Design a bidirectional solar tracking system engineering essay

Engineering

The final year project is to design a Bidirectional Solar Tracking System. This idea is come to get the maximum sun radiation by tracked the sun using microcontroller with motor drive control. It is using light alumuniums, mirrors, power window motor, dc motor, and PV panels. Nevertheless, it have to program the microcontroller PIC to make the tracking system automatically to track the sun. throughout the project, it is based on green energy concept to produce energy in the future by using solar energy by designed a system with low cost, simple but efficiency in the of stability, performance and power produced.

Chapter 1: Introduction

1. 1 Overview of project

Renewable energy are becoming more popular nowadays. But the question is how we can get the maximum energy from the sunshine by using photovoltaic system? In order to maximize the power output from the solar panels, the panel must get maximum radiation from then sun. Solar energy is most reliable green energy using in our country, Malaysia. Malaysia has tropical weather due to located at 2o30o North latitude and 112o30o as show in figure 1. Therefore, Malaysia will receive radiation from sun in whole years. (Maps of World, 2011)[12]Figure 1

1. 2 Project Description

The main idea is keep the solar panel in the perpendicular position towards the sun. Therefore, tracking the sun is required. The solar tracker is a device able turning after the sun, which means that it follow the sun’s track from its rising in the east to its setting in the west. It is more cost effective compare

than purchasing additional solar panels to increasing the surface area. Moreover, solar concentrator is used to get more light and produce more electricity. We use mirror as solar concentrators to reflects additional sun radiation to the solar panels. The system sense the change in intensity of Sun light by taking the output from solar conversion on PV cells directly. Microcontroller PIC is being used to receive data, make analysis, send data for operation, execute predefined program tasks and etc. Therefore, a prototype is created which could automatically provide great alignment with the sun and finally giving utmost output of possible and named it as " Solar Tracking System".

1. 3 Objective

In this project, the objectives are: To design and construct a solar tracking system using PV cells. To increase the intensity of the solar radiation by using the solar concentrator – mirrors. To make the solar tracking system turn automatically in 2 axis by programmed the microcontroller.

1. 4 Project Methodology

In this section will discuss the methodology involve in the design of the 2-axis solar tracker, time and money for components. The idea to design to make the solar tracker can turn in 2-axis so that it can get more sun intensity to increase the efficient, which type of motor use to turn the structure is very important. With the limiting time to produce this project, the solar tracker system have to plan properly to prevent delay the project. Therefore, initially searching the resource like journal, reference book and

video clips are very important. It bring a lot of idea to create and do this project.

Hardware and software development

The hardware and software have to communicate well, therefore they have to start develop together. To make the hardware have a better construct, the equipment like cutting tool is required. The Cad-cam Lab is applied from the manufacture department. The structure is made of aluminum to make the solar tracker become lighter. The motor that make turning of the PV panel is using power window that have more powerful torque. The mirrors are added to increase the concentrated of the intensity on PV cells and reduce the cost increase overall performance of Solar Tracking System. The main board design is according to the design of the structure and the program used is written in assembly language. The PIC is choose and recognized each pin that have to use in the PIC. The PIC act as commander to interface to control the structure to turn in the direction required. The program in the PIC is written using MPLAB IDE that is free software which can download in the Texas Instrument website. Besides, the motor driver have to design to make it turn in desire direction.[17]

Chapter 2 : Solar Energy

2. 1 Introduction

Solar energy is a renewable energy. It is using sun energy to produce energy in our home application nowadays. It can use to power up light bulb, fan, laptop and etc. Solar cells convert sunlight directly into electricity. They are made of semiconducting materials just like those used in computer chips.

Where sunlight is absorbed by these materials, the solar energy knocks electrons loose from their atoms, allowing the electrons to flow through the material to produce electricity. This process of converting light to electricity is called the photovoltaic effect. The PV cells deliver direct current(DC) electricity, whereas most common household appliances is using alternating current(AC). Therefore, an inverter is used to convert the DC voltage to AC voltage. The figure 2 is to image how the PV cells work. Figure 2The solar cell is designed to operate with the concentrated sunlight. These cells are built into concentrating collectors that use lens to focus the sunlight onto the cells. Therefore, the main idea is using less number of expensive semiconducting PV cells while collecting as much sunlight as possible. However, the lenses must be pointed at the sun, we can combine with simple tracking device make it more reliable. How we define the performance of solar cells or solar system? The performance of a solar cells or solar system is measured in terms of its efficiency at turning sunlight into electricity. Only sunlight of certain energies will work efficiently to create electricity, and much of it is reflected or absorbed by the material that make up the cells and system. Because of this, a typical commercial solar cell has an efficiency 15% about one –sixth of the sunlight striking the cell generates electricity. Low efficiencies mean that larger arrays are needed. And that means higher cost. However, the solar cell nowadays is much more improving and higher efficiency. Today there are essentially four different types of solar panels that you can purchase easily and use if you want to install solar panels on your home to generate electricity or heat your home. They are

