INNOVATIVE JOURNAL
OF INTELLIGENT CONTROL AND OPTIMIZATION FOR ELECTRICAL SYSTEM

Vol. 1 (2024) No. 1

Publisher by AITEKS : Aliansi ahlI TEKnologi dan Sains
https://ijcioes.org/index.php/ijcioes

Automatic Plant Sprinkler with Source Solar Panel

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***Abstract*— Plant watering is an activity that needs to be considered in plant maintenance to maintain food intake and plant growth. Plant owners in Balingka usually water the plants manually in the morning and evening, so it takes a lot of time and energy during the watering process. Farmers cannot leave the plants for a long period of time because the plants will lack water, which can inhibit plant growth. So an automatic plant sprinkler is made with a ROTC (Real Time Clock) sensor, Raindrops Sensor Module, Relay 1 channel and LCD (Liquid Crystal Display). The principle of this tool is to set the plant watering time according to the hour that has been determined using ROTC (Real Time Clock), which is then controlled by Arduino mega 2560 to activate the relay to the automatic plant watering pump and Raindrops sensor module as a relay breaker if at the time of watering rain and the result will be displayed on the LCD (Liquid Crystal Display). The benefit of this automatic plant sprinkler is to facilitate the process of watering strawberry plants**

***Keywords*— Automatic Plant Waterer; RTC (real Time Clock); Relay; LCD (Liquid Crystal Display); Raindrops Sensor Module; Arduino Mega 2560**

The manuscript was received on May 13. 2024; revised May 30. 2024; accepted Jun 22. 2024. Date of publication Jun 30, 2024.
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I. INTRODUCTION

Indonesia is an agrarian country with most of the population making a living as farmers. Of the vorious plants in Indonesia, there are strawberry plants, where in research strawberry plants are fruit plant in the from of herbd that were first discovered in Chili, America. One of the strawberry plant species, Fragaria Choiloensis L., has spread to various American, European and Asian countries, which have also been developed in Indonesia (Tulak, Khaerunisa and Shoy, 2020).

And one of the places where strawberry plant are cultivated is in the Balingka area, Agam Regency. Many residents in Balingka work as farmers and strawberry cultivation farmers. In additional to the area being on the Bukittinggi-Padang alternative road makes this place also an agro- tourism place as well as a stopver for road users to rest on the strawberry plantation. Balingka's location at the foot of Mount Singgalang allows strawberry palnts to thrive. Which for watering is done twice a day in the morning and evening. In research in the Nganjuk area, East Java where they watered onions twice day during the dry season (Muharom, Suseno and Setyawan). The making of automatic sprinklers aims to help farmers in Balingka to make it easier for farmers to take care of strawberry plants.

Therefore, the sun can be utilised as a sources of electrical energy, resulting in an innovation in the development of agriculture and electricity. So an automatic plant watering tool is made by using several sensors, namely the RTC (Real Time Clock) which is used as a watering timer, the rain sensor as a realy breaker to the water pump so that when it rains automatically the pump will not water, and the LCD (Liquid Crystal Display) is used to display readings from the sensor. And there are also studies that do automatic plant watering using moisture sensor. In research to overcome seasonal constraints in Indonesia in the dry season and the rainy season. This tool uses a microcontroller chip that is programmed based on the detection of agricultural soil moisture sensors. When the soil conditions are dry, the tool will automatically function to water the plants. Conversly, if the ssoil condition are wet, the tool will not water, so that plant can grow well because their water needs are met at all times (Sari, 2019).

The benefit of this tool ti facilitate farmers in talking care of strawberry plants with automatic plant sprinklers where the tool is equipped with controls and sensors that can work automatically and have been set and can be developed again if watering more than 2 times a day can be arranged in an easy code

II. THE MATERIALS AND METHOD

The research method is to conduct a literature study by interviewing strawberry farmers directly and reviewing previous journals on dual-axis solar trackers for plant watering.

