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Foreword

University of Yangon (UY) makes an all-out effort to be a leading higher educational institution in Myanmar as a Flagship university on par with regional counterparts and in line with international trends. UY therefore expands the frontiers of knowledge by developing research culture.

UY created a research-teaching nexus namely Universities' Research Centre (URC-UY) where research informs and enhances teaching agenda. University education is fundamentally about how to solve problems based on data and/or logical thought. Those involved in research are better at imparting these skills to students with inquiring minds. The Korea Foundation for Advanced Studies (KFAS) has been supporting research activities in UY through the Asia Research Centre (ARC-UY). To a researcher in UY, ARC-UY and URC-UY should be seen as two sides of the same coin in much the same way as financial support and research activity should be regarded.

Research is only meaningful if it is communicated, so the research outcomes must be published and contribute to the body of knowledge; even better if research outcomes can be impactful through commercialization or implementation. This journal proudly presents 15 research papers resulted from the outstanding research projects carried out by the academic departments of UY.

I would like to express my appreciation and congratulations on the concerted effort of the researchers who have made a great deal of excellent contribution to this issue. I also would like to to express my heartfelt thanks to Mr. Park In-Kook,President of the KFAS for his continued support to the ARC-UY.

Prof. Dr Pho Kaung
Rector, University of Yangon

Design and Implementation of an Automatic Solar Tracking System

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Abstract

Solar energy is available almost everywhere and solar power is very helpful in our everyday life. The plane of PV panel should always be normal to the incident solar rays to get maximum energy. The seasonal movement of the earth affects the radiation intensity received on the PV panel. Solar tracking systems can effectively improve energy efficiency of a solar PV panel. This research aimed to obtain maximum possible power from a solar panel all day long when the panel tracks the sun and rotates through the axis. This movement was achieved by installing a couple of servo motors with the solar panel that changes its direction according to the positioning of the sun. Arduino UNO with ATmega328p microcontrollers have been used for this purpose. It receives sensor output signal and controls servo motors according to the assigned program. One servo motor moves the panel vertically to upward and downward while the other moves the panel horizontally from left to right direction. Since the maximum solar ray is fallen down on the solar panel module, the maximum power output can be achieved from the module.

Keywords: Arduino UNO; dual axis; LDR, prototype; servo motor; solar tracking

I. Introduction

Global energy consumption is dramatically increasing due to higher standard of living and the increasing world population. The world has limited fossil and oil resources. As a consequence, the need for renewable energy sources becomes more urgent. The green energy, also called renewable energy, has gained much attention nowadays [Tiberiu, T., and Liviu, K., 2010]. Solar energy is one of the primary sources of clean, abundant and inexhaustible energy that not only provides alternative energy resources, but also improves environmental pollution. The most immediate and technologically attractive use of solar energy is through photovoltaic conversion [Morega, A. M. and Bejan, A., 2005]. Solar tracker is an automated solar panel that actually follows the Sun to increase the power. Solar tracking is the most appropriate technology to enhance the electricity production of a PV system [Abigail, K., 2007].

In this work, the solar tracker system with two axes has been designed and implemented by using four LDRs and two Tower Pro (MG90S) motors with gear arrangements. In order to get the maximum efficiency, the solar tracker with two axes sense the direct solar radiations falling on photo-sensors as a feedback signals [Akposionu, K. N., 2012]. The control algorithm has been implemented via Atmega 328p microcontroller on a simple and cheap mechanical structure.

II. Designing a Prototype Dual Axis Solar Tracker

In the first step, a block diagram for a prototype dual axis solar tracker was designed as illustrated in Figure 1. The layout plan of the prototype dual axis solar tracker

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is designed by coral draw software in the second step as shown in Figure 2. For the mechanism of this solar tracker, 4 mm thick acrylic sheets were used for all parts of the designed frame of solar tracker.

