CHAPTER 1
INTRODUCTION

1.1 Background

AGV (Automatic Guided Vehicle) robot is included in the type of mobile robot or moving robot. This robot runs based on a predetermined path. This AGV robot was created with the aim of developing industrial technology, especially in Indonesia. This robot serves to transport goods from one place to a certain place [1]. Multi-robot is one type of robot that is currently being developed and researched. This type of robot is more focused in terms of communication between robots. Multi-robot is a collection of several robots that are intended to communicate [2]. One method to localize and navigate a moving robot in a room is to place a landmark in a known position and use the camera as a vision sensor to recognize landmarks [10].

In research [10], an AGV robot has been built using landmark points stored on the ceiling. This landmark is used by the robot to determine the position of the robot and subsequently affect the robot's maneuverability. In research [10] all processing, both landmark detection, and algorithm processing is carried out directly on the robot so that it can burden the processor on the robot. The research only uses one robot in its operation so that when a multi-robot system is created, there will be several obstacles, including the relatively expensive financing side because the entire process is made in one robot so that when more than one robot is made, the processing components increase, prone to collisions because the point to the same landmark.

From the following problems, it is necessary to carry out further research such as moving the process to the server section so that processing can be carried out in one location. By installing a visual sensor at the top (inverted camera) it is expected to be able to visualize widely so that it can detect many objects. In addition, each robot will be marked as a landmark or differentiator between one robot and another to make detection easier.

In this research, a robot that moves based on the target point has been made. The camera sensor used is a pixy camera. The camera sensor will detect the target position and the robot's position based on the landmarks created. The landmark used is the difference between the robot color and the target color. Based on the background described above, the focus of this research is "Design of Multi-Robot AGV Maneuver Prototype Control Based on Inverted Camera".

1.2 Formulation of the problem

Based on the background and state of the art that has been described, a problem statement can be made, namely the need to design a tool using an inverted camera as a sensor that can control the maneuvers of multi-robot AGV automatically. The function of the inverted camera is so that the visual coverage of the robot's workspace can be seen widely.

1.3 Goals and Contribution

Purpose and benefits are needed to show what was done in this study.

1.3.1 Goals

In this research, a design and construction of an AGV robot maneuver control command using a camera as a sensor is made.

1.3.2 Contribution

The contribution of the research made is to provide a proposed algorithm for navigating multiple robots. Each robot is given two colors as landmarks to facilitate the translation of the robot's direction. The direction of the robot is obtained from the coordinate points which are converted into angles and vector directions. Next, enter the process to get the speed of the right motor and left motor. The contribution of the research made is to provide algorithm suggestions in navigating multi robots. Each robot is given two colors as landmarks to facilitate the translation of the robot's direction. The direction of the robot is obtained from the coordinate points which are converted into angles and vector directions. Then enter the process to get the speed of the right motor and left motor.

1.4 Scope of problem

It is necessary to limit the problem in making this tool so that results that are following the purpose of manufacture can be obtained. The limitations of the problem in this study are as follows:

1. The robot used is a type of wheeled robot.
2. The microcontroller on the robot is used Arduino mega.
3. Data transmission using NRF communication module.
4. Pixy2 Cam-type camera is used as a vision sensor.
5. There are 2 robots to be detected.
6. The fuzzy input parameters used are angle size and vector length.
7. The fuzzy method used is the Mamdani fuzzy method.

8. The system made only detects robots that have been marked and the system ignores obstacles.
9. The camera is placed on the ceiling with the lens facing down to get a wide visualization.
10. Robots only work in a limited space.

1.5 State of The Arts

State of the art is an affirmation of the authenticity of scientific work. This is to prevent plagiarism as a form of piracy of other people's work. In this case, the state of the art explains the comparison to the research that has been done previously and becomes a reference for making a thesis. With reference can be seen in Table 1.

Table 1. 1 Research Reference.