A. Tool Planning

In this tool the author will make a Automatic Plant Sprinkler with Source Solar Panel design tool optimization of solar energy absorption whicg is converted into electricity by solar cells for automatic plant watering sources. This tool uses 2 actuator as driver with details of actuator 1 for vertical motion and actuator 2 for horizontal motion. The Arduino mega 2560 microcontroller is used as a tool system controller, there are 4 Light Dependent Resistor (LDR) inputs that are limited between LDR modules. The solar panel used is 100 wp monocrystalline type with 35 Ah wet battery storage. The battery safety use a 10 ampere solar charger controller. The load used is a water pump as a plant watering with rain sensor input and a real time clock (RTC) module as a regulator of the life of a 5 volt 1 channel relay, where the 5 volt 1 channel relay as a switch on the life water pump. So the water pump will live according to the settings of the RTC module which is set to be active at 09:00 in the morning and 15:00 in the afternoon with an active relay for 1 minute when watering time, the water pump will not work when watering time arrives but rainy conditions so that the rain sensor detect water and gives a signal to the microcontroller so that the relay is not active, beside that there is also an I2C LCD as a display of time and watering commands when watering time arrives.

B. Tool System Design

Broadly speaking, the working principle that will be made can be seen in the block diagram.

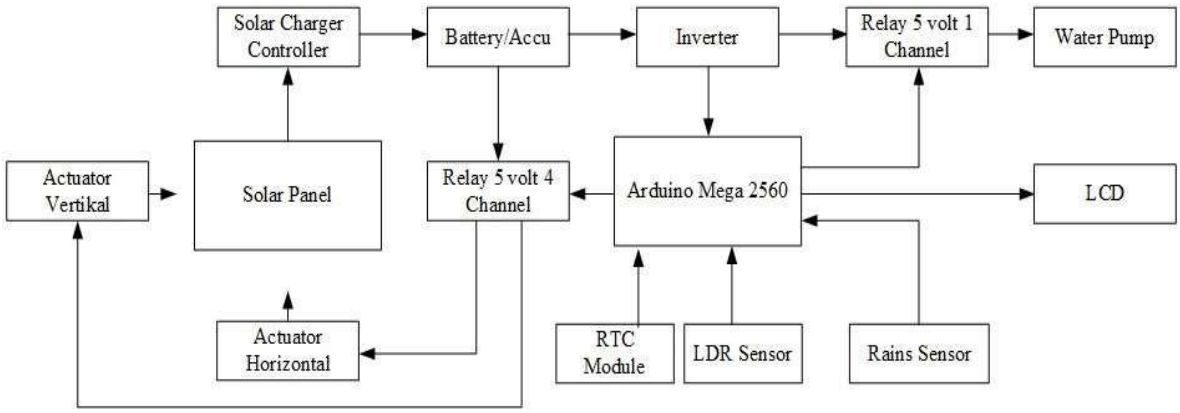


FIGURE 1 System Planning Block Diagram

Based on the block diagram in Figure 1. Solar Panel convert solar energy into electrical energy through the photovoltaic effect. Which solar energy will be used as a source of electrical for automatic plant sprinklers? Which is stored in a 35 Ah Accu/ battery with a voltage 12 VDC, and to turn on an automatic 125-watt water pump, an inverter is needed to converter the DC voltage to AC 220 V.

This automatic watering works by using several sensosr, namely the RTC (Real Time Clock) sensor as a watering to be done. Relay Module 1 Chanel 5V for automatic breakers to the water pump, Raindrops Sensor module as a water pump breaker if it is raining during watering time., and 2x16 I2C LCD (Liquid Crystal Display) to display the time and per cent (%) of rain discharge. From some of the above sensors where watering is done several times, namely at 09:00 in the morning and 3:00 p.m. when the sun is hot. Watering time is set with the RTC (Real Time Clock) sensor Module. If the watering time is rainy, the raindrops sensor module will automatically detect rain and disconnect the relay 1 chanel 5V connected to the 125 watt water pump. To use the hour and percent (%) of rain discharge from the LCD screen (Liquid Crystal Display) which LCD will display several commands.

Components of an Automatic Plant Sprinkler

In designing an automatic plant watering device, components are needed that are used to support automatic plant watering devices with several sensors used as follows in table 1.

TABLE 1
Components and their function

No	COMPONENT	FUNCTION
1	Arduino Mega 2560	Control multiple sensors for automatic plant watering
2	RTC Sensor	As a sensor for automatic plant watering timer
3	Rain Sensor	To detect if there is during watering
4	Relay	As a switch to switch on the water pump automatically
5	LCD (Liquid Cristal Display)	As a viewer of rainfall time and discharge on the

C. Circuit Planning

Arduino Mega 2560 function as a control for sensors, LDR as a follower of sunlight and Actuator as a motion mechanic from the tool and from this solar energy can be utilized possible, because it always follows the moving sunlight, from the circuit of Figure 2 it can be explained that Arduino will control several sensors that play a role in automatic watering of plants where, RTC (Real Time Clock) as a watering timer where the time set is 2 times a day in the morning and evening, the pins used are SDA (Serial Data line) as a data sender, SCL (Serial clock Line) provides a clock signal for data synchronisation between devices, VCC as a positive input source and GND (Ground) as neutral in the circuit. The rain sensor is used as a detector if at the time of watering, it suddenly rains where the pin used is AO analogue output as analogue signal giver that rangers according to the level of humidity detected, the higher the output value, the more water or rain is ditected. And also uses VCC and GND pins.