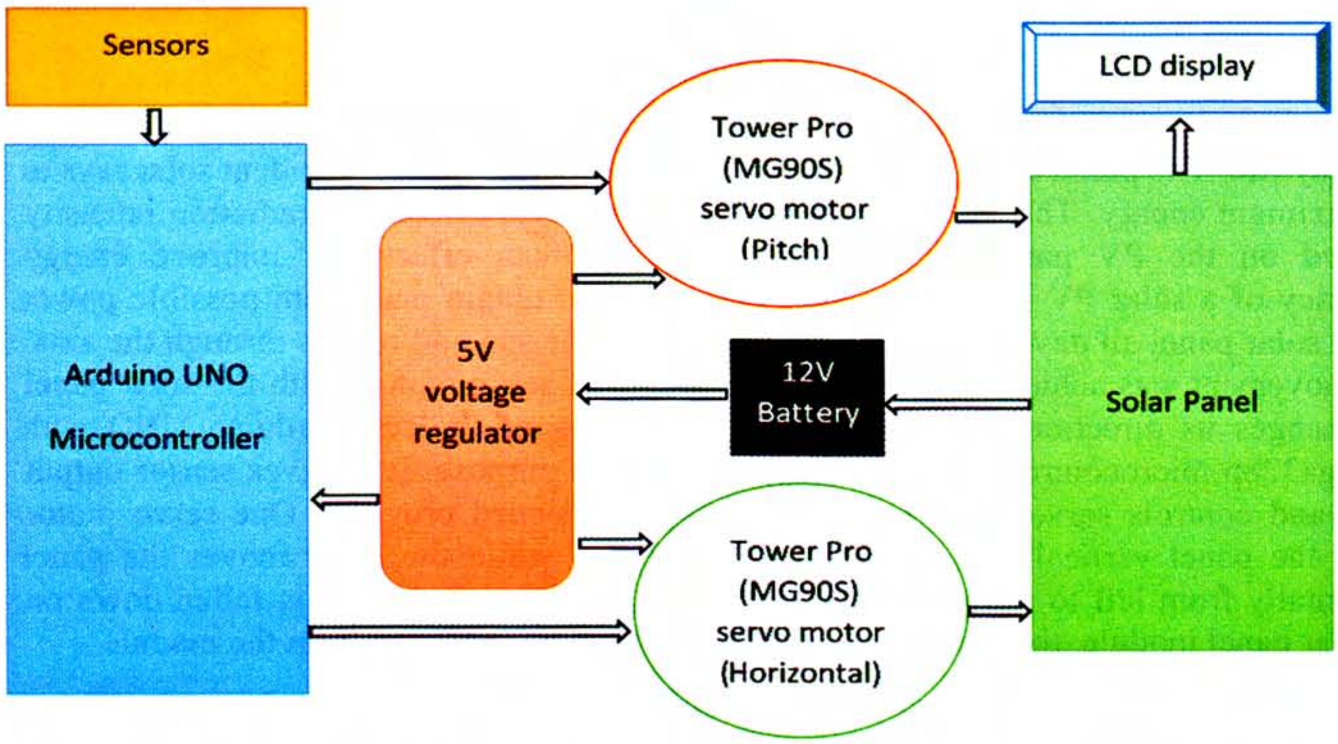

Figure 1. Block diagram of prototype dual axis solar tracker

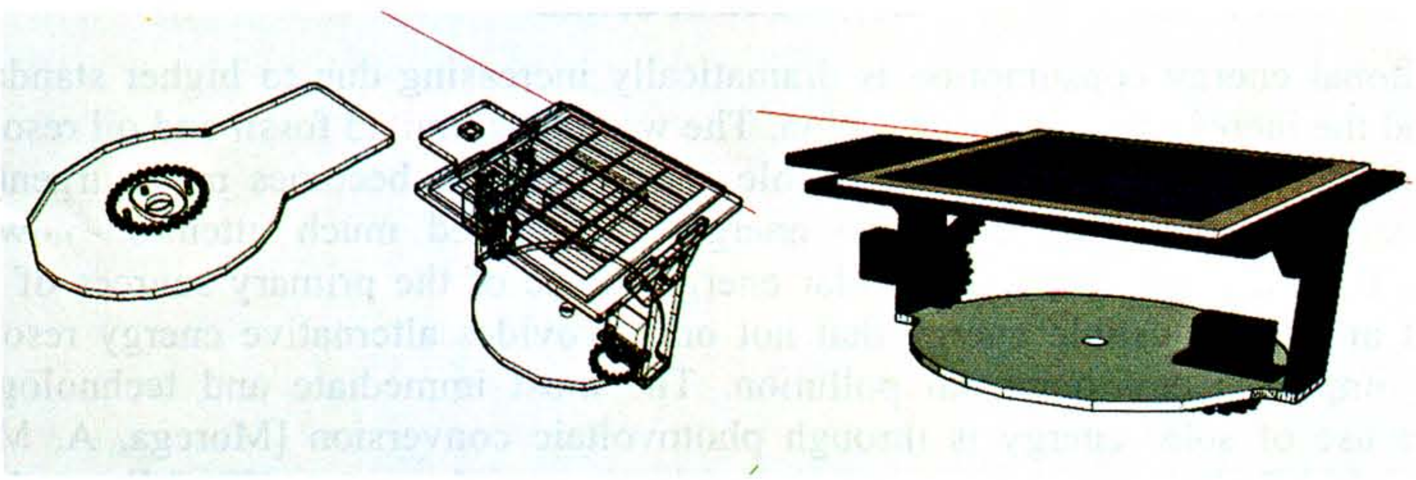

Figure 2. The layout design of prototype dual axis solar tracker

III. Architecture Development

The third step is architecture development. For dual axis solar tracker, it consists of four sensors which play very important role. These sensors have been calibrated to have nearly equal resistance values. As dual axis has used for solar tracker, two servo motors drive for vertical and horizontal movements. The solar panel is connected in servo motors so that the position of solar panel is same to that of the servo motors. The 4 mm thick acrylic sheets have been used for the frame of solar tracker and it has been cut as the layout design plan. After they have been cropped by the measured diameter, drill holes were made for all insertions. Firstly, the solar panel and sensors circuit were mounted on one of the acrylic sheets. Two servo motors were inserted in their respective positions of the designed frame with the gear mechanism to obtain more torque [Ankit, A. and Rahul, G., 2014].

Tower Pro (MG90S) metal servo motor and insertion on the frame is shown in Figure 3. After that Arduino UNO board and LCD (Liquid Crystal Display) were inserted on the base frame of acrylic sheets, the wiring system was carefully connected to each part of the whole circuit as presented in Figure 4.

In the fourth step, the software procedure was developed for the prototype dual axis solar tracker as shown in Figure 5. The circuit diagram of prototype dual axis solar tracker is shown in Figure 6.