No	Title	Writer	year	Method
1	Communication Method of Multi-Line Follower Robot In the Case of Obstacles Avoidance	Robisman Marpaung Angga Rusdinar Favian Dewanta	2016	In this study, the detection was carried out using an ultrasonic sensor. The ultrasonic sensor will detect an obstacle in the form of a moving robot. When detected, the speed of the robot will decrease so that the other robots will move first.
2	Moving Objek Detection, Tracking And Following Using An Omnidirectional Camera On A Mobile Robot	Ivan Markovic François Chaumette Ivan Petrovic	2014	In this study, the camera will follow a moving object. The direction of the image (optical flow) is used as a determinant of the movement of the servo.
3	Design And Implementation	Mindit Eriyadi	2016	This study uses Zigbee as a communication module.

	Data Communication Model in the System Robot soccer	A Hanhan Husna Firmansyah		The data sent is the motor speed data VL and VR
4	Camera Control Based on Position Detection Humans Move Falling Based on Multi-Sensor Accelerometer And Gyroscope	Rahmi Agus Melita Susetyo Bagas Bhaskoro Ruminto Subekti	2018	In this study, the camera is used as a comparison of the sensor value results which will later become input for machine learning. The output is a person's condition.
5	Real-Time Detection, Tracking, And Classification Of Moving And Stationary Objeks Using Multiple Fisheye Images	Ijoo Baek Albert Davies Geng Yan Ragunathan (Raj) Rajkumar	2018	In this study, a fisheye camera was used to classify moving objects and stationary objects. The method used is the deep neural network method.
6	Motion-Based Detection And Tracking In 3D Lidar Scans	Ayush Dewan Tim Caselitz Gian Diego Tipaldi Wolfram Burgard	2016	In this study, lidar sensors were used to map objects around them. The lidar sensor will get information on the location of the obstacle at every angle.

7	Prototype Design of Smart Home Sistem Base on LoRa	Sarah Opipah Eki Ahmad Zaki Hamidi Tutun Juhana	2020	In this study, the Lora Dragino 915MHz module was used. implementation of Lora research as a communication medium in smart homes. The result is that in a closed room, Lora can transmit data with a range of 63 meters, while in a semi-enclosed room it has a range of 183 meters.
8	Modeling Wall Tracer Robot Motion Based on Fuzzy Logic Control	Alwan Abdul Zaki Rina Mardiati Edi Mulyana	2020	In this study, a fuzzy-based ultrasonic sensor was used which was used for area mapping, wall follower, and obstacle detection.
9	Motor Vehicle Behavior Modeling Based on Markov Decision Process on Heterogeneous Traffic	Rina Mardiati	2019	In this study, the Markov Decision Process method was used. The data used is in the form of a video of motorcyclist behavior. Video data is analyzed for movement in the form of optical flow as a form of behavior motor Vehicle Behavior Modeling Based on Markov Decision Process on Heterogeneous Traffic.
10	Locating and Storage System Using	Artdhita Fajar Pratiwi	2017	In this study, an AGV robot with line and

	LabVIEW and Ultrasonic Sensors	Sugeng Dwi Riyanto		ultrasonic sensors was used. Coordinate and obstacle data is sent to the PC using the Bluetooth module.

From the state of the art, several studies were taken which would later be useful in writing this thesis. The research is related to image processing, mapping, and data communication. The explanation of the differences in each study is as follows.

In research 1, 3, and research 7, a discussion of the communication module was conducted. The difference with the research that will be carried out is that in future studies the NRF module is used as a communication module that sends the speed of the right motor and left motor of the robot.

In research 2, 4, 5, and 9, a discussion of the image process and object tracking was conducted. The difference with the research that will be carried out is that image processing is used to detect the position, type of robot, and direction. The robot will make certain landmarks on the chassis, making it easier to distinguish one robot from another and the camera module used is pixy2cam.

In studies 6, 8, and 10, a discussion of mapping using sensors was conducted. Sensors used include lidar and ultrasonic. In this research, the camera will use mapping if needed the sensor will be stored as safety or assistance when the image process error occurs.

