International Journal on Smart Material and Mechatronics
IJSMM Vol. 11 No. 2 2024 DOI. 10.20342/IJSMM.11.2. 291
p-ISSN: 2356-5314
e-ISSN: 2460-075X

Integration of Pixy Camera and AGV Robot Technology in Goods Distribution System at Politeknik Bosowa

Hasan, Yahya Bin Mulyadi, Al Muadza Zainuddin, Isminarti*, Muhammad Nur
Politeknik Bosowa
Jalan Kapasa Raya No. 23 Kapasa Kecamatan Tamalanrea, Daya Kec. Biringkanaya Kota Makassar, Sulawesi Selatan, Indonesia
isminarti@politeknikbosowa.ac.id

***Abstract*— This study discusses the integration of a Pixy2 camera on an AGV robot for a barcode-based navigation system at the Politeknik Bosowa teaching factory. The use of barcodes was chosen to avoid errors and inefficiencies that may occur with color detection, which is influenced by changing lighting conditions. Pixy2, with its powerful image processing capabilities, is used to read barcodes and send data to the Arduino ATmega Pro Mini microcontroller to determine the robot's direction. The results show that this system is effective in determining the robot's direction based on barcode readings, both indoors with a minimum light intensity of 60 lux, and outdoors with a minimum light intensity of 5 lux. This study successfully developed a more accurate and efficient AGV robot system compared to color-based systems, making it suitable for goods distribution applications.**

***Index Terms*— Pixy Camera, Robot AGV, Compass Sensor, Barcode.**

I. INTRODUCTION

The rapid technological advancements in recent years, especially in automation technologies to assist humans in the visual field, have led to the creation of various visual devices ranging from very simple cameras to those with numerous advanced features. One such device is the Pixy camera, which excels in reading and tracking objects based on color and has the additional capability of reading barcodes and lines. Color is a crucial feature of an object, and in many cases, object tracking can be effectively achieved using color as a reference. For instance, tracking an orange ball in the middle of a green field would best be accomplished using color features. The Pixy CMUCam5 is a type of camera frequently used in robotics. It is an image sensor with a powerful processor, preprogrammed to send information as data, thereby not burdening the microcontroller with the data reading process. This sensor can also read hundreds of objects with seven different colors simultaneously at a speed of 50 fps. Pixy CMUCam5 comes with an open-source application called PixyMon [1].

Research by M. Nizar Falafi Astoro et al. focuses on a robot that uses the Pixy CMUCam5 camera as a color-based object-following sensor. This research discusses the implementation of PID control on the robot for object positioning using the Pixy CMUCam 5 camera sensor. It successfully demonstrated the robot's ability to detect, pick up, and throw objects in a competition scenario by implementing PID control on the microcontroller, allowing the robot to reach the desired points. However, there are some limitations in this research, namely the reliance on the color detected by the Pixy camera, where changes in lighting can reduce the accuracy of object detection [2].

Lutfi Wahyu Aryanto et al. researched a forklift robot with automatic braking when an obstacle is directly in front of it, while the robot cannot detect objects on its sides or back. This forklift robot uses the Pixy camera to detect color-based obstacles and is equipped with an ultrasonic sensor HC-SR04 to detect the distance between the robot and the obstructing object. This system successfully detects and stops the forklift when an obstacle is within 20 cm, although it still has limitations in detection range and accuracy [3].

Additionally, research by Sukma et al. involves a Mechatronics system with a complex control circuit, where the Pixy2 CMUCam5 camera sensor is used for color detection of objects. The control circuit used is a Karnaugh Map circuit with Digital ICs (Not-And-Or) and Arduino Uno to operate a sorting machine as an educational medium. The resulting sorting machine can be easily operated, reprogrammed for color detection of objects, and motor control (DC motors and servos), and reconfigured for the Karnaugh Map circuit [4].

Research conducted by Andy Suryowinoto and Affan Zihar Wirandi discusses image processing using the Pixy camera to sort items by color and group them into containers according to their respective colors. The method used involves taking RGB threshold values obtained from the Pixy camera as identifiers for the primary colors red, green, and blue. These values are then processed by the microcontroller to give

International Journal on Smart Material and Mechatronics Vol. 11 No. 1 2024 p-ISSN: 2356-5314
DOI. 10.20342/IJSMM.11.2.291 Hasan, et.al, Politeknik Bosowa, Indonesia e-ISSN: 2460-075X

commands to the servo motors, which act as sorters and classifiers of the items based on their colors [5].

