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Development of Portable Solar-Tracked PV Powerbank Station

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Abstract: When it satisfies the most recent societal standards for operating silently and without pollution, the use of solar panels is growing in popularity. Solar trackers have been developed to improve the energy produced by solar panels even further. It was developed to improve the effectiveness of solar panels, hence capturing more voltage. The microcontroller for this project moves the solar panel so it always faces the sun using an Arduino processor. The LDR detector, which is used to determine the direction of the sun's rays before providing the signal to the Arduino processor, is what causes this solar panel to move. Despite the comparatively high expense of employing solar trackers, it is crucial to utilize all of the sun's limitless and pollution-free energy by making solar panels more efficient. It is intended that if solar trackers are used more frequently, the price will drop, and more people would be able to afford them. The servo motor's rotational speed will be shown on the LCD screen display. Based on the programming that has been done on the Arduino ide programming, the Arduino Mega microprocessor powers this project. This project's goals have been attained as a consequence of the tests that have been run. It is envisaged that numerous parties will utilize this solar radiation tracker in the future. This final year project introduces the project that stores solar energy from the sun and transforms it into electricity with the help of Sensors. This project employs an LDR that detects changes in light intensity and adjusts the output, accordingly, causing the solar panel to change direction to follow the light path. This project consists of several types of equipment such as USB charging, socket, LDR sensors, and servo motor. Arduino software to produce command/coding, allowing it to be called a Portable Solar-Tracked PV Powerbank Station.

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1. Introduction

Solar energy is a future-proof renewable energy resource [1] since it is free, nearly unlimited, and produces no damaging residues or greenhouse gas emissions [2]. Photovoltaic (PV) is one part of the solar energy type, that uses solar cells panel to turn sunlight directly into direct current (DC) electrical energy. Nowadays, PV panels are widely used as a source of electrical power to operate the load on both domestic and commercial applications. The electricity generated by PV panels can supply the load independently or be stored in the battery ups system. In current technology, PV source is also popular to be hybrid with another electrical source, either with conventional energy sources such as thermal turbine generators or wind, or hydro. Photovoltaic panels are available in the market and offer various options of types, sizes, and power handling. In domestic applications, a small energy capacity PV panel attached to UPS can supply lightweight and light-usage multipurpose loads such as low-energy lights, motors, and mobile phone/ battery bank chargers, for reasonable time consumption [3].

It can be connected and embedded as a compact lightweight box to become an easy-to-carry mobile power supply convenience for traveling or storage for recreational and emergency purposes which is connected to some unanticipated event that occurs in Malaysia. Malaysia recently had an unanticipated event happen which was a flood disaster. The incident took place in December 2021 in Flat Sri Muda and the neighborhood [4]. Thus, this project will help those who can make a kit for charging devices. Direct sunlight is used as an input in solar energy technologies.

Solar Energy is widely used in significant sources [5]. Solar power stations (SPS) create more green energy than traditional energy sources. This is because solar energy is unlimited, available worldwide, and clean [6]. The fundamental disadvantage of SPS can be overcome using a solar-tracking technology that allows solar batteries to be more energy efficient. There are two methods in the process of charging a gadget. The first is by using electricity, and the second is by using renewable energy. Solar irradiance measurement gives information that can be used to make critical decisions about future energy yield, efficiency, performance, and maintenance. This project requires irradiation since it can establish whether the solar panel installation is ideal for obtaining the most electricity. Use a sun tracker as a guide.

The unique feature of this system is that it uses the sun as a guiding source rather than the earth as a reference. The active sensors detect the amount of sunlight and move the panel in the direction where the intensity is highest. Energy electricity has been used since time immemorial, a direct connection to a socket or a power bank. Meanwhile, many are now turning to renewable energy generated from natural sources like the sun, water, and wind. Renewable energy sources can reduce financial costs towards energy resources and are environmentally friendly. This is because the process of generating electricity from a source nature does not emit chlorofluorocarbons and carbon dioxide. Therefore, along with inventing the solar tracker, the installment of the solar itself becomes more worthy and unconditionally, it archives the good terms of our life which is financial costs decreasing and eco-friendly. Today's gadget consumers demand a charging device that they can take with them. There are some disadvantages to current charging devices.

