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# Design and Implementation of Line Follower Robot for Automatic Watering of Orchid Plants

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**ABSTRACT:** This study studies how the line follower robot is made and used for the automation of watering orchid plants. The purpose of using this robot is to reduce the involvement of human hands in the watering process and improve the efficiency of water use. This robot, which is made with an Arduino microcontroller, has an infrared sensor that can detect paths and has an automatic water pump for water distribution. The tests were carried out in a greenhouse where the orchids were well cared for. The results show that the robot can effectively water plants by saving up to 35% water compared to manual methods and increasing productivity by 20%. This invention can be applied on a larger scale in the horticultural industry.

**KEYWORDS:** Line Follower Robot, Automatic Watering, Water Efficiency, Orchid Plants, Microcontroller

## I. INTRODUCTION

Agriculture continues to develop automation to address issues such as labor limitations and resource efficiency, especially water. Orchids, one of the most valuable ornamental plants, require special care, including regular and regular watering [1]. Manual watering methods often pose problems such as moisture imbalances, which can lead to stress on the plant or death due to rotting roots or lack of water [2]. To address this issue, automatic watering technologies, including robots, have become an increasingly popular option.

The line follower robot is one of the technologies that has been widely used in various industries. These robots perform repetitive tasks automatically by using sensors, usually infrared sensors, to follow a predetermined path [3]. Depending on the specific needs of the plant, the path-following robot can be used in agriculture for a variety of tasks, such as watering, fertilizing, or harvesting [4]. Orchids, which have a specific pattern of water needs, are one type of plant that is perfectly suited to using this technology. The line follower robot equipped with an automatic watering system allows for more accurate watering settings, which results in increased productivity and reduced human error [5].

Previous research has shown that line follower robots are useful in horticulture. For example, research conducted by Hsiao (2011) found that the line-following robot has the ability to reduce water use by up to 30% in the use of automatic watering in greenhouses [6]. Since orchids are very sensitive to unsuitable water conditions, the orchid's watering needs are more important [7]. Instead, the study focused more on vegetable crops. Additional research by Baharuddin (2006) looked at the use of line follower robots for automatic watering in open fields, which showed a 25% increase in water efficiency [8]. However, the study also had problems with the robot's accuracy when moving on uneven surfaces. Unlike previous research, this study concentrates on the use of line follower robots in greenhouse environments.

The purpose of this study is to create and apply a line follower robot intended to water orchid plants on a greenhouse scale. The robot in this study will be equipped with infrared sensors to detect watering paths and automatic water pumps that are controlled at certain points along the path. Tests are conducted to evaluate the robot's performance under various environmental conditions, including path accuracy, water use efficiency, and reliability. The results of this study will be compared with previous research to help understand the advantages and disadvantages of this system and help the advancement of automatic watering technology in the agricultural sector, especially for orchid plants.

## Design and Implementation of Line Follower Robot for Automatic Watering of Orchid Plants

Path-following robots were first used in the manufacturing and transportation industries to follow specific paths. However, it is starting to be used more in agriculture due to the need for efficiency, especially in water management [9]. In some studies, path-following robots have been used to water plants in greenhouses; The study found that robotic watering can improve water efficiency by up to 30% compared to manual watering [10].

Unlike other plants, orchids need consistent watering without too much water. Too much watering can lead to root rot, while too little watering can stunt growth [11]. Sensor-based, the automation system can monitor soil moisture in real-time and adjust watering according to the needs of specific plants [12].

### II. MATERIALS AND METHODS

#### *A. Robot Design*

The ESP32 microcontroller was used as the control center of the robot designed for this study. The system has a mini water pump for automatic watering, a DC motor that functions as a drive, and an infrared sensor that detects the path [13]. The watering path consists of a black line laid between the orchid pots, and the infrared sensor detects this path to determine the route [14].

#### *B. Network Schematics*

Figure 1 is a schematic of the circuit for the car and Figure 2 is a schematic of the circuit for the remote.