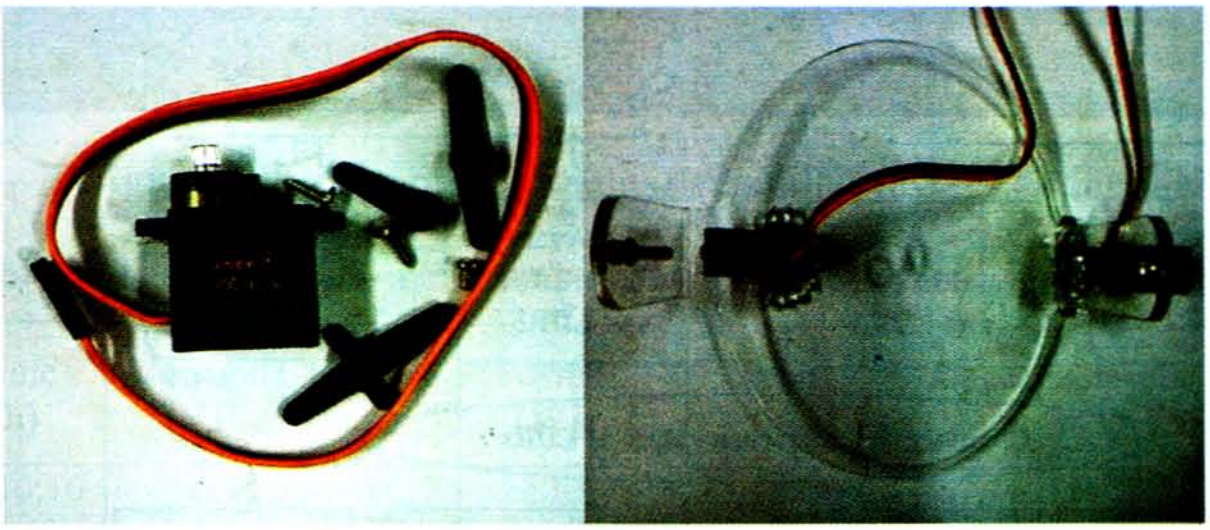

Figure 3. Tower Pro (MG90S) metal servo motor and insertion on the frame

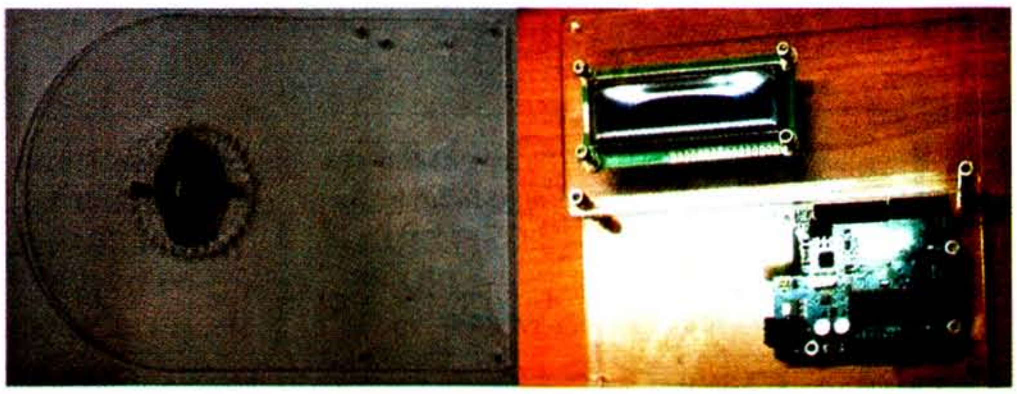

Figure 4. Base acrylic sheet, Arduino UNO and Liquid Crystal Display

IV. Test on Operation of Prototype Dual Axis Solar Tracker

The Solar tracker with hardware and software development has been assembled by using Arduino UNO Controller, two Tower Pro (MG90S) Servo Motor and four light dependent resistors (LDRs) for capturing maximum light source. The C programming language has been used to activate the Arduino UNO board [Mostefa, G., 2013]. The micro-controller has been programmed to rotate the servo motors with dual axis and it has been tested to develop the solar tracking system. In this solar tracking system, the pitch servo motor rotate from top to down and from down to top (between 10° and 170°) while the horizontal servo motor is active and rotate from left to right and from right to left (between 40° and 110°).

The solar tracker has been tested to track the sun and to get the highest efficiency all the day time. Table 1 shows the data of the power output between 10 am and 11 am, 11 am and 12 am, 12 am and 1 pm, 1 pm and 2 pm, 2 pm and 3 pm, 3 pm and 4 pm and 4 pm and 5 pm with six stops. It was investigated that the orientation of the solar panel was changed in each interval depending on the power generated by the solar panel from 126° south-east to 142° south-east. It is also worth to note that the maximum power was obtained around 12 pm as illustrated in Figure 7.

