Design watering system on greenhouse using microcontroller with matrix based

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Abstract. Chili commodities are urgently required by Indonesian citizens. Planting a chili are using two ways, with an open land such as a rich field and close land which is a greenhouse. In order to develop the highest quality for chili using greenhouse method, we need a right treatment to watering. Nowadays, many people still using a manual method to water plants with a long hose to reach all the plants in the garden. The purpose of this research is to give a solution regarding that issue which to make a new technology at watering plants using the automatic watering tool, therefore, we could save time and energy, also knowing the accuracy of motor stepper movement. This method research is designed and builds automatic watering tool with 3 rows x 3 columns with a total of 9 plants and method using soil moisture sensor. The result of this research proving that accuracy of the stepper motor is 99.48%, errors that occur in the movement of the stepper motor is very minimal and this watering system is working when the moisture content in a soil is less than 60%.

1. Introduction
Countries that produce the highest chilli in the world is China producing countries chili annually about 15.8 million tons, the State Meksino chili annually produce 2.2 million tons, the Turkish State chili annually produce 2.1 million tons, the State Spayol chili annually produce 1.01 million tons, the United States produces chili annually by 845 thousand tons. Indonesia's agricultural belong to the country that produces the highest in the world chili. In the State of Indonesia needs chili continue to increase every year, it is because the number of growing population and public knowledge about the importance of nutrition and the content in the chili. Chili production in every year do not meet the needs of people in Indonesia. But the agriculture sector in Indonesia is only dependent on the extent of land every year while diminishing the extent of land, land efficiency has not been done maximum one example is the greenhouse. Greenhouse is a place to cultivate pepper plants were covered with plastic material, glass translucent material.

The function of the glass that is to condition the state of the environment in order to maintain maximum. Pepper plants are crops that can be grown productively in soil moisture approximately 60% - 80%, if the soil moisture is less than 60%, it will cause productivity chili to be decreased while if the soil moisture is more than 80% will support the growth of fungi and bacteria that will easy to die and air temperatures were conducive to plant chili around 21°C - 28°C [1]. A watering method in Indonesia is still using manual methods by using a hose length of many meters and then the hose is installed centrifuges used to spin the water so that it can reach to many plants. Therefore, then be made automatic sprinklers plant titled "Design System Of Planting Flooring System On Greenhouse With
Microcontroller Matrix Based”. With the automatic watering tool, it is expected to do at the right time and save time in watering the plants with optimal results and determine the water needs for each plant.

Setting the position of watering plants on the greenhouse is determined based on X-Y coordinates. The coordinate position of the sprinkler is done by controlling Steper motor [2] robotically [3]. The stepper motor used is supplied with enough current to have a large torque [4]. While the command stepper motor motion is based on a program that is inserted into the microcontroller through a computer [5]. Communication between computers and microcontrollers requires interfacing [6].

2. Methods

2.1 Mechanical design
Mechanical systems are designed using SketchUp Pro 2017 program design according to Figure 1. The main ingredient in the manufacture of this system is composed of iron using nuts, bolts and M5-sized ring. Sprinklers plants with matrix method have two axes, namely the x-axis and y-axis is driven by two stepper motors using a timing belt size 2 mm for the movement, there are 4 iron buffer on the x-axis and y-axis is used to regulate the balance sprinklers plants. Dimensional size plant sprinklers P × L × T is 50 cm × 50 cm × 100 cm. The size of the tool to pepper as much as 9 plants with a matrix of 3 rows × 3 columns, with a size of about ± 15 cm.

![Figure 1. Mechanical Design Tools Watering Plant Using SketchUp Pro 2017](image)

Here is a short distance from one plant crops with other crops by using the matrix shown in Figure 2.

![Figure 2. Plants Using Matrix Method](image)
The distance for 1 step stepper motor can be known using calculations in equation. Where \( r \) is the radius depending on the pulley diameter used in the study and \( \theta \) is \( 2\pi \). In this study using pulley with a radius of 0.65 cm and the rotational angle of the rotor in the stepper motor is 0.9°, one rotation will produce 400 steps. So if one step is calculated using the equation above for 0.010205 cm. To get a distance of 11.25 on the x-axis it requires 1102 stepper step motors while the 12.5 cm distance on the y-axis requires 1125 step stepper motors

2.2 Block Diagram
Automatic watering system based on a microcontroller with matrix method using soil moisture sensor stands from several interrelated parts. The sections are explained in by the block diagram of Figure 3.

![Block Diagram Tool Automatic Plant Watering](image)

Figure 3. Block Diagram Tool Automatic Plant Watering

3. Results and Discussion

3.1 Soil moisture sensor test
The purpose of testing the soil moisture sensors to determine the feasibility of the humidity sensor YL-69 in this study. The humidity sensor is used as the primary input. Testing the humidity sensor is done in three conditions, namely the sensor fully immersed in water, the sensor is not immersed in water, and the sensors are plugged in land plants.

| Sensor fully immersed in water | The sensor is not submerged water |
|-------------------------------|----------------------------------|
| Humidity (ADC) | Voltage (V) | Humidity (ADC) | Voltage (V) |
| 375 | 1.75 | 4.49 | 1023 |

The next test sensor is plugged into the plant soil is done in stages, by providing as much as 100 mL of water, done when the soil is dry to the moist state.
Figure 4. Relationship Graph Against Soil Moisture Output Voltage

Based on Figure 4 shows that the larger the voltage value of soil moisture is removed from the sensor are also getting bigger as well, which means the value of soil moisture produced is proportional to the output voltage value and based on the measurement results obtained with the regression equation is \( y = 0.047x + 0.049 \) regression coefficient is 0.047 \( x \) means that any changes in percentage of the value of soil moisture, the output voltage of the sensor at 0.047 time, where \( x \) is the value of soil moisture (%) and \( y \) is a soil moisture sensor output voltage (V). Results obtained by linear correlation degree, this value had already indicated that the relationship between the output voltage with soil moisture sensor is linear.

