

# Implementation of AGV Robot Technology for the Goods Distribution Process at the Bosowa Polytechnic Teaching Factory

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**Abstract** — In the modern industrial era, increasing operational efficiency and automation have become top priorities in various sectors, including manufacturing, logistics, and distribution. In this context, Robot Automated Guided Vehicle (AGV) has become a highly sought-after solution to meet the increasing demands for efficiency and productivity. This study aims to implement Robot AGV technology in the distribution process of goods at the Bosowa Polytechnic Teaching Factory. This AGV robot is designed to move independently using a Pixy camera sensor that can read barcodes as a determinant of the direction of movement. This robot is equipped with a PID control system, GY-271 compass sensor, and Arduino ATmega Pro Mini microcontroller. The research method used is an experimental method that includes literature studies, system design, prototyping, and performance testing. The results of the study showed that the AGV robot was able to follow barcode instructions well, including moving right, left, or stopping. The conveyor system used in the robot is capable of carrying loads of up to 20 kg at varying speeds depending on the weight of the load. Further development is focused on improving sensor accuracy and energy efficiency.

**Keyword** — AGV Robot, Goods distribution, Pixy Camera, PID Control, Arduino ATmega

## I. INTRODUCTION

In the modern industrial era, increasing operational efficiency and automation has become a top priority in various sectors, including manufacturing, logistics, and distribution. In this context, Robot AGV has become a highly sought-after solution to meet the increasing demands for efficiency and productivity.

AGV robots are a type of robot designed to perform certain tasks independently and automatically in a specific environment, without requiring direct human assistance. Using advanced sensor, navigation, and control technology, AGV robots can move independently along predetermined paths, transport goods, and execute other tasks according to pre-programmed programs [1].

Research conducted by Munadi, Ismoyo Haryanto, and Muhammad Irvan Dian Surya on the design of an AGV robot chassis that has resistance to the load that the AGV robot will carry, the methods used in this research include chassis design, material selection, simulation, and the process of testing resistance to predetermined loads [2].

Research conducted by Justiadi, Jumaddil Hair & Yusdianto. It discusses the design of an AGV robot as a tool delivery from the tool center station to the CNC machine or vice versa, robot control using PID control, mecanum wheels, and line reader sensors so that the robot can move stably when crossing the line, this robot is equipped with a

bracket using hollow iron on the top to store the robot's belongings, the process of picking up goods uses wireless wifi as communication between the robot and the tool station, but the implementation of Mecanum wheels and adaptive PID algorithms requires a deep understanding of mechanics and control, which may add to the development and maintenance of the system [3].

In the previous study entitled "Design and Simulation of PID Control System on AGV Line Follower". This study aims to develop an AGV that can follow a white line using a PID (Proportional, Integral, Derivative) control system. This study uses an RGB-D camera as a navigation tool to detect the path. Using SketchUp software for 3D design and converted to format and for use in the Gazebo simulator. AGV is simulated in a Gazebo environment integrated with ROS (Robot Operating System). The PID algorithm is implemented and tested with various parameters to obtain the best response in following the path. However, in this study, AGV performance is highly dependent on the quality and calibration of the RGB-D camera, which may face problems on poorly lit or reflective surfaces [4].

Research by Sandy Bhawana Mulia, Wahyu Adhie Candra, and Mohammad Faisal on 'Design and Construction of Microcontroller-Based Automated Guided Vehicle Prototype' successfully demonstrated the implementation of an effective AGV prototype using line and ultrasonic sensors for navigation. Although successful in initial trials, this prototype has limitations in sensor accuracy and application flexibility in more complex environments [6].

Thus, this study will detail the latest developments in the design, navigation, control, and application of AGV robots at the Bosowa Polytechnic's tefa (teaching factory), as well as provide insight into the challenges faced and the research directions that are expected to shape the future of AGV robotics.

## II. RESEARCH METHODS

The AGV robot was created using an experimental method, where the microcontroller processing used Arduino and was assisted by the Arduino operating source to program the I/O pins of all sensors connected to the AGV robot. This study focuses on the implementation of the AGV robot for the distribution of goods at the Bosowa Polytechnic Teaching Factory. Figure 1 is a flow diagram of the research.

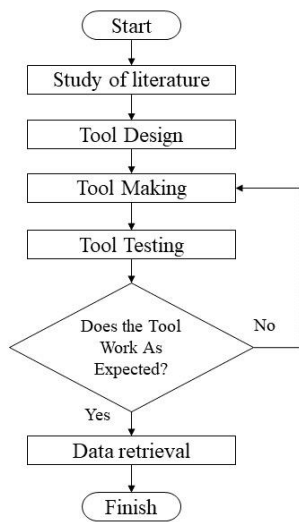


Figure 1. Research Flow Diagram

1. Literature Study

This research begins by conducting a literature study on AGV robots and looking for data and references that are relevant to the topic or tool to be developed, based on previous research this research will focus on the durability of robots in distributing goods, wheel rotation speed, and conveyor systems.