The charging gadget, for example, should be charged at home before being used or carried out of the house. The issue that led to this project is that it is one of the charging methods that makes use of renewable energy sources, allowing us to avoid the exhaustible use of power and charge. It is less polluting to the environment and more user-friendly. It may be utilized with ease during calamities and power outages, and the device and electricity will last forever. Such devices can be used even in rural places where electricity is scarce. During rainy and foggy days, it might get rusty and need maintenance. Aside from that, Some solar panel charging equipment is not appropriate for use in emergency situations when calamities like floods occur annually in Malaysia. The charging devices that use panels nowadays must be moved manually to get high levels of sunlight in order to maximize the current that can be charged. This is done in order to create devices that are suitable for emergency situations. Depending on the weather and where the solar panel is placed, it typically takes 3 or 4 days to fully recharge the devices using a standard solar powerbank. This problem limits the amount of electricity that can be produced.

2. Methodology

Using a block diagram of the project that shows every component of the project, the prototype of the PV solar tracker and the materials needed to make the prototype are shown. As software components, each component of the PV solar tracker's specification is also included in this chapter. This chapter will provide a detailed explanation of the project's production method and how it works, as well as the component used in the project. Figure 1 shows the flowchart of project.

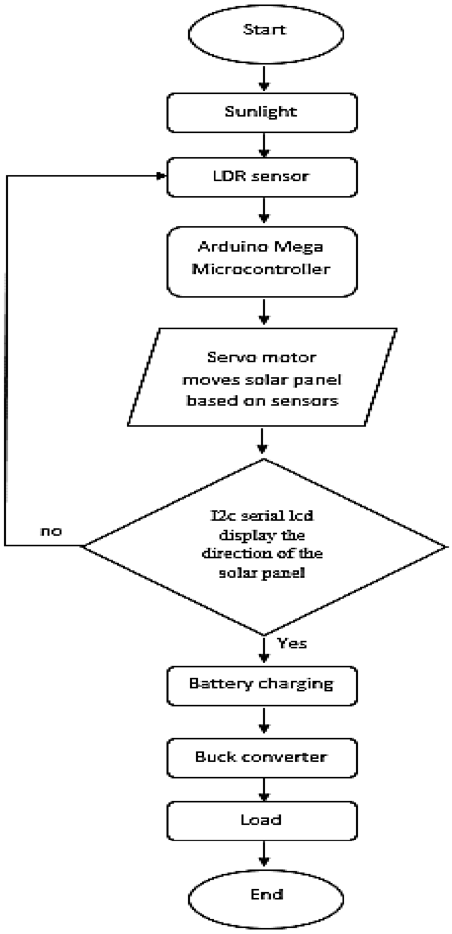

Figure 1: Proposed System Flowchart

This flowchart illustrates the proposed system flowchart. There are three stages that the project should go through to build the solar tracking charging. The Arduino IDE will be used during the entire session. When establishing a solar system, load determination should come first and foremost in your mind. The size of the solar panel, the required battery, and both. When step 1 is complete, attention should turn to phase 2, which is the preliminary outcome of modeling the design in proteus 8 professionals. LDR sensors are one of the sensors used to measure sunlight brightness; however, this project also includes a servo motor, ACS712 current sensors, an I2C serial LCD, and an Arduino Mega. Phase 2 is where the operation begins when the coding and commands are successfully compiled to send the data to the proteus. Phase three, where the hardware was designed, begins after the program is successfully executed by the command in the Arduino software and by proteus. The coding that has previously been successfully compiled must be combined with the Solar tracker when it is finally built in order to embed it in the hardware. The prototype's workflow is shown below. The intensity of the sun is first detected by the LDRs. As a microprocessor, the Arduino Mega will take data from LDRs that have already combined commands and send it to the servo motor so that it can move in response to the command. While the solar panel is facing the sun, current from the panel is also traveling through the ACS712 current sensors, which can read the current. Through a solar charge controller, a lead acid battery will be recharged for the charging portion (SCC). The voltage from the solar panel is controlled by the charge controller so that it won't overcharge the load.