The research that will be made is similar to research 2 and 3 where the concept of camera storage is stored at the top to get a wide working area. Research 2 utilizes a large area to detect the object's movement and then moves the camera to follow the object. While research 3 uses a camera to detect the presence of objects only. However, in this research, there is something new that is offered, namely the camera is used as a detector and navigation. Processing is carried out on the server with camera detection input, then after processing the data is sent to the robot in the form of right motor speed (Vr) and left motor speed (Vl).

1.6 Hypothesis

To be able to recognize and detect a robot, a landmark is made. Landmarks or markers are made on the top or cover using a certain algorithm, the server can identify the robot and from changes or pixel movements it will be processed and data can be

taken the direction of the robot's motion [2][4][5][9]. In the case of multiple robots, after detection, a motion command will be given to each of the robots. At this stage there is a communication process from the server to robot 1 and robot 2, the data sent is the right motor speed data and the left motor speed data [1][3][11].

1.7 Research methodology

The research methodology that will be used in the preparation of this thesis includes a literature study from various studies that have been carried out previously, then the formulation stage is carried out, and needs analysis and design are carried out until the prototype implementation is carried out to obtain results and conclusions. The stages in this research are described in Fig 1.1

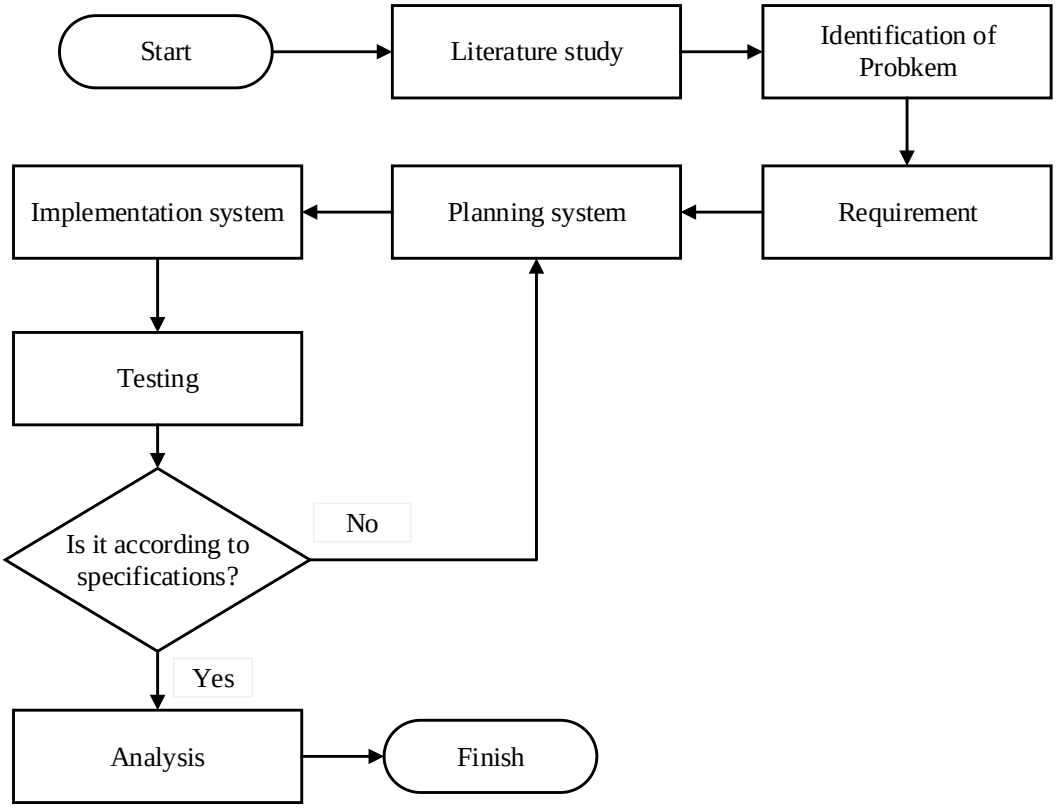

Fig 1. 1 Flowchart Research methodology

1.7.1 Literature Study

Literature study is used as a theoretical basis and to obtain references that support mastery of the material in research. This is done by reading relevant papers regarding the discussion of image processing, AGV robots, multi-robot communication, and conducting discussions with the lecturers concerned so that it will be easier to complete this research.

