Development of an Arduino-based Solar Power Tracking System

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***Abstract*—The use of fossil fuels and non-renewable resources to fuel our industry has an adverse effect on the environment. The use of solar power can be constructive in minimizing carbon emissions to the atmosphere. However, photovoltaic potential from the sun is not fully utilized due to some restrictions, and a solar tracking system is used to increase the efficiency of the energy harvested from the sun. Creating an affordable yet easily operated solar tracking machine will benefit the environment. A linear actuator and an RTC are used to manage the system with a time-based mechanism.**

Keywords*— *renewable energy, solar-tracker, solar power

I. INTRODUCTION

Renewable power sources have become the alternatives for fossil fuels, and the usage of fossil fuels has shown adverse effects on the environment; using renewable power sources such as solar, wind, hydroelectric and geothermal is considered environmentally friendly and sustainable [1-3]. Replacing fossil fuels with sustainable energy has become a trend in innovation and technology because it has shown over the years that using fossil fuels as the primary source of power in many countries has led to an alarming rise in carbon emissions, which are the majority source of greenhouse gases (GHGs) in the atmosphere [3-5]. The United Nations (UN) emphasized the utmost importance of sustainable development worldwide in 2015 with one of its goals of achieving affordable and clean energy and ensuring energy efficiency [6]. The promotion of renewable energy has become the standard agenda for many policymakers and to raise awareness of the harmful effects of the consumption of fossil fuels in countries with high dependency on coal, oil, and gas; solar energy has become known worldwide for it is one of the cleanest energy sources [1-8].

Solar is the most attractive renewable energy source and several studies have been conducted with the use of solar energy [9-13]. Solar power is used to provide electrification in the rural areas [9]. Even today, solar power is being implemented in water bodies such as lake through floating technologies [10]. Solar is being developed as well to advance its state with the implementation of artificial intelligence [11-13].

Solar energy has been commercially used since 1954, and the use of solar photovoltaic was made possible by the discovery of Edmund Becquerel in 1839 through his observation of the direct light that strikes one of the electrodes of an electrolyte process, the voltage generated is called the effect photovoltaic [14]. This new renewable power source has become the new way of generating electricity, making it the third most significant energy source after hydro and wind [15].

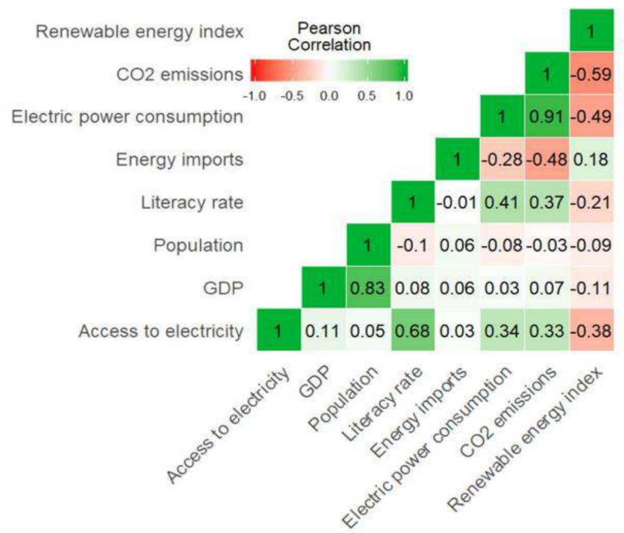

Fig. 1. Correlation heatmap of the Renewable Energy Index with selected socioeconomic indicators. The numeric values are Pearson Correlation Coefficients (r). Values greater than 0.2 indicate numeric association [13]

However, the efficiency of PV-based power in many cities in the world is still not considered economically reasonable compared to the current sources of energy [15]. Therefore, many academic and industrial research groups are still trying to improve the efficiency and the invention of PV conversion equipment; one way to enhance the performance and the efficiency of PV solar systems is to use a solar tracking system [16]. Compared to static solar panels, which are positioned at a constant angle, limiting the energy harvesting to only a few hours a day [17]– the solar panel's solar–tracking system has shown 30-60% of the PV yield [18].

II. OBJECTIVES

The implementation of the solar tracker system is proven to improve the efficiency of energy harvesting of solar panels. An estimated 384.6 yotta watts of energy in the time during daytime and completely shut off during night time.

The overall objective of this project is to design and develop a single-axis solar panel with a solar tracking system. The system will be able to track the motion of the.