Monocrystalline Silicon Panels, Polycrystalline Silicon Panels, String Ribbon Silicon Panels, and Amorphous Silicon Panels. [15]

Monocrystalline Silicon Panels

Figure 3Monocrystalline (or single-crystal) silicon solar panels have a return electricity rate of anywhere from 14% to 18%. These panels are made from one continuous sheet of silicon that has pieces of metal nailed to the edges to increase the conductivity and to excite the electrons. Monocrystalline panels are more expensive than some of the other types of solar panels that you can buy but they are also more effective, so in the long run you're better off buying these panels if you can afford the upfront cost.[14]

Polycrystalline Silicon Panels

Figure 4Polycrystalline (or multi-crystal) silicon panes have an electricity return rate of about 12%-14% so they are less efficient than monocrystalline silicon solar panels. These panels are made up of lots of individual PV cells that have metal conducting materials nailed to the sides that will help excite the electrons and also connect the cells together. Moreover, polycrystalline silicon panels are the cheapest solar panels to produce so they are usually the cheapest for consumers to buy. The maintenance costs of polycrystalline silicon panels is lower than the maintenance cost of monocrystalline solar panels because if one of the cells on a polycrystalline panel is damaged you can have the individual cell replaced without having to replace the entire panel.[14]

String Ribbon Silicon Panels

String ribbon silicon panels are made in a similar way to the polycrystalline silicon panels and have about the same electricity return rate. The difference between string ribbon silicon panels and polycrystalline silicon panels is that the PV cells in a string ribbon panel are made of strips of silicon attached to metal bars that connect the strips to form a cell. Using strips of silicon to form the cell instead of using one solid square of silicon make the production cost of string ribbon silicon panels a bit lower than the production cost of polycrystalline silicon panels.[15]

Amorphous Silicon Panels

Amorphous silicon panels have the lowest electricity return rate of any type of solar panels. Traditionally amorphous silicon solar panels have an electricity return rate of between 5%-6%. That’s because these panels aren’t made with crystalline silicon. They are composed of a piece of semi conductive metal, like copper, with a thin silicon film over the top that is attached to some metal pieces.[14]

2. 2 Solar tracking

A solar tracking is a generic term used to describe devices that orient various payload such as photovoltaic panels toward the sun. In this application, trackers system are used to minimize the angle of incidence between the incoming light and a photovoltaic panel. This increases the amount of energy produced from a fixed amount of installed power generating capcity. Solar trackers system can be classified into two types: Standard Solar Trackers and Concentrated Solar Trackers.

2. 2. 1 Standard Solar trackers – Dual Axis trackers

Solar panel accept both direct and diffuse light from the sky. The trackers always gather the available direct light. The solar panel always have to always perpendicular toward the sun to get maximum input energy. Dual axis trackers are part of designed in my thesis. Dual axis trackers have two degrees of freedom that act as axes of rotation. These axes are typically normal to one another. The axis is fixed with respect to the ground can be considered a primary axis. The axis that is referenced to the primary axis can be considered a secondary axis. The first light sensor will always give the instruction to the primary axis follow by secondary axis.[10]Figure 5

2. 2. 2 Concentrated Solar Trackers

In the photovoltaic industry, a concentrator is a mirror that reflects additional sun radiation to the solar panels. By this, the solar panels get more light and produce more electricity. The concentrators can be produced from various materials such as stainless steel, aluminum alloys, silver coated polymers or silver coated hardened glass.[8]Figure 6