1.7.2 Identification of problems

After conducting a literature study, this research is continued by determining the problem to be formulated which is the basis for doing this research. The problem is obtained based on the literature study that has been used.

1.7.3 Requirement analysis

Needs analysis is an activity to obtain information, models, and specifications of a system needed to obtain maximum and efficient results in making this research tool.

Hardware requirements in this study are as follows:

1. Laptops

   Laptops are used for programming, designing, and processing the results of the camera.
2. Pixy Camera

   The camera is used to take pictures of the AGV robot.
3. Three Arduino Microcontroller units,

   Arduino is used as a robot brain and is also used for serial communication from PC Ken RF.
4. NRF Module

   The NRF module is used to send commands from the server to the robot,
5. One unit PCB Board,

   The PCB board is used to make layouts and store components.
6. Jumper Cable.

   Used to connect one circuit to another.

Meanwhile, the software requirements in this study are as follows:

1. Pixymon

   Pixymon is used to display the record results from the pixy.
2. Ms. Visio

   Microsoft Visio is used to design block diagrams and flow charts.
3. Eagle

   Eagle is used to make a PCB schematic which will be printed on the PCB board.
4. Arduino IDE

   Arduino IDE is used to create program source code.

1.7.4 System planning

At the design stage, two system schemes will be made. The first system is that there is a server system including image detection, optical flow, and the command given. For the second system, the AGV robot system includes the receiving and processing blocks. At this stage, the coding will be made on the Arduino IDE and Pycharm while the schematic will be made on the Eagle software. The system design diagram can be seen in Figure 1.2.

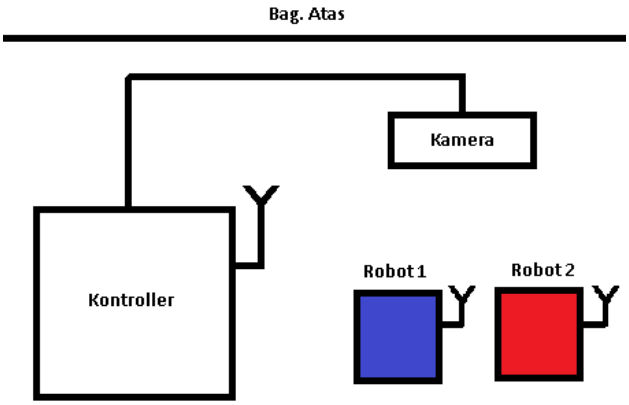

Fig 1. 2 Design block diagram

1.7.5 System Implementation

After the hardware and software results from planning and requirements analysis have been made and prepared, the next step is to build tools that have been designed in a tangible form and can be implemented.

1.7.6 Test

Testing is the next stage of the results of the installation of the hardware system, as well as the manufacture of the software system. At this stage, testing will be carried out on the camera, data transmission, and data processing.

1.7.7 Data analysis

Analysis of the measurement data will be carried out both in the image detection and data transmission sections. In the image detection section, there will be a discussion of the results of testing the change in the position of each robot, and in the data transmission section, there will be a discussion about the effect of delay on robot control.

1.8 Research Method

The techniques used in this research include:

1. Computer Vision

Computer vision has a function like the human eye, namely in vision. Humans see objects with the sense of sight (eyes), then the image of the object is passed on to the brain for interpretation so that humans understand what objects appear in their eyes. One implementation of computer vision is used to detect humans and their movements.

2. Optical Flow

   Optical flow is the flow of movement of a moving object based on the derivative of the light intensity. In 2D space, optical flow means how far an image pixel moves between two successive image frames. This method will be used in the process of detecting the location and movement of the robot maneuver.

3. Fuzzy Logic Control

   An appropriate way to map an input space into an output space. In this case, fuzzy logic will be used for robot movement. Input in the form of angle and distance and output in the form of motor movement.