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System Identification of a Solar Maximum Power Point Tracking System for Dual Axis

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Abstract*: The project is on Maximum efficiency of a solar panel. As the sun is not constant at one place and by fixing the solar array at one place, maximum power generation is not possible. This project develops a solar power generation system using maximum power point tracking system. More direct sun light on Photovoltaic (PV) modules leads to enhanced energy yield. Therefore, tracking systems are implemented to improve the performance of PV system by tracking sun trajectory. The current design of Maximum Power Point Tracking (MPPT) trackers are more efficient than conventional single state solar power generation. Then by comparing two designs initially produced, Maximum Power Point Tracking (MPPT) tracking devices are found to be at better efficiency than static models. The system locates maximum- power generating point using an MPPT controller. The base line results of this study were obtained via physical implementation of simulated system to analyze the various parameters. The system then uses a quadratic-equation based algorithm that calculates the quadratic function corresponding to the maximum power generation point. With the advent of different applications of PV solar power, system planners have been implementing different strategies and techniques to maximize the output of solar system with commonly available technology in market. Additionally, various mathematical techniques were utilized to analyze the results gathered from the physical implementation. The simulation results also implemented to compare between the hardware and software of the project. The comparison of static Photovoltaic output graphs with real time measured values for the systems and a Dynamic Photovoltaic Maximum power point Solar Tracker (MPPT) system was observed. Both PV systems were implemented practically to get appropriate results and mainly all the equipment and services utilized in installation are widely available in local market.

***Index Terms*: Maximum Power Point Tracking, Photovoltaic, Solar panel, Controller, Quadratic Function, Solar Tracker.**

I. INTRODUCTION

Renewable energy such as solar energy, being one of the cheapest and cleanest forms of energy sources, is readily available for the world serves as a good form of alternative power source to the current widely used and much damaging fuel and energy sources.

Sunlight based boards are valuable in a wide assortment of business and mechanical electrical gear requires control. In any case, because of the way that sun based power age frameworks have minimal measure of use in true applications notwithstanding its immense undiscovered possibilities in power age, the Photovoltaic cells are great decision for circumstances as a result of the accessibility of the wrong doing as a power source contrasted with different techniques for power age is substantially more improved.

By the investigation led in the previous decade, insights grandstands that the vitality utilization by the number of inhabitants on the planet in the previous decade, control has been the quickest developing vitality for the most recent decade in creating nations. Due to this huge vitality utilization factor, the world needs to create options in contrast to the present principle control utilization techniques. Since sustainable power source has a genuinely decent potential in the field of intensity age, this field of building has been the subject of concentrate as the final year venture's capacity age framework.

As an alternative, many technologies are arising to develop power from various sources, which in turn produces a very high power using advanced technologies the solar method of energy production is one of the various methods of energy production and harnessment. It is one of the many methods of power generation that comes under the parent category of renewable energy. Many methods of power generation require a substantial amount costing to feature in the system and maintain its operations. One of the methods to develop power from a source through the usage of Photo voltaic power cells otherwise known as the solar cell. Figure 1 shows the basic modelling of the project guided in the reference http://rredc.nrel.gov/solar/calculators/PVWATTS/.

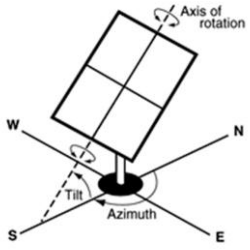

Fig. 1 Basic of project modelling

Developments of this project contributes to several benefits of community.

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Firstly, it helps to create a sustainable economy that can minimize overhead cost especially for bills (electricity) because this system uses a renewable energy source from the sun. Solar energy is arguably the most abundant renewable energy, and this project taps into its potential for the field of power generation. Moreover, it is to produce a working prototype of a photovoltaic power generation device using Maximum Power Point Tracking system (MPPT), to keep the environment clean.