Relay 1 chanel 5 volt is used a breaker and voltage link on the water pump which for input to the 5 volt pin relay used is In as a digital pin on Arduino mega, VCC 5 volt Arduino mega and GND to GND. And for the output of the relay used on close and activate the water pump and if the watering time ends then NO will be disconnected which makes the water pump turn off. The 35 Ah battery gets energy from the sun which produces a voltage of 12 VDC and ve able to activate the water pump with AC input it is rectified by using a 1500 watt inverter and a 1 phase MCB which is used as a safety circuit for automatic plant watering

D. Planning to Build an Automatic Plant Waterer

Before making a tool, of course, you must make a design of an automatic plant watering device and also the specifications of the tool to be made. The goal is to facilitate the process of making tools and also facilitate the selection of component to be used. Figure 2B is a design of an automatic plant watering devices designed using the sketchup application. There is a panel box that is used as a storage component such as sensors. Arduino, batteries, inverters, relay, MCB. Where in figure 2B can be seen a sketch Figure 2B is a design of an automatic plant watering devices designed using the sketchup application. There is a panel box that is used as a storage component such as sensors. Arduino, batteries, inverters, relay, MCB. Where in figure 2B can be seen a sketch of an automatic plant watering can. Starting from making the framework of the solar tracker, which is for the solar cell holder according to the size of 910x680x30mm, for the framework made of holo iron with a pole height of 115cm, pole legs with a size of 37cm x 4, solar cell holder with 107 cm and solar cell holder 910 x 680 x 30mm

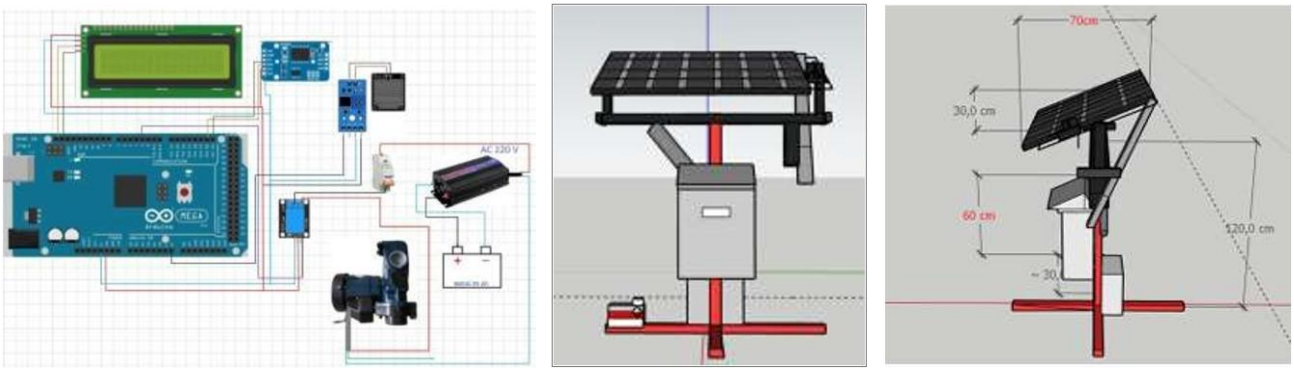


FIGURE 2 A. Wiring Circuit B. Planning of Automatic Plant Sprinklers (a)Front View and (b) Side View

E. Calculation Formula

This tool aims to optimize the absorption of solar energy which be converted to electrical energy through solar cells, with the solar solar panel tool, it is hoped that position of solar panel can be directly opposite the position of sunlight so that battery charging can take place quickly and the water pump gets its own supply continuously from the battery.

$$\text{Power} = \text{Voltage} \times \text{Current} \qquad (1)$$

III. RESULTS AND DISCUSSION

A. Tool Design Results

The design of this tool has produced a solar panel with a water pump load as an automatic plant watering. This design is useful as a battery charger/foot that will be used an energy source for automatic plant sprinklers, which are equipped with solar panel supporters.

