Design floating robot of shallots irrigation with GPS based and using the waypoint navigation method

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Abstract. Shallots are tuber plants that are used as a spice in cooking. Watering shallots in the right way regularly will produce quality shallots. Currently many shallot farmers in Indonesia still need the services of daily workers (laborers), especially farmers in Kab. Nganjuk, East Java. The watering process is still manual. In addition, it is difficult to find daily workers (laborers). This of course will create losses for farmers. With technological developments in the current era, the writer wants to make a tool that can be used by shallot farmers. This tool uses GPS to navigate the trench traversed using the waypoint method. Apart from using GPS, this tool also uses ultrasonic sensors which function to keep the robot in the trench line. For watering this robot uses a dc water pump with high pressure so that it can reach the plants from the trench. This tool can be operated using an android application that makes it easier for farmers.

1. Introduction
The development of technology in the current era can be said to be very fast. There are many studies to develop technology in various industrial sectors, one of which is in the agricultural industry sector. Our country, Indonesia, has enormous agricultural potential. One of them is shallot farming.

Shallots are tuber plants that are used as a spice in cooking. This plant is very much we find in various regions in Indonesia. Cultivating shallots is very profitable if done properly and correctly. Planting shallots must be paid close attention to and need good care in order to produce quality shallots. One important treatment is regular watering of the onion plants. The way to water onions is to make a trench between the beds where the onion plants grow, which functions to store water that will be poured on the shallot plants. Most farmers in Indonesia, especially in the Nganjuk Regency, East Java, currently still depend on daily workers (laborers) to carry out maintenance, especially shallot farmers. During the dry season when at that time the price of shallots can go up higher, but it is inversely proportional to the cost of maintenance and labor because it takes longer. Due to the watering process is still manual and it is difficult to find daily work (laborers). Things like this can make farmers lose and pay more [1].

From the above background, the researchers made and designed a final project entitled "Design Floating Robot of Shallots Irrigation With GPS Based and Using the Waypoint Navigation Method" to solve the problems of farmers in the difficulty of finding daily laborers. This robot uses a trench as a passage as well as a source of water to be sprayed on onion plants and is based on android.
2. Methodology

2.1. System Design

![System Concept](image1)

**Figure 1.** System Concept.

Based on Figure 1 this system design, it is explained that in a system there is a system block concept that is used to design and create a system. In the system block concept, it will be explained that in a system there are 2 inputs in the form of distance and coordinate points. The two inputs send data from the robot travel process which is then sent and processed to the Arduino microcontroller. Furthermore, the results of data processing are forwarded to the actuator control process as the output of this system. Then to make it easier for operators to monitor, the system is integrated with an interface in which there is an automatic actuator monitoring and control system.

![Design Hardware](image2)

**Figure 2.** Design Hardware.

In Figure 2 it is explained that when the robot is placed in the trench, then the ultrasonic sensor as a distance sensor detects the distance between the trench wall and the robot so that the robot does not hit the track. Furthermore, the GPS Module will read the coordinates of the robot if it is as desired. The results of the data are then sent to the Arduino microcontroller. Then the results of the detection of all inputs will turn on and off the water pump, and the dc motor is in accordance with the results of input processing. All data and conditions that are monitored and controlled will be entered and displayed on Android. Based on the explanation in Figure 2 above, here are the components needed:

2.1.1. Arduino Mega.
Arduino Mega is an Arduino board that uses an ATmega 2560 microcontroller IC. This board has 54 digital I / O pins, 15 of which can be used as PWM PIN outputs, 16 analog inputs, 4 UARTs. Arduino
here is the brain of this final project prototype. Because in the Arduino Mega, data obtained from all sensors and control methods are processed in such a way and will instruct the actuators to carry out their duties according to the input, so that the set point of the system being built is achieved.

![Arduino Mega 2560](image)

**Figure 3.** Arduino Mega 2560.

### 2.1.2. Telemetry.
Telemetry is a process of measuring an object whether space, object, nature or other parameters, when the required results are obtained it will be immediately sent to a place with a certain distance using either wired or wireless media (without using cables) using the data transmission method.

![Telemetry](image)

**Figure 4.** Telemetry.

### 2.1.3. Waypoint Method.
Making waypoints can be done by determining the longitude and latitude points in the application that has been made later, if 2 or more waypoints have been formed, draw a straight line to connect the waypoints. Then after the formation of the waypoints, the predetermined data will be sent to the Arduino in the robot.

### 2.1.4. DC Motor 12V.
DC motor is one type of electric motor that is often used today. DC motors require a direct voltage supply to the field coil to be converted into mechanical energy.

![DC Motor](image)

**Figure 5.** DC Motor.
2.1.5. Water Pump 12v.
Water Pump is a mechanical device used to raise fluids from lowlands to highlands or to flow fluids from low pressure areas to high pressure areas and also as a flow rate booster in a piping network system. In principle, the pump converts the motor mechanical energy into fluid flow energy. The energy received by the fluid will be used to increase the pressure and overcome the resistance found in the channel through which it is passed.

