

# Solar Cell Position Control Building Design Using Microcontroller Optimizing Power Sunway in the Coffee Drying Application

Saifuddin, Selamat Meliala, Rosdiana Wahyuddin Albra, Ikramuddin

**ABSTRACT:** *The problem faced by the coffee farming community in Teritit Aceh Tengah is the process of drying coffee beans when the weather is not bright while maintaining the quality of the coffee beans. This study aims to simulate in proteus software prototype model solar cell tracker drying coffee beans. Energy absorbed through a panel driven by a solar cell tracker is stored inside the battery as an energy reserve when the weather is not sunny, cloudy or rainy. Solar cell tracking using microcontroller is used to follow the movement of the sun direction perpendicular to the surface of the coffee bean drying apparatus. This tool is necessary because it can optimize energy absorption and heat. The simulated solar cell tracker is used to automatically drive solar panels and solar collectors at an angle of 90° solar rays to maximize the amount of energy and heat gained. This research method is quantitative that is by simulation, observe and measure the things done on the prototype then experiment and data processing and evaluation of research data. After simulation of solar cell tracker system, it can be concluded that the solar cell tracker system has been successfully simulated using four components of Light Dependent Resistors, two servo functionalized to drive the integrated solar panels and solar collectors automatically. The use of liquid crystal disk and also virtual terminal to monitor every angle of the smallest direction of movement of sunlight and also the value of servo speed either in the vertical direction or horizontal direction. Liquid crystal disk response capability to sunlight and connection with servo movement has a good accuracy value so that the response obtained by servo faster to improve the energy efficiency of solar and calor energy to be obtained.*

*Inex terms:* Solar cell tracker, control system, microcontroller, drying, solar thermal energy absorption.

## I. INTRODUCTION

The main problem in this research is the need of cheap and environmentally friendly energy in the coffee plantation sector is very unfulfilled, so researchers do some stages of innovation the use of solar cell panels and solar collectors to improve the productivity of plantation products in the application of drying process of coffee bean plantation products, with The goal can improve the economic results of the community, especially coffee farmers Uning Teritit

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Saifuddin, Selamat Meliala, Rosdiana, Faculty of Engineering,  
Universitas Malikussaleh, 24351 Lhokseumawe Indonesia

Email: [saifuddin@unimal.ac.id](mailto:saifuddin@unimal.ac.id)

Wahyuddin Albra, Ikramuddin

Faculty of Economic, Universitas Malikussaleh, 24351 Lhokseumawe,  
Indonesia

Email: [saifuddin@unimal.ac.id](mailto:saifuddin@unimal.ac.id)

Aceh Tengah Village. Other issues to be studied are: How to model and simulate the manufacture and development of solar cell tracking prototype innovation using microcontroller in controlling solar panel as a prototype performance optimization tool so as to produce maximum voltage, electric current and absorption of solar energy. The main elements and what support elements control the solar tracking system so as to be able to drive tracking to follow the sun's track automatically. How to run the AT89S52 microcontroller program command in order to detect the point of sunlight in getting the command from the detection sensor automatically[1].

Background on continuous energy requirements, the development of appropriate technologies that utilize sunlight as a renewable energy is highly applicable to solar dryers using sunlight to heat the air in the drying process. The use of solar energy can be used in coffee bean dryers to reduce the use of fossil-based energy that will cause global warming. Post-harvest processing of plantation products has an important role in the life of the Indonesian people, is also a source of significant foreign exchange income. With the use of solar energy system in this technology, is expected to accelerate the drying process, quantity and quality of post-harvest products. System is effective despite the rainy season or overcast weather[2]. This study aims to simulate with proteus software and design prototype tracking of the sun direction automatically for optimization of microcontroller based solar cell work.

## II. LITERATURE REVIEW

### A. The Working Principle of Solar Cells

The arrangement of a solar cell is equal to a diode, consisting of a layer called PN Junction. The PN Junction was obtained by staining a pure silicon semiconductor material (valence 4) with a validity of 3 on the left side, and on the right is tainted with a divalent impulse. 5. Sehingga on the left an impure silicon is formed and is called silicon type N. In pure silicon there are two kinds of balanced electric charge carriers. Positive electric charge carriers are called holes, whereas negative ones are called electrons. After the process of desecration. In the P type silicon is formed a hole (positive electric charge carriers) in a very large amount compared to its electron. Therefore in silicone the P hole type is the majority cargo carrier, while

the electrons are minority carriers. In contrast, in the N-type silicon, electrons are formed in very large quantities, so they are called majority carriers and holes are called minority carriers[3].