It is significant of the project to utilize an elective wellspring of vitality as sunlight based vitality that is created can be straight forwardly utilized as an elective well spring of vitality or power in residential, enterprises and considerably more. This project will expand the current technological knowledge and trends that are readily available in the field of Solar energy production by implementing a Maximum Power Point Tracking (MPPT) system into the Photovoltaic cell. The MPPT system will help the solar cell track the most amount of sunlight during its operative hours.

II. LITERATURE REVIEW

A. Introduction

A solar tracker is a modular system that tracks the movements of the sun by using flat panel photovoltaic system to increase the amount of energy produced.

B. Project Background

When the journal by Marc Perez and Richard Perez changed in 2015 entitled A central see supply side vitality saves for the planet, depicted the tremendous undiscovered possibilities contrasted with other vitality sources. The announcement is bolstered by an examination of vitality utilization by determined classes in the diary as delineated beneath which demonstrates the evaluated limited and inexhaustible planetary vitality saves in Terawatt-years. The aggregate recoverable stores are appeared for the limited assets and the yearly potential is appeared for the renewables starting at 2015. Solar trackers were first developing in the 1950s to solve the problem on agricultural equipment.

Advantages of Tracker frameworks are demonstrated through a money back investigation that was directed in 2017 by Imran Ali Shah, Waqas Khalid, Tallal Ahmed*, et.al in the gathering paper entitled Energy Yield and Economic Analysis of Tracker Controlled and Fixed Angle Photovoltaic Solar Power System which demonstrates that sun based tracker frameworks are greatly proficient in vitality harvestment, as well as temperate for clients as far as cashback stream when contrasted with traditional Static models of sun oriented boards.

III. METHODOLOGY

The principle method used in the project is exploring the MPPT system for dual axis solar system. The hardware developed by assemble the Arduino controller and 4 units of photoresistors Light Dependent Resistor (LDR) which allow the acquisition of ambient light intensity. A voltage is sent and the photo resistors varies according to the brightness, therefore the current changes accordingly to the brightness.

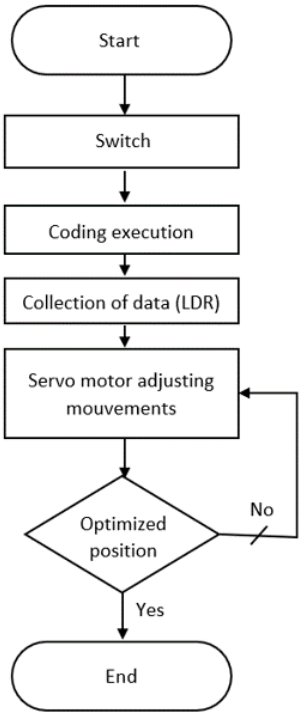

Fig. 2 System Flow Chart

Figure 2 illustrate a basic operational MPPT system with which the switch, coding execution, collection of data (LDR), servo motor adjustments and optimized positions. From the project background, there are 2 types of power generation models, which includes the static and dynamic MPPT tracker model. It shows that the MPPT model has its advantage.

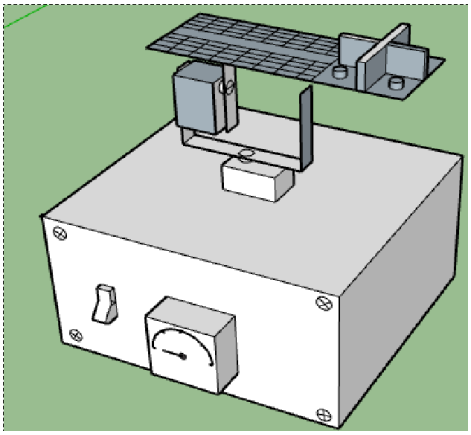

Fig. 3 Basic Model Development

Figure 3 shows the basic illustration of solar tracker which consist of photovoltaic cell, light dependant resistor (LDR), servo motor and Ardiono Board. The project has virtual results in Proteus simulations as shown in Figure 4. The schematic used Arduino Uno Library, with 4 LDRs and 2 engines. For the motor operation, the minimum and maximum values, which are 0^0 and 180^0 were added. Thus, the pulsation is 1ms and 2ms, respectively.