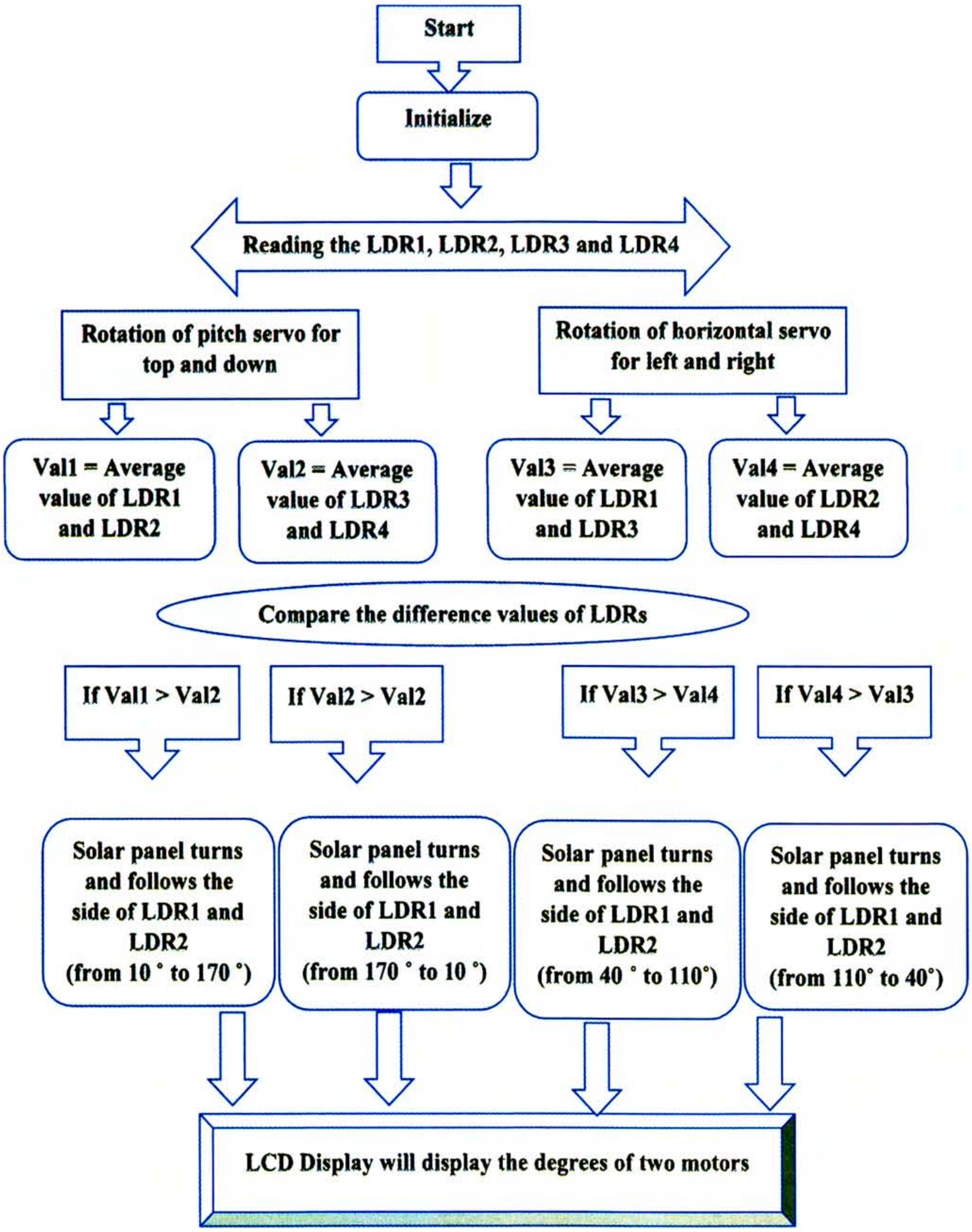

Figure 5. Software procedure of prototype dual axis solar tracker

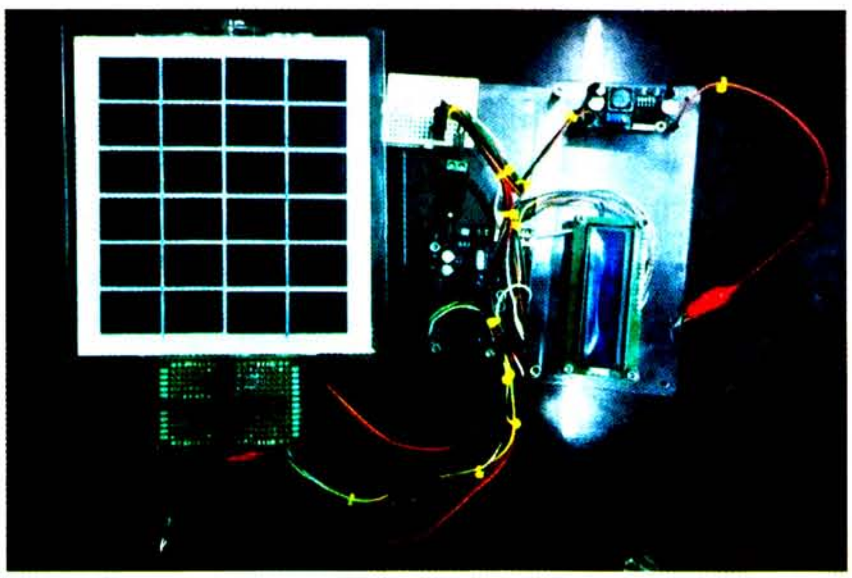

