trajectory, such as start, stop, speed change, etc.

Fig.5- RFID Tag (Landmark)

Before being used on an AGV track, RFID landmarks must first be identified by assigning a number to the RFID landmark through the connection between the PC and the AGV controller. After the connection between the PC and the AGV controller is successful, on the AGV software display, we can choose the appropriate brand and type of RFID. To identify an RFID landmark, we place a new RFID landmark under the RFID sensor and type the landmark number on the software interface by typing "1". Then click the "write" button. After this operation, the new landmark number was assigned as "1". The landmark program controls the movement of the AGV. The user must identify each landmark action by software on the AGV. The AGV will perform different actions according to the landmark defined by the user. Users can define more than one action for each RFID landmark, such as start, stop, charge, wait, radar field switch, speed change, and so on. Usually, there is more than one RFID landmark in an AGV route, resulting in different actions. The AGV will maintain the same status on its path until it detects the next new landmark. The RFID Traffic Avoid System uses a broadcasting system where traffic avoidance is controlled through landmark information. Each AGV unit will notify other AGVs of landmark information, such as avoidance systems on the AGV path. Figure 8 illustrates the method for avoidance on the AGV path. Fig- 9 Program display on landmark

Fig.6- Program display on Landmark

Based on Figure 6 it can be seen that there are two AGV routes in the room, the first route and the second route. There is one AGV on each way, which moves in the direction indicated by the arrow. The area that contains numbers, called the black box area, is the traffic avoidance area. If AGV No.1 arrives at landmark one, it will send landmark information on AGV No.2 by AGV No.1. AGV No.2 will stop at landmark three and wait automatically until AGV No.1 arrives at landmark 5, then AGV No.2 will restart automatically.

5. CONCLUSIONS

Using an Automated Guided Vehicle (AGV) in the engine test line can solve the problems of the material handling system and distribution system on the engine before and after the test. The movement of the AGV is based on a line

follower, which will follow a track made of adhesive magnetic tape attached to the floor. Movement performance on AGV is controlled by RFID tags, such as stop, start, field change on radar, speed change, and auto-fill ,The workflow design of the AGV has three manual processes that are given manually to the AGV, namely the process when the engine testbench, the process when the engine is qualified, and the process when the machine is repaired on the engine test. The control system on the AGV consists of two main controls in controlling the AGV, namely PLC as a performance control and signaling on the AGV and CIZON controller as the primary navigation control on the AGV. In the RFID localization process, there are several parts: RFID landmark information and action, RFID landmark defining, RFID landmark program, and RFID traffic avoidance system. Human Machine Interface (HMI) on the AGV functions to monitor the operating status of the AGV, where the device and operating status on the system can be displayed in real-time. It also serves as a notification to the operating system if there is an error.

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