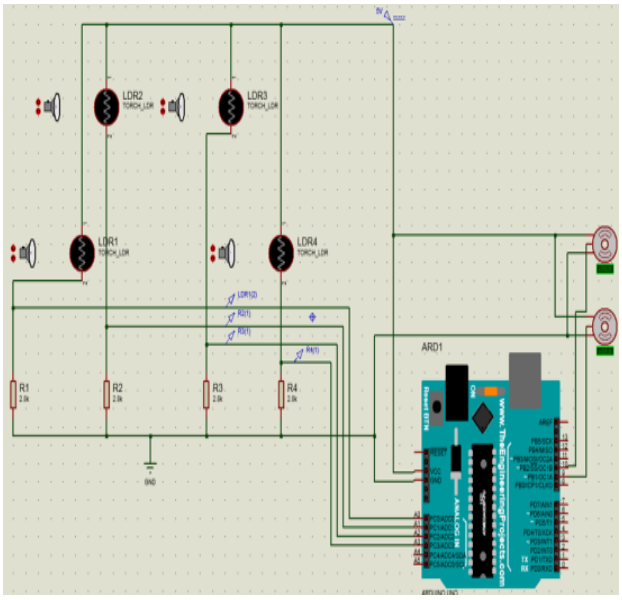

Fig. 4 The circuit diagram for Arduino connections

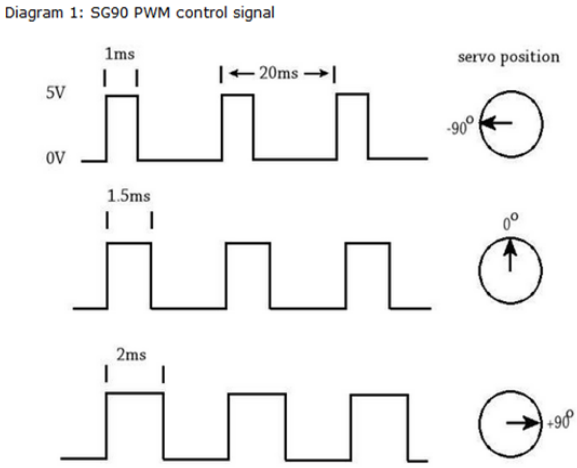

Fig. 5 PWM Signal

Figure 5 shows the pulse width modulations setting on Proteus of a minimum and maximum angle at 0^0 and 180^0, that is the signal sent was 5V on a 50Hz frequency with 20 miliseconds.It meant that the signal has a duration that varies from a minimum of 1ms corresponding to an angle 0^0 and 2ms for an angle 180^0.

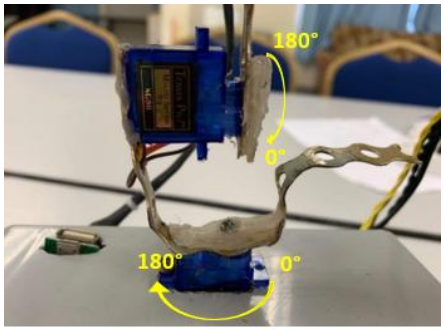

Fig. 6 Tracking angle by the project model

A vertical motor is initially 180^0 and the horizontal motor for rotation on the other axis is initially 0^0 as shown in Figure 6.

IV. EXPERIMENTAL RESULTS

From the research, there are two types of solar power generation models which are the static model and the dynamic MPPT tracker modelling. The study was focused on the MPPT modelled system, which include a maximum of four Light Dependant Resistors (LDR), and four at 2.8KΩ resistors.