2. System Design

The system design on the AGV robot starts from the robot design using Autodesk Inventor Software, followed by mechanical design and determining all the sensors needed. Figure 2 is a block diagram that describes the microcontroller system in this study.

The following is a picture of the wiring diagram of the entire tool:

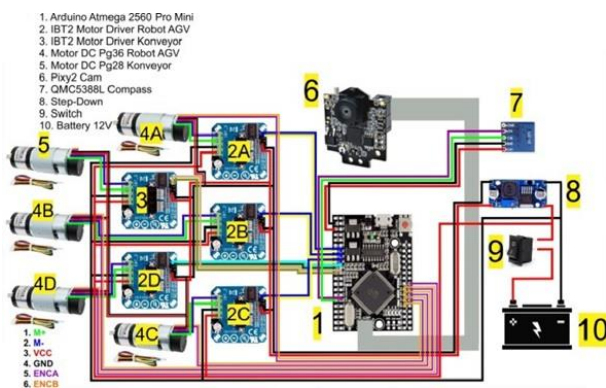


Figure 2. AGV Robot Wiring

In the wiring section, initial research has been conducted on the selection of components and circuits that will be used

in the system. This system controls the AGV using a motor driven by a motor driver. The Pixy Camera detects barcodes for navigation, while the compass provides direction orientation. The microcontroller acts as the brain of the system, controlling all components based on data received from the camera and compass as well as programmed instructions.

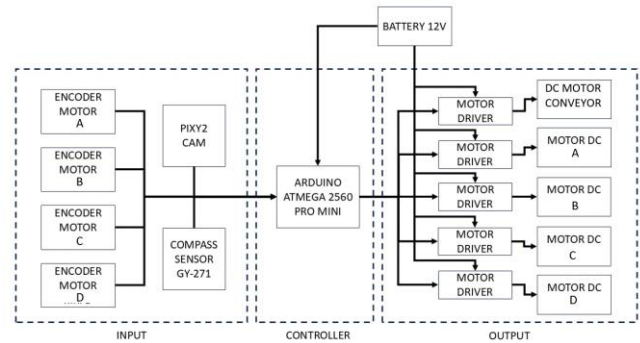


Figure 3. Block Diagram of AGV Robot

Based on the block diagram in Figure 3, the integration of the Pixy camera, the GY-271 compass sensor, and four DC motors on the wheels and one for conveyor control is explained, which are controlled by the Arduino ATmega Pro Mini. The Pixy camera and compass sensor function as inputs that send data to the Arduino. The Arduino processes this data and controls the motors through the motor driver. Based on the barcode detected by the Pixy, the Arduino will activate the motor on the left side, the right side, or stop all motors. This system is operated using a battery that provides power to all components. The microcontroller used is the Arduino ATmega Pro Mini, where this component is a microcontroller board that is compatible with the Arduino Mega 2560. This board has a smaller size when compared to the Arduino Mega 2560 board which has a large size [7].

3. Design Plan

In the design of the frame, model, shape and construction of the frame, it is necessary to remember the strength and durability of the material. The most important thing to consider in designing something is the support/chassis. The chassis is a supporting structure that is the main support for the robot [8]. Figure 4 is the design of the AGV robot chassis carried out in Solidwork Software with millimeter units.

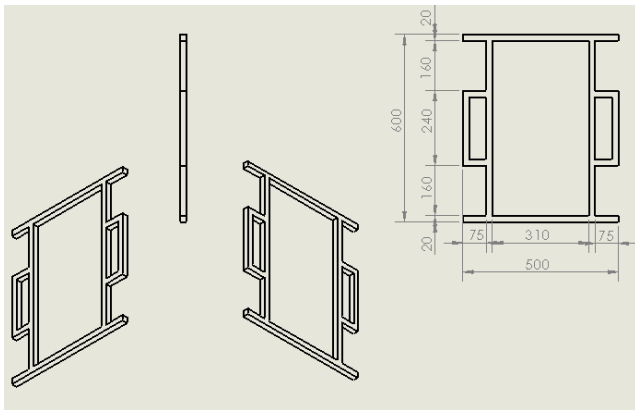


Figure 4. AGV Robot chassis design

The robot frame design process uses hollow iron measuring 20x20 mm with a thickness of 1.8 mm, with this material allowing the robot to move lighter and able to withstand quite heavy loads. The robot design is made in a rectangular shape with a length of 600 mm, a width of 500 mm, and a height of 550 mm, for the robot body uses acrylic with a thickness of 3 mm, while the conveyor is on the top of the robot with a length of 700 mm.