The automatic watering system is equipped with a rain sensor which when it rains, the water pump will automatically not work where the output of the rain sensor is located above near the LDR which directly detects rain, the frame is equipped with a panel box which in the panel box there is an SCC (Solar Charge Controller) for battery safety and solar panels as a water pump safety and AC Voltage, seeker as an 9V DC adapter connector, relay 1 channel as a breaker and connector from Arduino mega to the water pump, Arduino mega 2560 as control of automatic plant sprinklers and solar tracker, RTC (Real Time Clock) which function as a timer and automatic watering time 09:00 and 15:00. LCD (Liquid Crystal Display) which function as a rain percent viewer, time and commands for watering, 1500 watt Hinomaru Inverter which is used to convert DC voltage into AC voltage, Battery/Accu is used as a place to store energy generated by the sun. Figure 3A is result of the design

B. Real Time Clock (RTC) Testing Results

The rain sensor works if the sensor detects the is the presence of water on the sensor plate, it will read the output where if the serial monitor reads 1028 then the rain discharge is 0%, if the serial monitor reads 282 then the rain discharge is 100%. Where the smaller the ADC the greater the rain discharge. In this test, several measurements were made on the rain sensor where what was tasted was how much the output of the rain sensor, the input voltage of the rain sensor, the output voltage and the percentage of rain discharge readings

TABLE II
Components and their function

Rain Sensor (ADC)	Vin (Vdc)	Vout (Vdc)	Percentage of rain (%)
880	4,82	2,57	18
583	4,84	2,60	59
427	4,82	2,52	80
339	4,84	1,55	92
322	4,82	1,20	94
Average	4,82	2,80	68,6

From table 2 where the rain sensor is measured Vin and the result are different from Vin from Arduino mega, Vout measurement are carried out on the analaogue pin of the rain sensor and the GND pin of the rain sensor where the average measured Vin is 4.82 Vdc and the avarge measured Vout is 2.08 Vdc with rain discharge during the test 68,6% indicating rainy weather result can be seen on the serial monitor. The results of each rain sensor start from the 880 ADC rain sensor reading with an input voltage of 4,42 Vdc, an output voltage of 2.57 Vdc with rain sensor percentage of 18%. And the rain is increasing with a rain sensor reading of 583 ADC with a voltage of 4.84 Vdc, an output voltage of 2,60 Vdc with a percentage of 59% which if above 50% will disconnect the relay to the water pump. After that the rain continues to be heavy until the sensor reading is up 322 ADC with an input voltage of 4.82 Vdc, an output voltage of 1.20 Vdc with a rain percentage of 94%.

C. Real Time Clock (RTC) Testing Results

The results of this test are carried out to see the difference between the actual time and the time programmed on the RTC (Real Time Clock) sensor, which can be seen in table 3.

TABLE III
RTC (Real Time Clock) Testing Data

Time in RTC Module	Actual time	The difference
08.30.04	08.30.01	-3 seconds
09:00:00	08.59.57	-3 seconds
10:54:30	10.54.27	-3 seconds
13:30:33	13.30.30	-3 seconds
15:02:04	15.02.01	-3 seconds
Average		-3 seconds



FIGURE 3 A. Tool Design Results B. Time Testing Results C. Automatic Watering Display Results

From the RTC (Real Time Clock) sensor test where at 08:30 on the RTC module and at the actual time the clock shows 08:30:01 with a time difference of 3 seconds. And testing was carried out until 15:00 with a time difference of 3 seconds. This happens because when uploading the RTC programme the actual time and in the module will have a difference due to the time consuming upload process. The test results can be seen in Figure 3B below.

TABLE IV
Watering Time Testing Data

Watering Time	Hours	Duration	Water pump
Morning	09.00.00	1 minute	ON
Afternoon	15.00.00	1 minute	ON

The test is carried out find out when the time is done for automatic plant watering. Watering time will take place twice a day to keep the soil moist, where between these times the sun will provide direct light, therefore watering is carried out in the morning at 09:00 and afternoon at 15:00 with the duration of one watering for 1 minute can be seen in table 4. Watering is done so that the soil remains moist until the next morning. For watering commands are also displayed through the LCD (Liquid Cristal Display). The display result can be seen in Figure 3C above

D. Battery/Accu Voltage Testing

This test is carried out find out the difference in Battery/Accu how much voltage drop when given a water pump kind and also compare the Baterry/Accu voltage measurement when charging and not charging.