2. 2. 3Concentrated Dual Axis Solar Trackers System

This system is currently developed in my final years project. This system is combined the dual axis system and concentrated idea. This system is more reliable with lower cost in material but higher efficiency. It is using simple dual axis tracker and flat mirror with V-shape as concentrator as show in figure 7, it is an advantage that the solar concentrators for the photovoltaic systems do not require any highly specialized and expensive mirrors. However, the mirrors must be resistant to any weather condition for the

period of ten years as the minimum and must be with high total photons reflectance in the wave lengths interval. Mirrors may be made from either of: Rolled plate from stainless steel with a special surface finish. Rolled aluminum plate protected with a polymer finish protection against weather conditions. Silver coated acrylate foil. Aluminum coated acrylate coil. [8]Figure7

2. 3 How the Solar tracker system work

The solar panel play the most important part in my project. It not only use to produce energy, it is also use as sensor to give a instruction to tracker system. The different angle of solar radiation from the sun, the tracker will always adjust the solar panel until it is perpendicular toward the sun. the output from the sun energy is being sense by solar panel before entering the microcontroller. The data will be processed through analog-to-digital converter(ADC) to convert the data in digital form. The data will store in a temporary register. The data will be implement by microcontroller with a self tuning function, which is automatically compare the incoming voltage of two side solar panel until both sides of input is equal. Figure 8 show how the idea to implement.

For 1 axis idea:

RB3(left)RB2(right)(output signal)ANO(PV cell 1)AN1(PV cell 2)(compare voltage)Sun radiation(input signal)MotorRB1(down)RB0(up)(output signal)AN2(PV cell 3)AN3(PV cell 4)(compare voltage)Figure 8

Whole system idea

Figure 9Refer from figure , we can know that the RB3 is forward turning for the motor A and RB2 is reverse turning for the motor A. Whereas, RB1 is forward turning for the motor B and RB0 is reverse turning for the motor B. The motor are connecting to the structure so that the PV cells always perpendicular to the sun.

Chapter 3: PIC MICROCONROLLER

Programmable Interface Controller or PIC is a computer liked chip, part of the family of Harvard architecture microcontrollers. The PIC 18 family of microcontroller is well position to be the PIC architecture family of choice, having peripheral features similar to those of the mid-range family which have the widest range of peripheral enhancement that has significantly increases capabilities. The PIC18 processor offers the following advantages : Up to one megabyte of instructions can be addressed in the program memory. Up to 4K of the file and hardware register. Software accessible option. Enhanced ICD capabilities, including multiple breakpoints. The PIC18 has a 16 bit instruction set that is " source code" compatible with the mid-range devices. This level of compatibility makes it convenient to work with the low-end, mid-range and PIC18 families of devices and share code together with programming gimmicks between the architectures. While increased memory access and more oscillator options are useful advantages of the PIC18 over other PIC microcontroller families, the ability to read and write to the stack is every exciting.[18][19]

3. 1 Introduction on PIC18F 4520

PIC18F 4520 is produce by Microchip Technology Inc. in 2007. It can serve 8-bit and 16-bit embedded control application, support many features, deals with signal performance, power and thermal management. In compact, PIC18f 4520 is an enhanced microcontroller with 10-bit A/D and nanoWatt Technology, 40pins. It has high current sink/source of 25mA/25mA, there programmable external interrupts and four input change interrupts. Besides, it also has Enhanced Capture/Compare/PWM module which gives up to one, two or four PWM outputs, selectable parity, programmable dead time and Auto-Shutdown and Auto-Restart. Many other highlights include Master Synchronous Series Port(MSSP) module supporting 3-wire SPI(all 4 modes) and I2C Master and Slave Modes. Enhanced Addressable USART module which supports RS-485, RS-232 and LIN1. 2 with RS-232 operates using internal oscillator block, auto-wake-up on start bit, auto-baud detect, supports 10-bit up to 13-channel Analog-to-Digital(ADC) with auto-acquisition capability and conversion available during sleep mode. Its flexible oscillator structure is very interesting and handful esoecially the four crystal modes available up to 40Mhz, two external RC modes, and two external Clock modes. PIC18F 4520 is very different from other previous technology microcontroller for its special microcontroller features. With addition C compiler optimized architecture, user are given optional extended instruction set designed to optimize re-entrant code. Availability of 100, 000 erase/write cycle Enhanced Flash program memory typical and 1000, 000 erase/write cycle date EEPROM memory typical speeded up the time required to program a device. Figure 10: Pin diagram of PIC18F 4520PIC18F 4520 is a