3.2 Testing the movement automatic watering x-axes and y-axes
The purpose of this test is performed to determine the accuracy of the present system of sprinklers plant in working order. Testing is done by comparing the distance that has been made in the program by measuring the real distance using a vernier calliper with accuracy of 0.02 mm.

| No. | Distance Watering Requested X-axis (cm) | Distance Watering Measured X-axis (cm) | Error (Cm) | Distance Watering Requested Y-axis (cm) | Distance Watering Measured Y-axis (cm) | Error (Cm) |
|-----|----------------------------------------|----------------------------------------|------------|----------------------------------------|----------------------------------------|------------|
| 1   | point A (11.25)                        | 11.190                                 | -0.060     | 12.5                                   | 12.438                                 | -0.062     |
| 2   | point B (22.5)                         | 22.420                                 | -0.080     | 12.5                                   | 12.438                                 | -0.062     |
| 3   | point C (33.75)                        | 33.836                                 | 0.086      | 25                                     | 25.040                                 | 0.040      |
| 4   | point D (33.75)                        | 33.836                                 | 0.086      | 25                                     | 25.040                                 | 0.040      |
| 5   | point E (22.5)                         | 22.410                                 | -0.090     | 25                                     | 25.040                                 | 0.040      |
| 6   | point F (11.25)                        | 11.350                                 | 0.100      | 25                                     | 25.040                                 | 0.040      |
| 7   | point G (11.25)                        | 11.350                                 | 0.100      | 37.5                                   | 37.556                                 | 0.056      |
| 8   | point H (22.5)                         | 22.562                                 | 0.062      | 37.5                                   | 37.556                                 | 0.056      |
| 9   | The point I (33.75)                    | 33.836                                 | 0.086      | 37.5                                   | 37.556                                 | 0.056      |
Based on Tabel 2 errors greatest on the x-axis is at position F and the position G of 0.889%, which means in these positions have the accuracy of 99.111% and the smallest error on the x-axis at the position A in the amount of 0.533% which has the accuracy of 99.467% while the fault or error on the y-axis is in a position Y1 of 0.496% has amounted to 99.504% accuracy and error on the y-axis at the position Y3 smallest of 0.150% has a 99.850% accuracy. But, mistake or error at each of its points can still fairly small at less than 1%.

3.3 Overall Test

The purpose of the test as a whole to determine whether the system has been made in accordance with the chill and running well or not. Tests carried out at the address Kosan Pitaloka Geger Kalong Girang Jalan 73 / 173A. Tests conducted for 6 days on July 9, 2018 - July 14, 2018 hours from 6 a.m. to 18:00 pm. This test is to control the value of soil moisture every 10 minutes, in one day conducted 73 times the control value changes of soil moisture.

The working principle of the automatic watering tool that is when the humidity value above the setpoint value then the tool will move towards plant A to plant crops I. When the last of the sprinklers is already up on the plant A relay will be activated and the water pump will be activated, the process of watering this is done for 25 seconds to remove the water as well as a number of 225 ml and so on.

![Figure 5. Graph Soil Moisture Against Time](image)

Based on Figure 5 shows that during the six days of testing soil moisture values experienced one percent decrease in the period of 12 hours, which means experiencing one plant dry soil conditions. Watering time on day 1 hour 8:00 pm, on the 2nd day 07:40 hours, on the 3rd day 08:00 pm, on day 4 hours of 7:50 pm, on day 5 07:50 hours, on day 6 hours 08:100 or can be said for every day watering process is done around 08:00 pm.

4. Conclusion

From the results and discussion can be obtained several conclusions, among others: (1) The design of an automatic sprinkler system with matrix method plants in a greenhouse-based microcontroller with attention to soil moisture with time can work well. (2) Sprinklers automatic plant with matrix method has an error or errors greatest on the x-axis is at position F and the position G of 0.889%, which means in these positions have the accuracy of 99.111% and the smallest error on the x-axis at the position A is equal to 0.533% which has amounted to 99.467% accuracy while the fault or error on the y-axis is in a position Y1 of 0.496% has amounted to 99.504% accuracy and error on the y-axis at the position Y3 smallest of 0.150% has a 99.850% accuracy. This is consistent with the theory that one of the hallmarks of the stepper motor that has a high accuracy.
In this study, sprinklers automatic plant with matrix method that has been designed already able to work and function well, but still needs further development in order to automatically crop sprinklers can work efficiently and more accurately. Need for additional types of sensors are used, not only the soil moisture sensors but can also use other sensors such as temperature sensors and humidity, soil pH sensors and sensors that optimize the performance of automatic sprinklers with matrix methods.

5. References
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