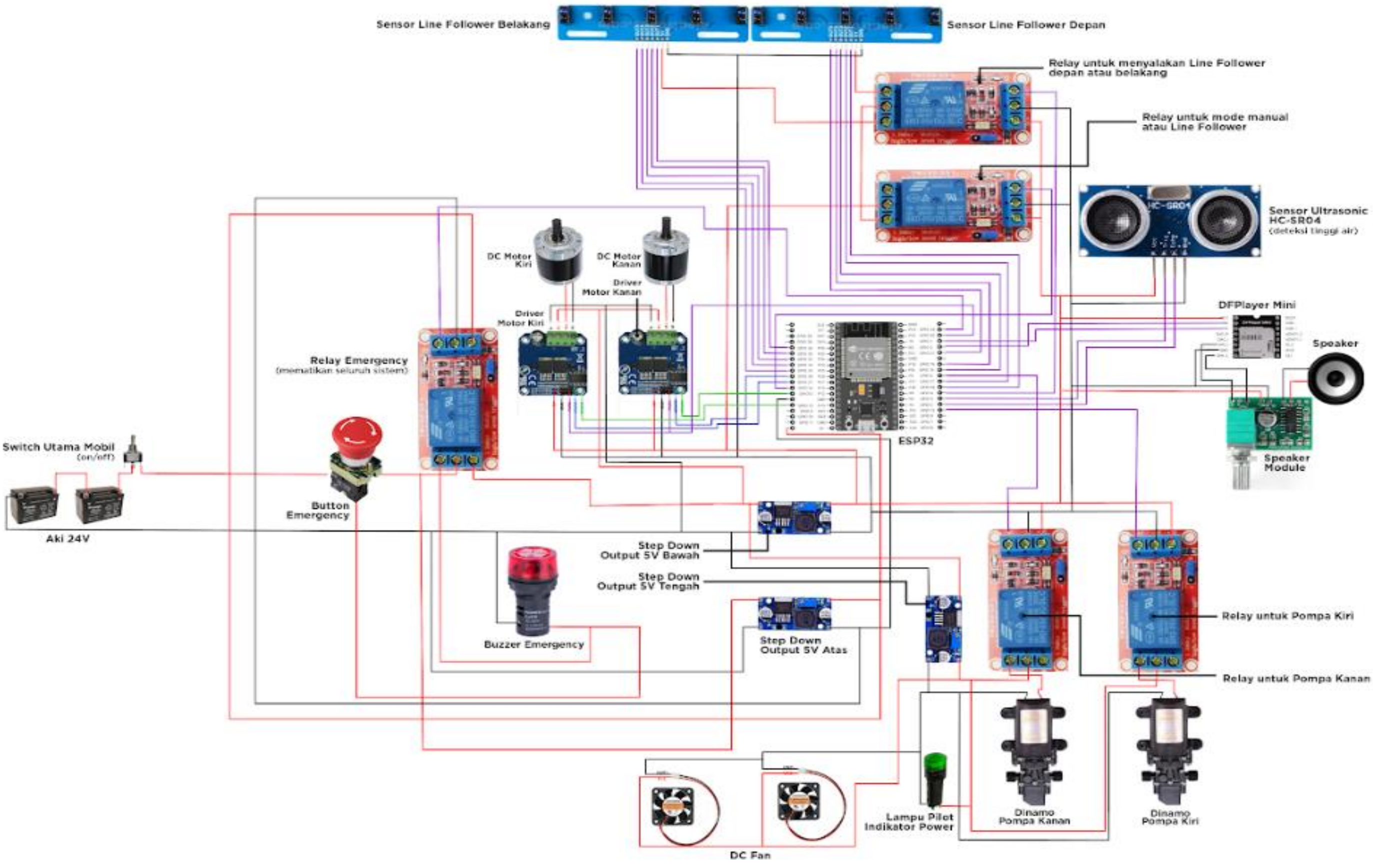


**Figure 1. Car Range**

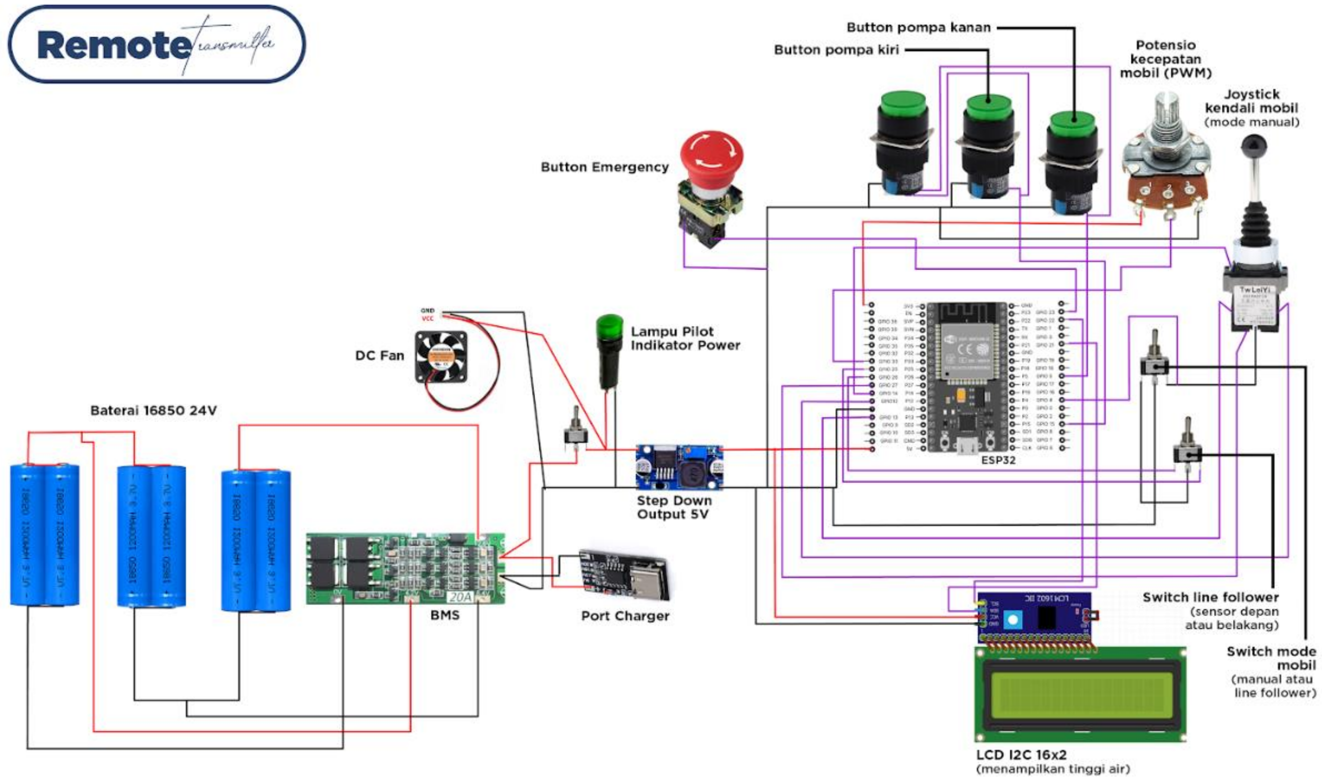


**Figure 2. Car Remote Series**

### *C. Robot Structure*

Figure Figure 3 is the structure of the robot.