Research by Erwin Ramadhani and Sujono resulted in a conveyor system with a robotic arm. In this system, when the robot is active, the conveyor moves objects through the CMUCam5 camera to detect the color of the objects. The conveyor stops when the ultrasonic sensor detects a specified distance to an object, and the robotic arm's gripper works to pick up the object and move it to a location based on its color. This process continues until all objects on the conveyor are sorted into their respective containers. However, this system is highly dependent on color detection, which can be inaccurate under changing lighting conditions or for objects with similar colors [6].

This research discusses the integration of the Pixy2 camera with barcode reading on an AGV robot used for goods distribution at the teaching factory (tefa) of Politeknik Bosowa. In this study, the Pixy2 camera is not used for image processing or color detection but solely for reading barcodes to avoid errors and inefficiencies that may occur when the Pixy camera reads colors. Thus, the main focus of using the Pixy2 camera is on more accurate and efficient barcode reading to demonstrate the robot's movement during navigation and effectively determine the robot's direction.

II. Research Methods

This study uses an experimental method focusing on the integration of the Pixy2 camera with the AGV robot as a navigation system to determine the robot's direction through barcode reading. This approach aims to avoid color reading errors due to the influence of changing light conditions. Fig. 1 shows the research flowchart.

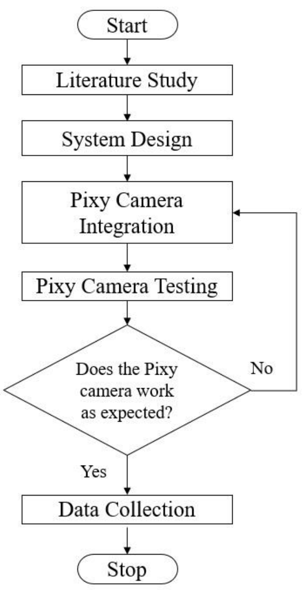

Fig. 1. Research Flowchart

1. Literature Study

   This research begins with a literature study on AGV robots and gathering data on the Pixy camera and its working principles, as well as references relevant to the topic or tools to be developed. According to Bill Earl, "The Pixy camera has powerful image processing capabilities that can track colored objects, track dozens of objects simultaneously, and report their locations to an Arduino in real-time" [7]. This study uses the Pixy camera as the main sensor and the Pixy2 camera for barcode reading.

2. System Design

   The system design for the AGV robot starts with the robot design using Autodesk Inventor software, followed by mechanical construction and the setup of all required sensors. Fig. 2 shows the block diagram illustrating the microcontroller system used in this research.

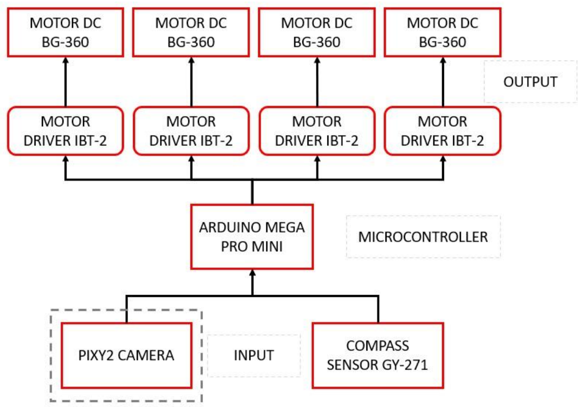

Fig. 2. AGV Robot Block Diagram

   Based on the block diagram in Fig. 2, the integration of the Pixy camera, GY-271 compass sensor, four DC motors for the wheels, and one for conveyor control, all controlled by an Arduino ATmega Pro Mini, is explained. The Pixy camera and compass sensor function as inputs sending data to the Arduino. The Arduino processes this data and controls the motors via a motor driver. Based on the barcodes detected by Pixy, the Arduino will activate the motors on the left side, right sides, or stop all motors. This system is powered by a battery that supplies power to all components. The microcontroller used is the Arduino ATmega Pro Mini, which is compatible with the Arduino Mega 2560. This board is smaller in size compared to the larger Arduino Mega 2560 board [8].

3. Pixy Camera Integration

   This stage involves integrating the Pixy camera to read barcodes and send data to the Arduino to determine the direction of the AGV robot. The flowchart for using the Pixy camera can be seen in Fig. 3.