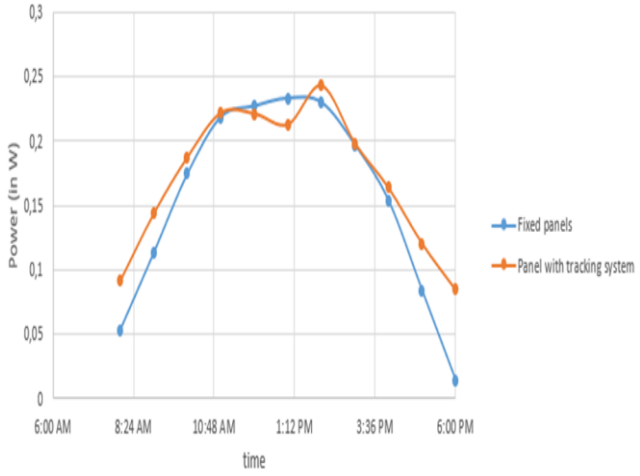

Fig. 7 Power Distribution

As a result of these measurements, I determined that the average power value over a day is 0.16777 Watt for a solar panel in the standard position (180 ° motor), and that for a solar panel in maximum search of sunshine, it is 0.18295 Watt. This allows me to calculate a gain of about 9% (0,18295 / 0,16777 = 1,09) in the rainy season, which is not negligible, knowing that the measurements were made only of 8h to 18h while the sun rises at 6am and goes to bed around 22h, and that the tracking system is more efficient on the morning and end of the day time slots. This solar panel had a poor performance, it had to be improved by the sun tracking system as shown in Figure 8.

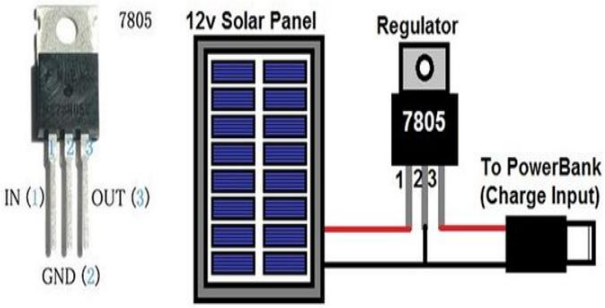

Fig. 8

Figure 9 shows the final product of the project that capable to capture the solar energy based on MPPT module system. The circuit was encapsulated into a controlled box and solar panel is attached with 4 LDRs as the sensors to be dynamic MPPT.

Fig. 9 A complete model of MPPT

V. CONCLUSION

The main hindrance of solar energy going widespread on the high capital cost of solar modules. However, the benefits reaped from the systems implementation prove to be well worth the cost as over several years, the cost of implementing the MPPT system can be recovered back ,and the overall power yield of the MPPT is greater than those of static single axis tracker over a long term period. The disadvantage of solar energy production that the power generation is not constant throughout the day as it changes with weather conditions. This disadvantage is overcomed in the project by implementing the tracker based solar system that eliminates this disadvantage entirely. The project worked on its operational for both theoretical point of view and simulations.

More samples done to the project was found that the use of a tracking system was 9 times more expensive than buying a single solar panel, but that this installation allowed again of 9% of power compared to a normal installation. However, this 9% would be higher if the measurements made had been carried out over a longer time period, in the dry season during the least cloudy days. So these 9% obtained are not reliable enough, it would take much more measures over a longer period. Thus, improvements can be made such as the use of a larger photovoltaic surface and the addition of a larger number of photoresistors for optimal reliability, but with an impact on the final cost of the product. The project is ecological, economic and social. It meets the standards to be sustainable and thus act for sustainable development. Despite the wind fragility of such a sun tracking system and a significant investment price, the project remains profitable for a larger photovoltaic area.

With a return on investment certainly a little longer, the electricity produced still allows better profits.

However, solar panels are a pollution not to be neglected, because they are composed for the most part of silicon, boron atoms and phosphorus which favor the creation of electrons when the exposure to the sun is quite important, as well only plastic. The improvement made to store energy directly in a lithium battery also has an impact on the ecology.