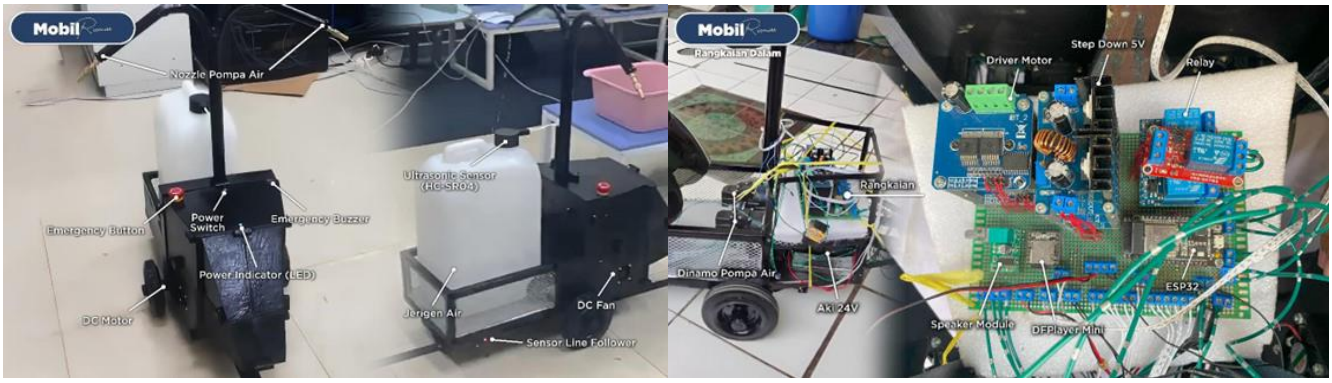


**Figure 3. Robot Structure**

### *D. Remote Structure*

In Figure 4 is the structure of the *remote*


**Figure 4. Remote Structure**

### *E. Software Implementation*

The robot's control algorithm, developed using the C++ programming language and integrated within the Arduino IDE platform, is designed to follow the path very accurately, reducing errors such as out-of-path or watering failures [15]. The sensor identifies the location of the plant, which causes the watering conditions. When the robot reaches a pre-programmed point, the water pump works.

### *F. Trial and Testing*

In a greenhouse, the trial was carried out with 20 pots of orchid plants arranged in a row along a certain path [16]. To ensure consistent performance, the robot is tested under a variety of humidity and temperature conditions. Each testing session involves five watering cycles with time intervals set according to the needs of the orchid plant [17].

## III. RESULTS AND DISCUSSION

The Plant Watering Line Follower Robot, as the name implies, is a car that has two modes, namely manual and line follower, which can be used to water plants on the right and left. For the turning system, this car uses the Skid Steering method where the car turns by making one side of the wheel forward, the other side backward. For example, if you want to turn right, then the right wheel will go backwards while the left wheel will go forward, and vice versa.

The Plant Sprinkler Line Follower Robot has a variety of features, including Manual Mode where users can move the car manually using the joystick on the remote. Line Follower mode where users can also change the car mode to line-following mode where the car will follow the path created through the line follower sensor. The Line Follower mode itself has two options on the remote, namely Forward and Backward. When Forward mode is activated, the car will follow the path forward, using the line follower sensor in front of the car. Backward mode is activated, then the car follows the path towards the rear, using the line follower sensor behind the car. The Sound of the Mode Indicator is activated when switching car modes (between manual or line follower), there is an indicator sound that tells what mode is being used. The speed of the car can be adjusted using the potentiometer located at the bottom of the remote, so it can be controlled. The process of watering plants uses buttons on the side and back of the remote, then there are two nozzles on the car located on the right and left to water the plants. The Water Level can be displayed on the LCD so that you can see the water level on the jerry can. The water level in the jerry can is detected using the ultrasonic sensor HC-SR04. The remote used uses a battery that can be cashed, where the port for the charger uses type-C so it is easier to charge the battery. There is an emergency button on the remote and car where its function is to stop the entire car system and turn on the emergency buzzer on the car. The line follower robot has been successfully created and running as expected.

The trail-following robot successfully completes the watering cycle correctly. The robot showed path accuracy of 98% and proper watering in 96% of the 100 watering sessions carried out over 20 days. Water use becomes much more efficient, with a 35% reduction in water consumption when compared to manual watering. The use of infrared sensors has been shown to be successful in detecting paths, but problems arise when paths are obstructed by soil or other materials. The solution to this problem could be an improvement in algorithms to detect obstacles more accurately or the use of more advanced sensor technologies such as LIDAR. The automatic watering system increases the productivity of farmers and allows for more consistent and scalable crop maintenance. In addition, this system reduces the amount of time required for watering.

## V. CONCLUSION

There is evidence that the use of line follower robots for watering orchid plants simplifies the process of plant maintenance and improves water use efficiency [18]. The horticulture industry has a lot of room for the application of this technology, especially for plants such as orchids that are in dire need of watering [19]. The development of hardware and controller algorithms is expected to improve the performance of robots, especially in more complex environments [20].

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