40-pin microcontroller with power supply(VDD) at two pin, two ground reference pins(VSS), and oscillator or clock input and output pins(OCS1/CLKIN and OSC2/CLKOUT). There are five group of input/output(I/O) ports namely PORTA, PORTB, PORTC, and PORTD and 3 pins for PORTE. Each of the I/O pins can be configured as input or output. There pins also can be used for other special function. For example, PORTA and PORTB can be used as analog-to-digital converter input pins and PORTC can be configured as transmit and receive pins.[6]

3. 2 Register

A register is a small amount of storage system where its contents can be accessed faster than other storage system. Hence, data is shuffled from subordinated memory, for example Random-Access Memory(RAM), into registers undergoes operations by running instructions from the instruction set then transferred out. Processors register are on top of the memory hierarchy and provides the fastest way to PIC in this case.[1]Among the categories of registers used are: Data registers, or accumulators hold integer or floating point value. General purpose register(GPRs) can store both data and addresses. Special function registers(SPRs) hold program state, which usually includes the control and status registers such as program counter, instruction register, and stack pointer. Instruction registers stores the current command being executed.

3. 3 Input/Output(I/O) Ports

I/O ports or pins allow the microcontroller to access external or peripheral devices which make this an advantage having built in I/O ports in all

microcontrollers. The capabilities of the I/O ports define the peripheral functions the microcontroller can perform and what applications a manufactuter’s part or a specific part number is best suited for. Along with memory size, the peripheral functions of a microcontroller are the important characteristics used to select a device for a specific application. In PIC18F 4520, we can set the either PORTA, PORTB, PORTC, and PORTD as input/output. It is just depend on how we program it.[1][6]

3. 4Memory Units

In common, memory space is used to store the application software. There are three possible types of memory that are provided in embedded microcontrollers: Nonvolatile program memoryVolatile variable memoryOptional nonvolatile memoryThe adjective " nonvolatile" desctibes the ability of memory to retain the information stored in it even when power is removed. This is every important because for each moment power is applied to the microcontroller, the application code should start working. The program memory space is maximum size of application that can be loaded onto the microcontroller and contains all the codes being executed in any application along with the initial values for the variables used in the application. The variable memory available in an embedded microcontroller consists of a fairly small anount of RAM, which is used for temporary storage of data. Variable memory is volatile, meaning its value will be lost when power is removed from the microcontroller. The nonvolatile data memory provides long-term storage of information even when power is lost. Typical information stored in this memory includes data logging information, calibration data for different peripherals, and IP address information for

networked devices. The nonvolatile program memory will probably the Read-Only Memory(ROM), for during execution the processor can only read from this memory, instead of writing new information into it. In the PIC microcontroller there are four types of program memory available in devices and applications: none(external ROM), mask ROM, EPROM, and EEPROM/Flash. All four provides same function , memory for the processor to read and execute but they each have different characteristics and are useful for different purposes.[6]

3. 5 Interrupts

Interrupts can be divided into software interrupts and hardware interrupts. Software interrupts are instructions similar to subroutine calls but instead of jumping to a specific address, they make calls to predefined interrupt handler routines. It is advantageous for software interrupts to be able arithmetically create a new address and load new values directly into the program counter registers rather than providing instructions that immediately change the program counter and where the program is executing. The PIC mictocontoller architecture is one of the few processors that does allow the program to access the program counter’s register and change them during program execution. However, when updating the processor’s program counter it is essential to make sure the correct address is calculated before it is updated. Processor control instruction to execute interrupt such as sleep and interrupt mask are every device specific and is different for each microcontroller family. Possible hardware interrupt requests include situations as changing digital inputs, the completion of an

analog-to-digital conversion, and the receipt of a serial character and so on. [6]

3. 6Analog-to-Digital Converter(A/D)

In PIC18F 4520, the analog-to-digital converter module has 13 input for 40 pin devices. This module allows conversion of an analog input signal to a corresponding 10 pin digital number. The module has five registers : A/D result high register (ADRESH)A/D result low register (ADRESL)A/D control register 0 (ANCON0)A/D control register 1 (ANCON1)A/D control register 2 (ANCON2)The ADCON0 register controls the operation of the A/D module; ADCON1 register configures the functions of the port pins and ADCON2 register configures the A/D clock source, programmed acquisition time and justification. Figure 11: ADCON0 register mapFigure 12: ADCON1 register mapFigure 13: ADCON 2 register mapThe analog reference voltage is software selectable to either the device’s positive and negative supply voltage (VDD and Vss), or the voltage level on the RA3/AN3/VREF+ and RA2/AN2/VREF-/CVREF pins.[6]The following step should be followed to perform an A/D conversion: Configure the A/D module: Configure analog pins, voltage reference and digital I/O(ADCON1)Select A/D input channel (ADCON0)Select A/D acquisition time (ADCON2)Select A/D conversion clock (ADCON2)Turn on A/D module(ADCON2)Configure A/D interrupt (if desired): Clear ADIF bitSet ADIE bitSet GIE bitWait the required acquisition time (if required). Start conversion: Set GO/DONE bit(ADCON0 register)Wait for A/D conversion to complete, by either : Polling for the GO/DONE bit to be cleared; ORWaiting for the A/D interruptRead A/D Result register(ADRESH: ADRESL); clear bit ADIF, if required. For next conversion, go to step 1 or step 2, as