APPENDIX

It is shown that the listing codes is to program the motor for vertical and horozintal rotation in Figure 10.

```
#include <Servo.h> // include Servo

Servo vertical; // vertical servo
int servov = 141;//141=>200ms <=>180degre
int servovLimitHigh =141;
int servovLimitLow = 93;//(141-44)/2+44=92.5 soit 150ms et un angle de 90 degre

Servo horizontal; // horizontal servo
int servoh= 44;//44=>100ms <=>0degre
int servohLimitHigh1 = 141;//141=>200ms <=>180degre
int servohLimitLow1 = 44;

int ldrDL1 = 0; //LDR down Left bas gauche
int ldrTL2 = 1; //LDR top Left haut gauche
int ldrTR3 = 2; //LDR top right haut droite
int ldrDR4 = 3; //LDR down rigt bas droitee
void setup()
{Serial.begin(9600);
horizontal.attach(9);
vertical.attach(10);
horizontal.write(servoh);
vertical.write(servov);
delay(10);
}
void loop()
{ int DL1 = analogRead(ldrDL1); // Down Left
int TL2 = analogRead(ldrTL2); // Top Left
int TR3 =analogRead(ldrTR3); // Top Left
int DR4 = analogRead(ldrDR4); // Down Right

int dtime = 100; int tol = 10;
int avt = (TL2 + TR3) / 2; // average value top
int avd = (DR4+ DL1) / 2; // average value down
int avl = (DL1 + TL2) / 2; // average value left
int avr = (DR4 + TR3) / 2; // average value right
int dvert = avt -avd; // check the diffirence of up and down
int dhoriz = avl -avr;// check the diffirence of left and rigt
```

Fig. 10 Program listing

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AUTHORS PROFILE

Noorazlina Mohamid Salih is a teaching staff for Marine Electrical and Electronics Technology Section in Universiti Kuala Lumpur Malaysian Institute of Marine Engineering Technology in Lumut Perak. She has working experience in educational field for at least 17 years since she had her first experience in Twintech University College in 1999. She obtained her first Bachelor Degree in Electrical (power) in De Monfort University, Leicester, United Kingdom in 1997. Her master degree is in Telecommunication and Information Engineering from Universiti Teknologi MARA Shah Alam, Selangor in 2008. She also has an administrative experience for about 10 years as the Dean and Coordinator program for engineering Faculty at the University College. She is currently teach EE courses such as Digital Electronic System, Electronic Communication and Introduction to Electrical and Electronics. She now has Technologist Professional – TS designation from MBOT.

Mohd Shahirizan Mohd Said has started his teaching services since July 1997. He obtained his diploma interior design and Bachelor degree in Construction Management from UiTM. He has a Master of Facilities Management in 2008 from UiTM. He has a research background in communication for design based students and conceptual design of machines and building. He is currently a lecturer in UiTM (Perak Campus) for Interior Design Program.

Thomas Davion has completed the International Student Exchange Mobality (ISEM) from France (2019). He is currently persuing his degree in industrial electronic in Anguloame University, France.

Nordiana Jamil served Universiti Kuala Lumpur as a technical assistant for almost 12 years. She has a background of 16 years experience in maintaining IT communication equipment and devices such as radar and satellite. She obtained her Diploma from Ungku Omar Polytechnics, Perak in Electrical and Electronic Engineering (Computer) in 2002. She is currently involved in research and development of automated underwater vehicle using Arduino controller.

Aminatul Hawa Yahaya served in Universiti Kuala Lumpur, Malaysian Institute of Marine Engineering Technology (UniKL MIMET) for over 13 years. Immediately after graduation, she joined Universiti Teknologi MARA (UiTM) as a lecturer for 3 years before joining UniKL MIMET in 2006. She is currently a Lecturer in Maritime Management Section, UniKL MIMET. She also appointed as Final Year Project Coordinator under Research and Innovation Section. She previously holds posts in the institute where she was a Head of Section Applied Science and Technology. She graduated with Bachelor of Science (Honour) majoring in Statistics in 2002 from Universiti Putra Malaysia (UPM) and with Master of Applied Statistics from Universiti Malaya (UM). Her research interest are in applied statistics focusing on regression model development, model building procedure and logistic regression. The main programming tool for his research was SPSS. She got expertise in SPSS and practicing it since 2010. She also had a great contribution in publishing articles, journals, symposium papers in the field of Applied Statistics.