The creation of the tracking function's algorithm was dependent on the lighting source, and four photo sensors were put adjacent to the PV modules to read the light. Photoresistors were utilized as photo sensors in this project, and their resistance varied depending on the amount of light they received. The photo sensor signals were sent into the microcontroller as analog inputs. The microcontroller was able to determine the incidence angle between incoming sunlight and PV modules based on the light intensity of all four sensors.

On the same mount base, The photo sensors were installed along with photovoltaic panels, ensuring that sun rays from the sun reach the sensors with photovoltaic panels at the same direction and brightness. As a result, when the microcontroller program appropriately managed greater attention were appropriately managed by the microcontroller program, PV modules could produce their maximum amount of solar energy. The device was able to calculate the exact angle between the PV modules and the incoming sun rays because of the positioning. Figure 2 shows the complete of proposed system.

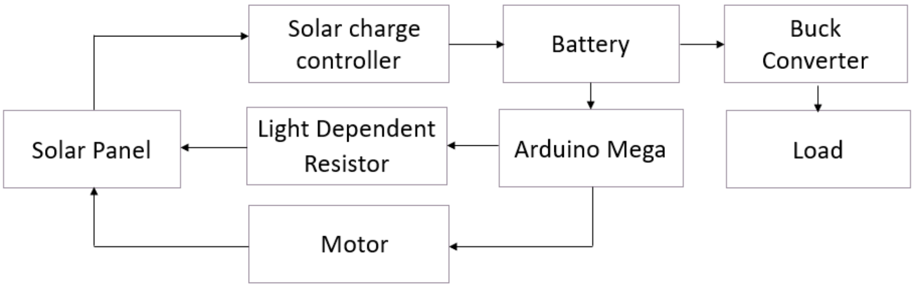

Figure 2: Block Diagram of Proposed System

3. Results and Discussion

The findings of the tests undertaken on this project are described in this chapter. This solar radiation tracker project was put to the test to see how well it worked and how far it could go. The test is separated into four sections in this chapter: interior test, open place test, output test, and the continuous voltage charging of the battery. When the project is finished and working properly, this test is done. The Proteus software was used to simulate a solar panel tracking system. A simulation was run to see if the system that was created and implemented would meet the expectations. The simulation procedure reveals the system's precise circuit design and connections.

A. Connection Testing

Figure 3 shows the connection of the proposed system.

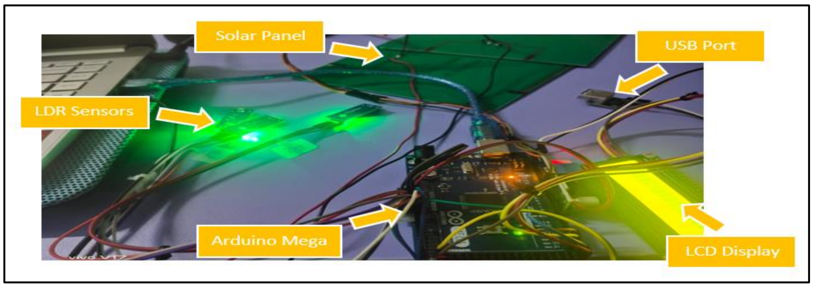

Figure 3: Connection of Proposed System

B. Displaying on LCD

Figure 4 illustrates the connection to LCD display. The LCD and LDRs are also tested. The I2C LCD display is controlled. The project's switch is connected to both the VCC and the ground. This supply includes each and every part. The LCD will show the phrase 67.5' east discharging.

Figure 4: LCD Test

C. The Hardware Prototypes.

Sun radiation tracker testing was conducted at Taman Pura Kencana Sri Gading on December 25, 2022. From 11:00 in the morning to 4:00 in the evening, there was a testing phase. The test was conducted at the same place over two days, with results being recorded every hour. Figure 5 displays the results of the experiment that was carried out on December 25, 2022, at 11 a.m. During this test, servo motors rotated in the prescribed direction when LDRs 4 detected sunshine. Figure 5 shows the prototype of this project.