The specific objectives of the projects are:

1. To control the position of a solar panel in accordance with the motion of the sun.

2. To increase the amount of solar energy received by the solar panel using a tracking system.

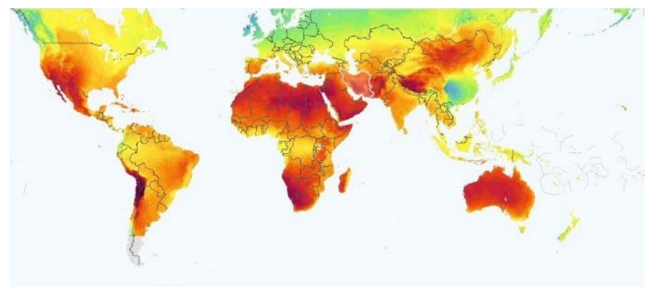

Fig. 2. Photovoltaic Potential of the World [10]

forms of light and other forms of radiation are produced by the sun, the Earth approximately receives 1,000W/m2 on a clear day [17]; however, most of this energy is lost due to the positioning of the panel. According to the report from the Global Solar Atlas, the Philippines has a great photovoltaic potential all over the country. The image shows that most potential for photovoltaic power is located mostly in the Luzon region of the country [18].

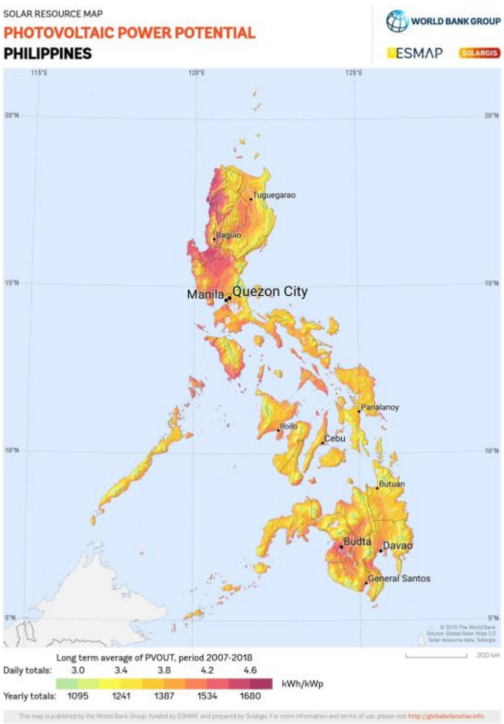

Fig. 3. Photovoltaic Potential of the Philippines [19]

III. Materials and Methods

A. Hardware Materials and Equipment

The following materials and equipment are used in designing the prototype of the single-axis solar tracker for the solar panel:

- Arduino Uno R3
- Linear Actuator
- 100 W Solar panel
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- 12V Battery
- Solar Charge Controller
- L298N Motor Driver Module
- Real-Time Clock
- Bearings
- Wires
- Bolts and Screw
- Wood for the base and stand

The Arduino Uno microcontroller hardware is a very popular choice in programmable devices. This has been proven to work in various development projects [20-26]. The intellectual property for the developed device using the Arduino microcontrollers may be subject to the intellectual property policy of the university [27].

B. Software used in the project

Arduino Software IDE includes a code editor, a message area, a text console, a toolbar with buttons for common functions, and a series of menus. It communicates with the Arduino hardware and uploads applications to it.

In designing and developing this project, three main components were implemented; (i) construction of the frame and circuitry, (ii) installation of hardware components, and (iii) development of the program to control the linear actuator. The flowchart of the overall system is shown in the figure below.

C. Connecting the Hardware Components

The Arduino board serves as the circuit's brain. A Linear actuator is used to position the solar panel where maximum solar energy is achieved. A Real-time Clock (RTC) will determine the position of the solar panel. The linear actuator is connected to the load output of the solar charge controller; the battery is also connected to the solar charge controller that will power the L298N Motor Driver Module. The Motor Driver is connected to the actuator and Arduino Uno board.

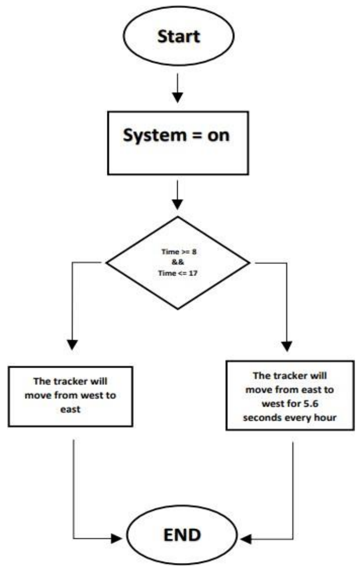

Fig. 4. Flowchart of the Overall System

D. Arduino Program for Solar Tracking Device

Once the hardware is ready, connect the Arduino Uno board to the computer and start programming. Start up the code by including libraries and defining all the pins used. Download the RTClib from the Library Tools of the Arduino IDE, as well as the Linear Actuator Library.