required. The A/D conversion time per bit is defined as TAD. A minimum wait of 2 TAD is required before the next acquisition starts.[6]

Selecting the A/D conversion clock

The A/D conversion time per bit is defined as TAD. The A/D conversion requires 11 TAD per 10-bit conversion. The source of the A/D conversion clock is software selectable. There are seven possible option for TAD : 2 TOSC4 TOSC8 TOSC16 TOSC32 TOSC64 TOSCInternal RC OscillatorFor correct A/D conversions, the A/D conversion clock (TAD) must be as short as possible, but greater than the minimum TAD.[6]Figure 14: TAD vs Device Operating Frequencies

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3. 7 MPLAB IDE

MPLAB IDE is a software program that runs on a PC to develop application for Microchip microcontrollers and digital signal controllers. It is called an Integrated Development Environment or IDE, because it provides a single integrated " environment" to develop code for embedded microcontrollers. MPLAB IDE offer the basic development function, including an editor, assembler linker, builder interface and a simulator, and it also includes more advanced features such as programmer, emulator and debugger interfaces that eliminate the need for learning new tools. In shorts, MPLAB IDE is a tool for us to communicate with the PIC microcontrollers.[18]

Chapter 4: Hardware Review

4. 1 Voltage Regulator

A voltage regulator is designed to automatically sustain a constant voltage level as show in figure 15. In my design circuit, I am using a 7805 voltage regulator for my PCB board. The 7805 voltage regulator look like a transistor but it is actually an integrated circuit with 3 legs. It can take a higher, crappy DC voltage and turn it into a nice, smooth 5 volts DC. It have to feed at least 8 volts and no more than 30 volts to do this. It can handle around 0. 5 to 0. 75amps, but it gets hot. However, we can use a heatsink to release the heat. There are features of 7805 voltage regulator: [20]Output current in excess of 0. 5ANo external componentInternal thermal overload protectionInternal short circuit current limitingOutput transistor safe area compensationFigure 15

4. 2 Motor Driver

Motor driver is a device that serves to govern in some predetermined manner the performance of an electric motor. A motor controller might include a manual or automatic means for starting and stopping the motor, selecting forward or reverse rotation, selecting and regulating the speed, regulating or limiting the torque, and protecting against overloads and faults.

4. 3 Relay

A relay is an electrically operated switch. Current flowing through the coil of the relay creates a magnetic field which attract a lever and change the switch contacts. The coil current can be on or off so relay have two switch positions and most have double throw(changeover) switch contacts as shown

in the figure 16.. Circuit symbol for relays5 pins relaysFigure 16COM = Common, always connect to this, it is the moving part of the switch. NC = Normally Closed, COM is connected to this when the relay coil is off. NO = Normally Open, COM is connected to this when the relay coil is on. Relays allow one circuit to switch a second circuit which can be completely separate from the first. For example a low voltage battery circuit can use a relay to switch a 230V AC main cicuit. There is no electrical connection inside the relay between the two circuits, the link is magnetic and mechanical.[21]

4. 4 Principle and operation - Motor driver using relays

PIC microcontrollerIn my final year project, the relays is used to switch the 12V motor with a 5V circuit. I am using two relays to allow flow of electricity in two direction by controlling the direction of motor. The motor can either move in clockwise or anti-clockwise direction. Figure 16 show the operation diagram how system is work. Solar panel stop turning when both signal is equalSignal from sensor 1(turn the solar panel to left)Signal from sensor 2(turn the solar panel to right)Motor driverFigure 16: Operation diagramThis is for the primary axis rotation of the tracker system and this concept is applied to secondary axis too. The table 1 is simple table to show the rotation of the motor turn. Signal 1Signal 2Motor RotationOffOffNo rotationOffOnClockwiseOnOffCounter-clockwiseOnOffNo rotationTable 1: of motor action due to signal output