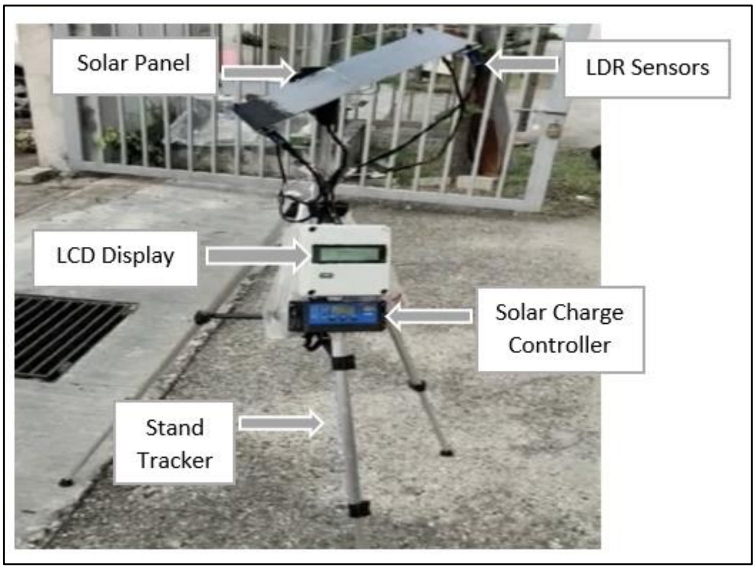

Figure 5: The prototype of the project

D. Solar Panel Testing

A digital multi-meter was used to measure the charging produced by the solar panel to recharge a 12V 2.3 ampere-hour battery. After then, readings for the solar panel exposed to the sun were taken every hour from 11.00 a.m. to 6 p.m. Figure 6 shows a digital multimeter was positioned between the two leads of the solar panel in order to collect the measured value. These findings were run three times, with the average readings used for the analysis, to ensure a more precise result and we collected the last readings. Table 1 displays the solar panel's recorded voltage from the solar panel. Between 11:00AM in the morning and 4:00PM in the evening, the voltage is collected. Then, set up a graph such as Figure 6 which provides an explanation of the hourly difference in amount.

Figure 6: Movement and the reading for Voltage for Solar Panel

Table 1: The Average Voltage collected from Solar panel.

Time	Voltage Average
1100-1200	11.73V
1200-1300	11.89V
1300-1400	11.99V
1400-1500	11.97V
1500-1600	11.79V
1600-1700	11.71V

E. Analysis and Discussion

The graph in Figure 7 indicates that between 12:00PM and 2:00PM, 11.99V of average voltage is created. The outcome also demonstrates that the generated voltage was more than 12V throughout the entire tested period. indicating that the battery can receive charge from the PV module. Therefore, from the result the peak of average voltage is at one o'clock to 2 o'clock with the reading of the voltage is higher, 11.99V. it means the amount of solar energy receive from the solar panel at that time is higher which mean the direction of the sun and the energy at that time is contribute to that result.

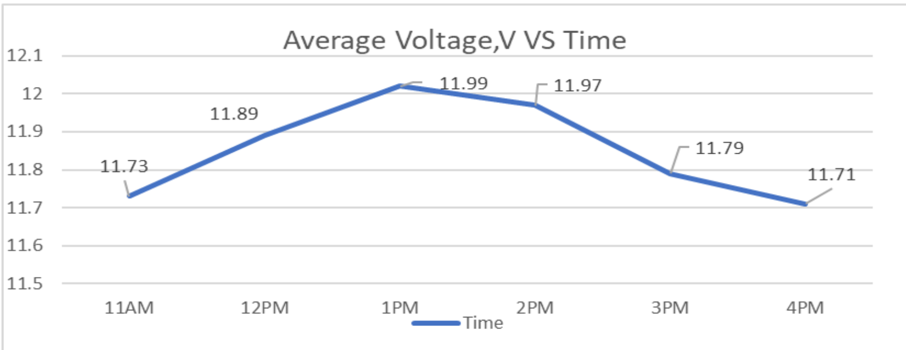

Figure 7: Graph of average voltage versus Time

Starting the test, the solar tracker will be on and follow the part towards the sun. So, the reading is proceed from late morning until evening which starts with 11.73V to 11.99V at highest state of receiving solar energy, then starts steadily decreasing 0.03V in the first decreasing line then the graph keep decrease until the end of the testing. This effect is based on the sunlight or sun irradiation who keeps the energy supplied to solar panel plus the movement of the cloudy interrupting the process.