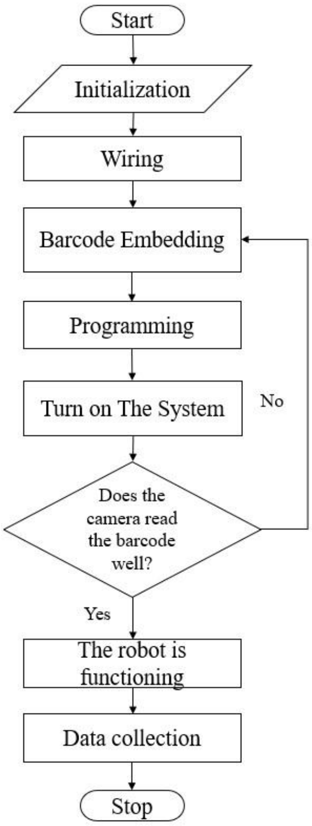

Fig. 3. Pixy Camera Flowchart

The method for embedding barcodes is done using the PixyMon software with the line_tracking program, where this action includes two functions: line reading and barcode reading. PixyMon is software used to configure and monitor the Pixy CMUCam5 camera. Pixy is a camera sensor specifically designed for robotic and machine vision applications. PixyMon allows users to see what the Pixy camera sees in real-time, set parameters for color detection, barcodes, lines, and calibrate the sensor to ensure it correctly recognizes objects [10]. Fig. 4 shows the process of embedding barcodes to determine the robot's direction using the PixyMon software.

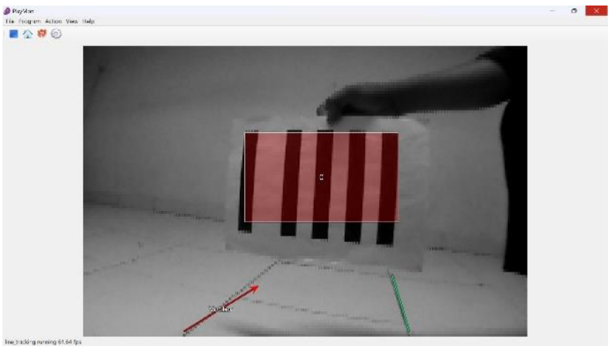

Fig. 4. Pixy Barcode Camera Reader

III. Result and Discussion

This research produced an AGV robot that uses a Pixy camera image sensor with barcode reading to determine the robot's direction. Fig. 5 below explains the integration of the Pixy camera as an image sensor on the AGV robot.

Fig. 5. AGV Robot

1. Pixy Camera Testing

Pixy camera testing was carried out by measuring the light intensity in the area the robot passed through. This testing aims to determine the sensitivity of the Pixy camera's detection of light lux to read the embedded objects. Light lux is the unit of light intensity received by an object on its surface [11]. Table 1 shows the results of camera reading tests under varying indoor lighting conditions. In this experiment, barcode reading was performed perpendicular to the robot, and the light intensity (lux) was adjusted according to the conditions of the TEFA (Teaching Factory) room during production hours from 5:00 PM to 8:00 PM.

TABLE 1. Camera Reading Testing in Indoor Light

No.	Light Lux (lux)	Pixy Reading
1.	30 lux	Not readable
2.	40 lux	Not readable
3.	50 lux	Not readable
4.	60 lux	Readable
5.	90 lux	Readable

Table 1 above shows that the light intensity needed to read barcodes effectively in the TEFA room is a minimum of 60 lux. Lighting levels below 60 lux are insufficient for accurate barcode reading while lighting above 60 lux provides better results. This is important to consider when setting up room lighting during operational hours to ensure smooth barcode reading by the robot during production.

TABLE 2. Pixy Camera Reading Testing in Outdoor Light

No.	Light Lux (lux)	Pixy Reading
1.	0 lux	Not readable

No.	Light Lux (lux)	Pixy Reading
2.	5 lux	Readable
3.	10 lux	Readable
4.	20 lux	Readable
5.	30 lux	Readable

Based on the comparison of Tables 1 and 2, it can be analyzed that indoors, the Pixy2 camera requires higher light intensity (at least 60 lux) to read barcodes properly, while outdoors, the Pixy2 camera can read barcodes at lower light levels (starting from 5 lux). This is influenced by the lower contrast of indoor lighting compared to outdoor lighting.