TABLE V
Testing While In Charging

Initial Stress	Duration	Voltage at load	Voltage - Drop
13.71 Volt	1 minute	11.97 Volt	1.74 Volt
13.71 Volt	1 minute	11.97 Volt	1.74 Volt

The experiment was carried out at the time od charging with solar energy and the experiment was also carried out twice the voltage before the water pump started was 13.72 Volts and after 1 minute the water pump started the voltage dropped by 1.74 Volts. The cause of the drop is because the motor start load is very large, namely 510 watt and the output is 125 watt can be seen table 5.

TABLE VI
Testing Without Charging

Initial Stress	Duration	Voltage at load	Voltage - Drop
12.73 Volt	1 minute	11.03 Volt	1.7 Volt
12.57 Volt	1:30 second	10.54 Volt	2.03 Volt

In table 6 experiment can be seen the difference in voltage drop when not a state of charging, the first experiment can turm om the water pump for 1 minute with a voltage drop of 1.7 Volts and in the second test where the assumption of time is 1 minute 30 seconds and the voltage drop to 2.03 Volts which causes the water pump to die because. The power from the battery/Accu is only 35 Ah and modified inverter is 1500 watt. And the input power power of large water pump with 510 watts of power. The experiment can be seen in Figure 7.

Battery Capacity (Wh) = Battery Capacity (Ah) x Battery Volatage (V)
Battery Capacity (Wh) = 35 Ah x 12 V = 420 Wh

E. Overall System Testing Results

The test in table 7 starts from 07:00 in the morning in the tim module in the RTC (Real Time Clock) sensor there will be a time difference of about 3 seconds and in the test if the time shows 09:00 then the relay will automatically lock and turn on the water pump automatically where the watering time is set for 1 minute of watering and after 1 minute of watering the relay will reopen and water pump will turn off. And at 15:00 will return of watering for 1 minute if it suddenly rains during the watering procces then the rain sensor will automatically detect the water discharge end cut off the relay to the water pump. And at 15:00 it will return to watering for 1 minute if it suddenly rains during the watering process, the rain sensor will automatically detect the water discharge and disconnect the relay to the water pump

TABLE VII
Overall Tool Testing Results

Time in RTC Module	Actual Time	Rain Sensor (ADC)	Vin (Vdc)	Vout (Vdc)	Rainfall discharge (%)	Description (Water Pump ON/OFF)
08.00.00	07.59.57	943	4,82	04.50	10	OFF
09.00.00	08.59.57	954	4,84	04.52	9	ON
10.00.00	09.59.57	952	4,84	04.43	8	OFF
11.00.00	10.59.57	959	4,82	04.50	9	OFF

12.00.00	11.59.57	954	4,85	04.54	8	OFF
13.00.00	12.59.57	956	4,84	04.49	9	OFF
14.00.00	13.59.57	987	4,89	04.56	9	OFF
15.00.00	14.59.57	956	4,86	04.59	10	ON
16.00.00	15.59.57	583	4,84	0,125	59	OFF
	Average		4,84	04.30	14.05	

The results of testing the automatic plant sprinkler with source solar panel where the tool work accoeding to weather condition when the wheater is sunny, charging will be carried out on the battery / Accu. If the weather is rainy then automatically watering will no be done because rain is a natural plant watering. The author also adds a water pump security system, namely a 1 phase MCB for water pump safety

IV. CONCLUSION

Based on the results of the tools made, namely automatic plant watering with sources solar panel where the driving energy from the sun is in the battery and to drive the water pump motor, the DC voltage is converted to AC voltage, and the sprinkler will be active at a predetermined time, namely at 09:00 in the morning and 3:00 p.m. with a watering duration of 1 minute,if at the time of watering it rains with a discharge reaching 50% then the relay will automatically cut off the voltage to the water pump, because watering will be continued by the rain. And for the battery capacity used must be greater than the load used because the greater the battery capacity the longer the duration that can be done when watering plants automatically. This tool is a project of 2 people who do the design in terms of generators and automatic plant watering it self and this is part of automatic plant watering

ACKNOWLEDGEMENTS

Thanks to the supervisors who have halped in the research process of making tools and reports and journals, thanks to all the academic community of the Electrical Engineering Department of Padang State Polytechnic.

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