F. The Battery and current from solar panel Measurement

Additionally measured is the current that the PV module produces. The produced current was measured using an ACS712 current sensor. The sensor is attached between the battery and the PV module. Every second, the current flowing between the module and the battery is measured; the reading is recorded and shown by using multimeter which flows through the Arduino IDE programme. The measurement setup for the reading of solar panel and battery voltage is recorded in Table 2.

Table 2: Battery voltage and current charging from Solar Panel

Time	Battery Voltage (V)	Current (A)
11:00 pm	11.69	0.1
12:00 pm	11.79	0.3
1:00 pm	11.84	0.4
2:00 pm	11.99	0.3
3:00 pm	12.02	0.2
4:00 pm	12.04	0.2

Figure 8 shows the reading current from the solar panel by using multimeter. Besides, the battery voltage also been measured throughout the process from 11:00AM to 4:00PM by attached to the battery terminal and being measured with a digital multimeter. A graph is plotted from Table 2 is shown in Figure 9.

Figure 8: Current Reading for Solar Panel

The graph in Figure 9 explained that the battery voltage is increasing steadily from the start until the end of the testing. In the meantime, it shows the current from the solar panel is going up until the peak current which at 1:00PM with the measured current of 0.4 amperes. Then it started to drop 0.1 at 2:00PM and continue constantly at 0.2 amperes until the end of the testing.

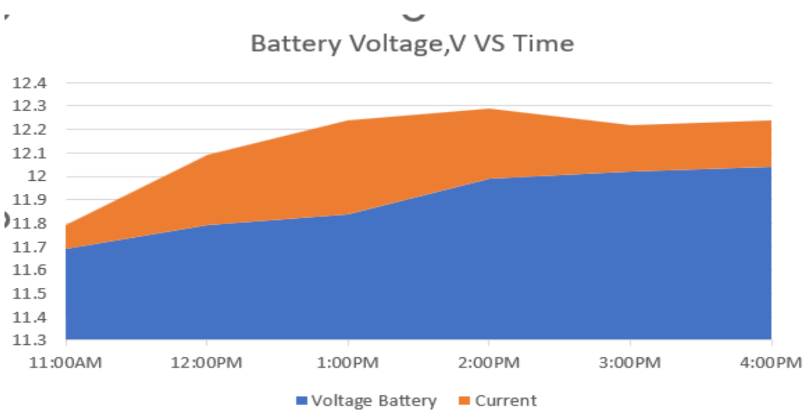

Figure 9: Graph between Battery charging vs Time

4. Conclusion

The goal was successfully met after this project was finished. Based on the project's test findings, which were detailed in chapter 4, this may be demonstrated. In order to use energy on electrical tools, energy generation must be as high as feasible. The only difference is the quantity of energy utilized, and this applies to tools in the house, business, office, or anywhere else. The solar panel tests' findings demonstrated that it delivered the necessary voltage and power output to satisfy the application. Because solar radiation generates a lot of energy to support the loads, it is implied Solar system was suited for usage in our daily life in daylight time or in this case as an emergency charging kit.

The solar panel was unable to provide the 12 V required to power the apparatus, though, because the solar radiation fell to such low levels in the evening. The system was kept running for a long time during the evening thanks to the battery's role as an additional power source during this time. In addition, it is fair to predict that the solar system, which is going to power a small load DC implementation, would function as intended in the morning and be able to operate independently for six hours in the evening without the assistance of solar energy,

In conclusion, solar energy will enable people to utilize more electricity now without increasing costs or damaging the environment in the process. Plus, it is believed that this project will enable students to gain a deeper understanding of solar energy usage, operation, and advantages. The project's introduction, the goal of problem identification, and project scope are all covered in the first chapter, which also outlines the project's fundamentals. The project's goals were successfully attained once it was finished.

The project's literature review is conducted in the second chapter in order to gather the knowledge needed based on prior research to finish the project. The technique is covered in Chapter 3; it is crucial to monitor project progress using this flow chart; and Chapter 4 looks at the finished suggestions and test results.

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