Figure 6(a). The prototype dual axis solar tracker (top view)

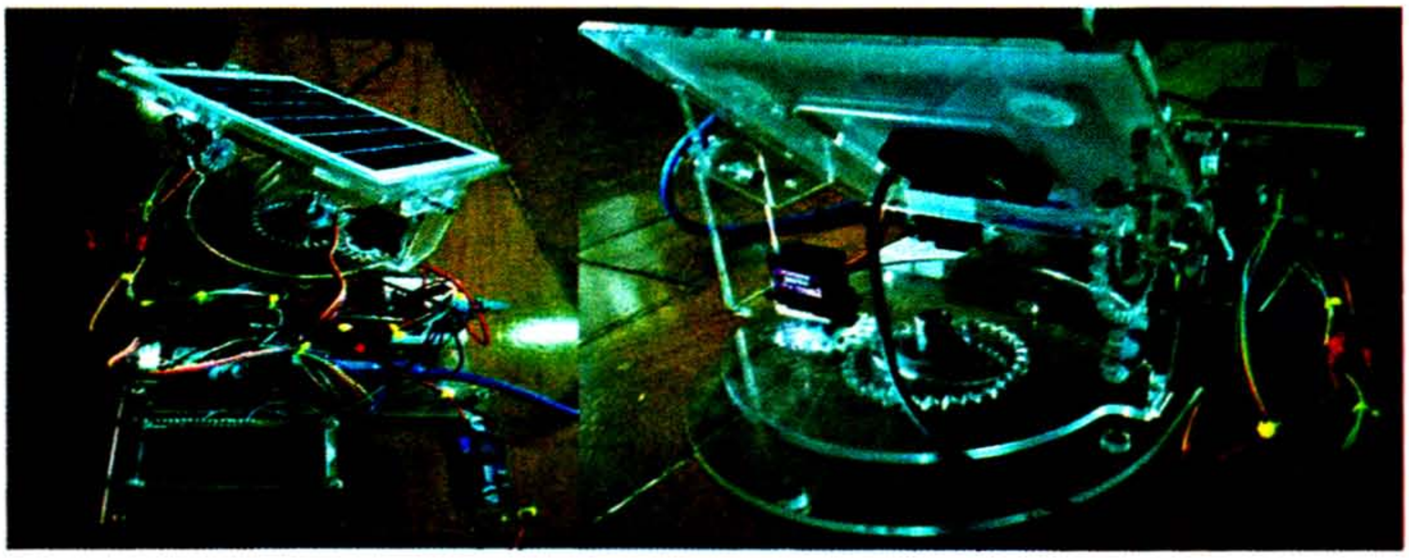

Figure 6 (b) The prototype dual axis solar tracker (side views)