![Figure 6. Water Pump.](image)

2.1.6. GPS Ublox Neo M8N.
In this system, GPS is very influential because all system processes depend on the accuracy of the value provided by GPS. The Neo M8N GPS module is very easy to connect to Arduino. This GPS can work with an input voltage of 3VDC. This GPS is used to bring up the coordinates of the robot.

![Figure 7. GPS Ublox M8N.](image)

2.1.7. Ultrasonic Sensor HC-SR04.
In this system, the sensor used is an ultrasonic sensor. Here the proximity sensor functions to help the robot stay on track. This sensor can read distances of up to 4 meters with a minimum distance of 2 cm which is very sufficient for the needs of this study. This sensor can work with an input voltage of 5VDC.

![Figure 8. Ultrasonic Sensor.](image)
2.2. The System Works

Figure 9. Flowchart System.

Figure 9 is the working principle used from this final project. In a system that is designed, GPS is an important part of the system because all system processes depend on the accuracy of the values provided by GPS. Android devices are not only a monitoring tool but also a navigation system calculation as input for the robot to move autonomously.
In this system, the actuator used is a 12v DC motor with 2 motors to drive the propeller of this floating robot, the next actuator is a 12v dc water pump with 80Psi water spray pressure. This actuator is used to spray water from the trench to the shallot plants.

3. Results and Discussion

3.1. Floating Robot Mechanical Testing
The mechanical testing process is carried out based on the realization of a pre-designed design. Testing is carried out after the floating robot is formed, this stage is the first step in making the robot, to determine the condition of the floating robot, whether it is suitable for use or needs repair before use. One indicator of the feasibility of a floating robot is that there is no leak, so that the floating robot can float in the water perfectly. The next stage, the robot is given a load according to the components used to determine the strength when it is in the water and see the movement performance with the maximum load carried.

3.2. Ultrasonic HC SR04 Sensor Testing
The HC-SR04 ultrasonic sensor test was conducted to determine the measurement data. In testing the HC-SR04 sensor using a comparator in the form of a ruler where this ruler is the reference for the actual distance data, as in Figure 11.

Testing is done by placing the object in front of the sensor then the distance is adjusted to 5 times the test. Then after that it is compared to the output on the Arduino serial monitor with a ruler.
Below is table 1 comparison of the ultrasonic sensor readings with a ruler comparison.

| No. | Arduino (in cm) | Ruler (in cm) | Error (%) |
|-----|-----------------|---------------|-----------|
| 1.  | 3               | 3             | 0         |
| 2.  | 5               | 5             | 0         |
| 3.  | 10              | 10            | 0         |
| 4.  | 15              | 15            | 0         |
| 5.  | 20              | 20            | 0         |
| 6.  | 25              | 26            | 3.85      |

Average Error 0.64

Table 1 shows the analysis of the HC-SR04 ultrasonic distance sensor testing using Arduino. The sensor is able to read the distance with an average error value of 0.64%.

3.3. GPS Testing

This GPS test is used to determine the position with coordinate points and serves as a sensor to determine the distance to which the robot moves. To prove the accuracy of the ublox M8N gps module, the Google Maps application is used as a gps validator. Google Maps will provide the smartphone location coordinate point data so that from the test results of the gps module coordinates with google maps points an error is obtained from the ublox M8N gps module.

![Figure 12. GPS Testing.](image)

From Figure 12 gps testing, the data received by Arduino are the coordinates of the GPS. In this test, the latitude and longitude points are obtained which are compared with the Google Maps application, here are the results of the GPS test.
Based on Figure 13 and Figure 14, it can be seen that the GPS reading on the Arduino is very stable and the coordinates displayed on the Arduino look the same as the points on Google Maps.
3.4. Android Interface

![Android Interface](image)

Figure 15. Android Interface.

Based on Figure 15, the function of this android is the control and monitoring of the android system used to select the waypoint points that the robot will go to so that the robot can water the plants according to the path. In this display, you can also see the data output from the sensor sensors used.

4. Conclusion

This floating robot for sprinkling onions is a robot that is able to navigate rice fields with trenches automatically with the help of a waypoint navigation system. In addition to using waypoint navigation, the robot also uses ultrasonic sensors so that the robot does not hit an obstacle and remains on the trench. From the realization and testing of the tools carried out, it can be concluded that the ublox m8n gps system is very stable in displaying coordinate points, the error obtained from the test is not more than less than 3 meters. In testing the hc-sr04 ultrasonic sensor, a very small error of 0.64% was found, so it can be concluded that this type of ultrasonic sensor is suitable as a robot safety so as not to hit trenches or robot lines.
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