IV. CONCLUSION

This research successfully developed an AGV robot system that integrates the Pixy2 camera with a focus on barcode reading for navigation in the teaching factory environment at Bosowa Polytechnic. The study shows that using barcodes can avoid errors and inefficiencies that may occur due to changing light conditions. Test results indicate that this system is effective in determining the robot's direction based on barcode readings, both indoors with a minimum light intensity of 60 lux and outdoors with light intensity starting from 5 lux. The integration of the Pixy2 camera with the AGV robot navigation system has proven to be more accurate and efficient compared to color-based systems, making it suitable for applications in the field of goods distribution.

V. ACKNOWLEDGMENT

The author would like to express gratitude to the Directorate General of Learning and Student Affairs of the Ministry of Education, Culture, Research, and Technology, as well as Bosowa Polytechnic, for their support in facilitating this research. This study was funded by the Student Creativity Program (PKM) grant under the PMK-KC (creative work) scheme in 2024. Special thanks are also extended to all parties who have contributed, provided suggestions, and technical support, particularly the Mechatronics Engineering Laboratory team at Bosowa Polytechnic for their assistance in testing and developing this AGV robot system.

REFERENCES

[1] Muh. Rezki Kurniawan, “Implementasi Object Tracking Berbasis Filtering Warna Pada Sensor Kamera Pixy CMUCam5”, Jurnal Fokus Elektroda, vol. 7, no.3, Agustus 2022, e-ISSN: 2502-5562 (in Bahasa).

[2] M. Nizar Falafi Astoro, Totok Winarno, Achmad Komarudin, “Implementasi Kontrol PID *Positioning* Robot Pada Titik Pengambilan Objek Shagai Menggunakan Sensor Kamera”, Jurnal Elkolind, vol. 07, no. 2, Juli 2020 (in Bahasa).

[3] Lutfi Wahyu Aryanto, Sujono, Akhmad Musafa, “Rancang Bangun Sistem Pendeteksian Objek Halang dan Pengereman Otomatis pada Robot *Forklift*”, Jurnal Maestro Vol 6 No 2, April 2023, E-ISSN 2655 – 3430 (in Bahasa).

[4] Sukma Meganova Effendi, Agatha Mahardika Anugrayuning Jiwatami, Nugroho Budi Wicaksono, “Reka Cipta Mesin Sortir Warna Benda Menggunakan Kamera Pixy2 CMUCam5”, Silampari Jurnal Pendidikan Ilmu Fisika Vol. 5, No. 1, 2023 P-ISSN 2654-4105 E-ISSN 2685-9483 (in Bahasa).

[5] Andy Suryowinoto, Affan Zihar Wirandi, “Pengembangan Sistem Pemilah dan Pengelompokan Penghitung Objek Produksi pada Konveyor Berbasis Kamera dengan Metode RGB *Threshold*”, Seminar Nasional Teknik Elektro, Sistem Informasi, dan Teknik Informatika, ISSN 2775-5126 (in Bahasa).

[6] Erwin Ramadhani, Sujono “Perancangan Robot Lengan Pemilah Obyek sesuai Warna Berbasis Arduino Mega 2560”, Jurnal Maestro Vol. 2. No. 2, Oktober 2019, ISSN 2655-3430 (in Bahasa).

[7] Adafruit “Pixy Pet Robot - Color vision follower”. December 1, 2022 [Online]. Available: learn.adafruit.com [Accessed on: June 14, 2024, 11:20 GMT+8].

[8] DigiWare, “Arduino Mega 2560 Pro Mini”, 2020 [Online]. Available: digiwarestore.com [Accessed on: May 11, 2024, 23:51 GMT+8].

[9] DroneBot Workshop (October 10, 2018) Pixy2 Camera - Image Recognition for Arduino & Rasberry Pi [YouTube]. accessed through: https://youtu.be/391dXDjqzXA?si=HX7tAfD5q8xL3nMK [Accessed on: July 1, 2024, 20:20 GMT+8].

[10] Pixycam, "PixyMon_index documentation", June 7, 2018 [Online]. Available: pixycam.com [Accessed on: July 4, 2024, 19:47 GMT+8].

[11] Anakteknik, “lux dan lumen” 26 Mei 2021 [Online]. Available: www.anakteknik.co.id [Diakses 7 Juli 2024, 4:41 GMT+8] (in Bahasa).