Table 1. Test results of measuring the power output between 10 am and 5 pm

Time (h)	Voltage (V)	Current (A)	Power (W)	Time (h)	Voltage (V)	Current (A)	Power (W)
10:10	6.70	0.27	1.81	13:40	6.54	0.23	1.50
10:20	6.60	0.27	1.78	13:50	6.52	0.23	1.50
10:30	6.57	0.27	1.77	14:00	0.50	0.22	0.43
10:40	6.62	0.27	1.79	14:10	6.54	0.18	1.18
10:50	6.57	0.27	1.77	14:20	6.53	0.18	1.18
11:00	6.58	0.27	1.77	14:30	6.51	0.18	1.17
11:10	6.62	0.29	1.92	14:40	6.46	0.18	1.16
11:20	6.66	0.29	1.93	14:50	6.48	0.18	1.17
11:30	6.68	0.29	1.94	15:00	6.44	0.17	1.09
11:40	6.62	0.29	1.92	15:10	6.20	0.16	0.99
11:50	6.59	0.29	1.91	15:20	6.50	0.15	0.98
12:00	6.63	0.29	1.92	15:30	6.44	0.15	0.97
12:10	6.67	0.29	1.93	15:40	6.43	0.14	0.90
12:20	6.68	0.29	1.94	15:50	6.40	0.13	0.83
12:30	6.71	0.29	1.95	16:00	6.42	0.12	0.77
12:40	6.70	0.29	1.94	16:10	6.44	0.12	0.77
12:50	6.67	0.27	1.80	16:20	6.45	0.12	0.77
13:00	6.65	0.25	1.66	16:30	6.38	0.10	0.63
13:10	6.61	0.23	1.52	16:40	6.36	0.09	0.57
13:20	6.60	0.23	1.52	16:50	6.36	0.08	0.51
13:30	6.58	0.23	1.51	17:00	6:14	1:40	10:33

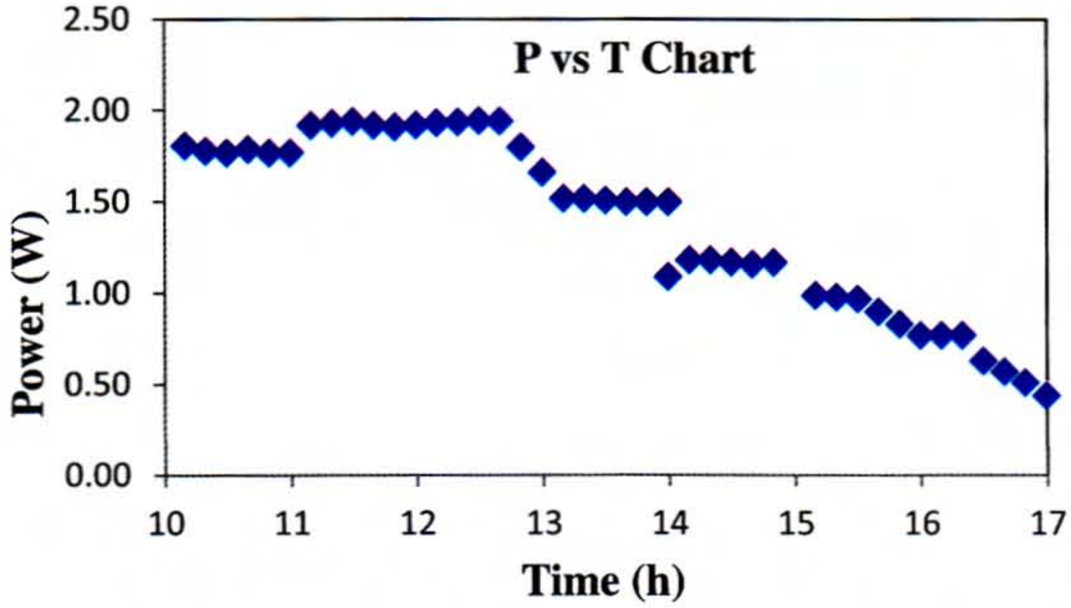

Figure 7. The variation of power output with time

V. Future Perspective

The control system and the design architecture have been developed to reach the project's objective of a solar panel outputting with its maximum possible power. However it still has the parameters to be improved. The two axes are functioning one after another and the sun tracking has to take brake due to the efficiency of electronic circuit. Therefore, the control program and the mechanism have to be modified to have simultaneous operations in dual axis. Moreover, it also needs to modify the control electronic circuit for continuous measurement in pilot type solar tracking system.

Acknowledgements

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