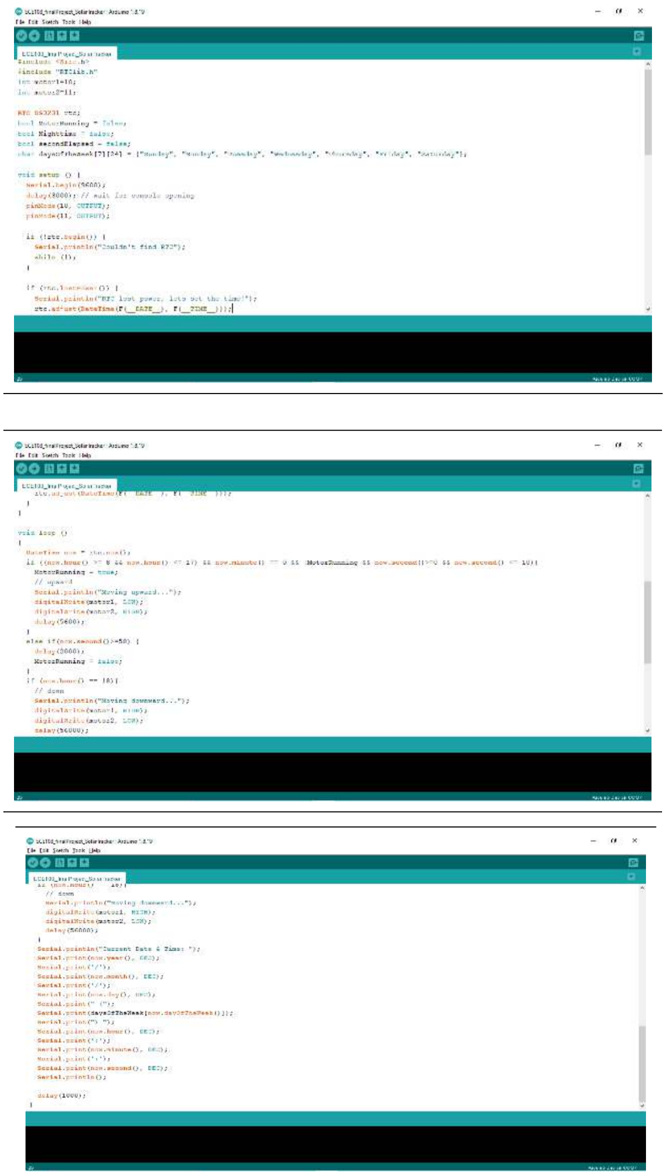

Figure 5. Programming codes shown for the automation of the device developed.

IV. RESULTS AND DISCUSSIONS

The implementation of a solar tracking system for solar panels is applied to get maximum power output from the sun. The prototype of the solar-tracker project is equipped with RTC that will determine the position of the solar panel in accordance with the time during the daytime. This design is an effective method of implementing a single-axis solar tracking system, and a single-axis solar tracker is more likely to be used in the utility sector because it costs less than the dual-axis solar tracker.

Figure 6. Linear actuator of the system.

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Figure 7. The system as designed and implemented.

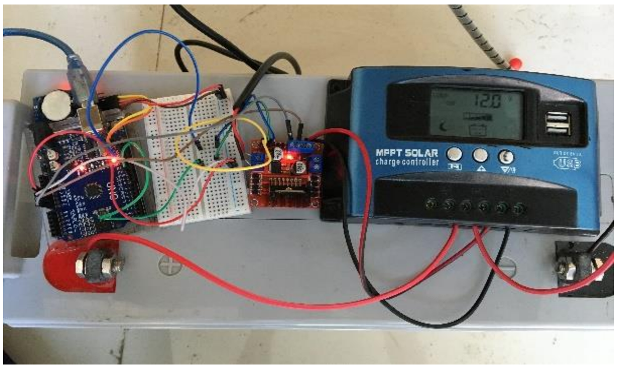

Figure 8. Arduino microcontroller and system developed.

The mechanism used in the solar tracking system for the prototype is a linear actuator. As shown in figure 5, the linear actuator will push one side of the solar tracking system to tilt it upward and will contract back to tilt it back to the other side. The use of the linear actuator and RTC is an effective method of designing a single-axis solar panel with the help of Arduino Uno R3. This design of solar tracker is less expensive and much easier to operate. An RTC is used to control the movement of the linear.

The actuator is programmed to control the movement of the linear actuator to move hourly during the day; the operation will start at 8:00 AM and will end at 5:00 PM. At the end of the program, the operation will return back to the original state and will start the next day again.

Figure 9. Design of the system as implemented.

V. CONCLUSION

The system's protection is also essential for the Solar tracker. The solar tracker must be installed in an area with no obstruction that prevents the solar tracker from harvesting maximum energy from the sun. However, it can also be prone to damage caused by rain, wind, etc. Thus, the researchers must create a casing that will protect the circuit from these environmental damages.

The current project is a single-axis solar tracker which tracks the sun's movement from east to west. The sun changes its position on the Earth's atmosphere due to Earth's revolution around the sun, so the light we get from the sun will not always be in the exact longitude and latitude coordinates. A dual-axis solar tracking system is recommended to collect the maximum energy harvested from the sun.

VI. RECOMMENDATION

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