Figure 5. AGV robot frame manufacturing process

#### 4. AGV Robot Working System

The AGV robot working system is powered by a 12V battery, after being turned on the pixy camera will read the barcode in front of it to determine the robot's movement at a speed that has been determined in the programming. When the robot operates the microcontroller will calculate the encode value of the DC motor, the encoder is an electronic device used to convert physical movement or position into a digital signal that can be read by a computer or control system [9]. This allows the AGV robot to stop according to the encoder reading that has been determined and calibrated.

### III. RESULTS AND DISCUSSION

The result of this research is the creation of an AGV robot that uses a Pixy camera image sensor with barcode reading to determine the direction of the robot's movement. This robot is equipped with a mehanum wheel. The following is an explanation of the AGV robot system testing.

#### 1. Motor Speed Testing

Motor speed testing is carried out to determine the speed of each motor with a tachometer measuring instrument. Each motor is given a pwm value of 0 to 255, then the speed value (rpm) of each motor is measured and observed on the digital tachometer [10]. The following is a table of motor speed test results.

Table 1. DC Motor Speed Testing

PWM	rpm			
	Motor A	Motor B	Motor C	Motor D
40	44	46	44	45
50	56	58	58	57
60	68	71	73	73
70	80	83	81	81
80	92	95	95	93
90	104	106	106	106
100	115	118	118	118
110	127	131	130	130
120	139	142	143	143
130	153	155	155	153
140	164	168	168	167
150	177	180	180	180
160	190	193	192	192
170	203	205	208	206
180	214	218	218	218
190	227	232	230	231
200	238	244	244	243
210	250	257	258	256
220	252	263	264	263
230	269	282	282	282
240	276	294	294	294
250	307	307	307	306

Testing the speed of DC motors was conducted by varying the PWM value from 0 to 250 to measure the rotational speed in RPM across four different motors: Right Motor A, Right Motor B, Left Motor C, and Left Motor D. Initially, when the PWM value was 0, all four motors did not rotate, indicating an RPM of 0. As the PWM value was increased to 10, the motor speed began to rise uniformly, with each motor reaching a speed of 8 RPM. As the PWM value continued to increase, all motors showed a nearly consistent rise in speed, with slight variations among them. For example, at a PWM value of 40, the speed of Right Motor A reached 44 RPM, while Right Motor B was

slightly faster at 46 RPM, and Left Motors C and D ranged between 44-45 RPM. These minor speed differences could be due to mechanical differences or tolerances in the motor construction. At a PWM value of 100, the speed of all motors was around 115-118 RPM, indicating a more significant increase in speed. When the PWM value reached 200, the average motor speed ranged between 238 and 244 RPM, with Right Motor B being slightly faster than the others. At the maximum PWM value of 250, the speeds of Right Motors A, B, and Left Motors C, D showed almost perfect uniformity, reaching approximately 307 RPM. These test results demonstrate that the speed of DC motors can be effectively controlled using PWM, with an almost linear increase in speed corresponding to the increase in PWM value. The slight variations among the motors may indicate the need for calibration or adjustment in the control system to achieve uniformity.

## 2. Load Testing on Conveyors

Conveyor testing is done by giving a load on the robot and then the conveyor is moved to move the goods. This test also measures the maximum load that the conveyor can withstand.

Table 2. Load Testing of Conveyors

Num.	Motor Rotation	Burden	Conveyor Capability	Traveling Time
1.	255 pwm	2 kg	Succeed	4s
2.	255 pwm	10 kg	Succeed	9,5s
3.	255 pwm	15 kg	Succeed	15s
4.	255 pwm	17 kg	Succeed	15,3s
5.	255 pwm	19 kg	Succeed	19s
6.	255 pwm	20 kg	Succeed	21,1s
7.	255 pwm	21 kg	not successful	-

Based on table 2, it can be concluded that the conveyor's ability to transport loads up to 20 kg with a motor rotation of 255 pwm is successful, although the travel time increases with increasing load. This shows that the maximum limit of the conveyor's ability with a motor rotation of 255 pwm is 20 kg.

## IV. CONCLUSION

In this study, an AGV robot has been successfully designed and tested using a Pixy camera as a sensor to read barcodes in determining the direction of the robot's movement. The test results show that the AGV robot is able to move according to the instructions given via barcode, both to turn left, right, and stop. The conveyor system on the robot is also capable of carrying loads of up to 20 kg with a motor rotation of 255 PWM, although travel time increases

with increasing load. Further development can be focused on improving the sensor accuracy and energy efficiency of this AGV robot.

## THANK-YOU NOTE

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