Chapter 5 : Result and Discussion

Experiments were carried at open area in the University Malaya. These experiments ran continued 5 day to get the result of power produced by

solar panel. TimeVoltageCurrentPower6000726. 270. 1522. 56828. 660. 3145. 76928. 670. 4307. 891028. 670. 4498. 231128. 670. 4498. 241228. 670. 4498. 241328. 670. 3566. 541428. 670. 4057. 431528. 670. 4498. 231628. 670. 4498. 231727. 540. 4287. 541825. 940. 4297. 121923. 40. 2583. 86Table 2: Experimental results on 11th April 2011TimeVoltageCurrentPower6000722. 360. 1381. 98825. 670. 3455. 67928. 670. 4488. 221028. 670. 4498. 241128. 670. 4498. 241228. 670. 4498. 241328. 670. 4337. 941423. 680. 3976. 011524. 870. 3966. 31624. 980. 4717. 531727. 230. 4608. 011826. 540. 4667. 911921. 870. 2623. 67Table 3: Experimental results on 12th April 2011600. 0000720. 530. 1171. 54820. 420. 1501. 96920. 320. 1481. 921021. 210. 1652. 241123. 540. 2543. 831228. 240. 3366. 071328. 230. 4427. 991428. 240. 4558. 221528. 230. 4568. 241628. 220. 4568. 241728. 230. 4438. 001825. 670. 4076. 691923. 150. 2914. 31Table 4: Experimental results on 13th April 2011TimeVoltageCurrentPower600721. 550. 1653. 55826. 680. 2637. 01928. 560. 2878. 21028. 550. 2878. 191128. 640. 2878. 211228. 660. 2878. 221328. 650. 2878. 231428. 510. 2878. 191528. 480. 2878. 151627. 990. 2868. 001727. 710. 2817. 791824. 60. 2255. 541920. 650. 1773. 65Table 5: Experimental results on 14th April 2011TimeVoltageCurrentPower600079. 210. 0590. 35814. 020. 1741. 56918. 20. 3133. 651025. 630. 3996. 541128. 540. 4327. 891228. 450. 4528. 231328. 010. 4437. 941427. 350. 4367. 641523. 120. 3374. 981619. 650. 2933. 681715. 740. 2412. 431813. 050. 1601. 341910. 80. 0970. 67Table 6: Experimental results on 15th April 2011

Figure 17: Graph Power vs time (11april 2011)

Figure 18: Graph Power vs time (12april 2011)

Figure 19: Graph Power vs time (13april 2011)

Figure 20: Graph Power vs time (14april 2011)

Figure 21: Graph Power vs time (15april 2011)

The experiments were run from 11april 2011 to 15april 2011 from 6am-7pm. The power output at 7am and 7pm are low due to low radiation from sun. The peak power normally is from 9am to 4pm. On 11april and 12april, the outputs are low on 1pm due to raining. Where else on 13april, the power output only peak at 1pm-5pm due to heavy raining on morning. The radiation of the sun is block by the cloud. On 14april and the good whether show the effective of solar tracker system to produce peak power for the whole day. The peak power for the system is 8. 24W. On 15april, the experiment was run with non tracking system. The solar panel was placed in stationary position which was always toward position of 12pm. The peak power range only from 11am-2pm.

Chapter 6: Conclusion

Solar tracking systems are able continually orient the photovoltaic panel towards the sun and can maximize the power produced. It helps increase the effectiveness of the panels. Therefore, it reduces the high cost to install large area of PV panels. The efficiency and reliable of the system conversion of solar energy into electrical energy is very good prototype that can be ready for future market. The most important of this project is to make the solar tracking system track the sun with longer time. The dual axis tracking

system can track the sun with maximum power output about 8-10 hours. It is also less power consumption by motor because the system track the sun every 5min. Therefore, addition power convert from the sun energy can be stored in the battery. The result from the experiment, maximum power can be produced is 8. 23W. There is another method which does not physically moves to track the sun but able concentrates on operating photovoltaic cells. It is known as the Maximum Power Point Tracking(MPPT). It is currently develop by my labmates Mr. Tey Kok Soon and Mr. Tan Cha Fook. It should be compared which is more reliable and focus develop it.

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