Within the silicon rod there is a meeting between the P and the N part. Therefore called the PN Junction. Now, the P section is connected to the positive pole of a battery, whereas the negative pole is connected to the N section, then there is a relationship called "Forward Bias" . In the forward bias state, inside the circuit there is an electric current caused by the two kinds of charge carriers[4]. So the electric current flowing inside the PN Junction is caused by the movement of the hole, but in opposite direction with the movement of electrons. Just to further explain, the electrons moving inside The conductor material can generate electrical energy. And this electrical energy is called an electric current flowing in opposite direction with the movement of electrons.

However, when the P port is connected to the negative pole of the battery and the N port is connected to its positive pole, it is now formed a relationship called "reverse bias". Under such circumstances, the hole (positive carrier) can be connected directly to the positive pole, whereas electrons Also directly to the pole positif. So, clearly in the PN Junction there is no movement of majority carriers both hole and P move trying to reach the positive pole of the battery, so also the minority carriers (holes) in the N section also move trying to reach the negative pole. Therefore, in the reserver state bias inside PN Junction there is also a current that arises even in very small amounts (micro amperes)[5]. This current is often referred to as reserve saturation current or leakage current (leakage current).

### **B. Solar Module**

To get a considerable amount of power required many solar cells are usually solar cells that have been prepared so that the form of solar panels and called photovoltaire panels (PV)[6] .PV as a power source was first used in the satellite, then also thought PV as a source of energy for the module, So that there are solar electric modules now overseas, PV has started to be used as used as roof or wall of the house[7].

In theory it is said that there are seven main things that affect the performance / performance of solar cell panel module that is:

1. Material of solar cell
2. Load resistance in solar cells
3. The intensity of sunlight
4. Temperature / temperature of solar cells
5. Shadow / shading on the solar cell device
6. Engineering surface shapes used in solar cell devices
7. The angle of sunlight on the solar cell device

Therefore, the application of the seven main factors that are appropriate will be able to minimize the amount of light reflected and maximize the ability of absorption of sunlight absorption[8]. As a result the amount of light trapped and absorbed into the device will increase. Which is coupled in series and parallel, to increase the voltage and current generated so that it is sufficient to use the power supply system load. To get the maximum electrical energy output then the surface of the solar module must always lead to the sun. In Indonesia, the optimum energy will be obtained if The solar module is directed to the slope angle of the latitude of the location of the PLTS is located. For example, for the area that is north of the equator then the solar module must be confronted to the south, and vice versa. Further electrical energy is stored in Battery. Battery here serves as a storage of electrical energy S Ecara chemical during the day and serves as an electrical power supply at night.

### **C. Stepper Motor As A Solar Panels And Collector Panels**

Solar panels for maximum light are required by the sun tracking devices. Active traces are trackers that work on the basis of coordination or combination of microprocessors with electro-optical or time-based sensors. Using a solar tracker system can increase the effectiveness of solar panels, since the largest energy received By solar panels is the direction of solar radiation perpendicular to the field of solar panels. Sun tracking system with 2 rotary axis is designed to improve the effectiveness in energy reception.

Sunsets basically have the same working principle. Both of these sun trackers use a one-axis tracking system. This system can only follow the movement of the sun from east to west which is caused by the motion of the rotation of the earth. The sensors in use is a photo resistor. To be able to increase Efficiency on the sun's tracks, the two-axis system can be applied to the sun's tracks. The two-axis system allows the sun's tracker to control the azimuth and latitude position from the sun's position. This allows the sun's tracker to follow the sun more precisely throughout the year.

The stepper motor in the tracking system is used as a panel drive. In the electric driving motor is known two kinds of motor drive that is the motor DC / AC and stepper motor. Motor DC / AC consists of 2 pieces of coil as a stator and magnetic core that can rotate on its axis as a rotor. Karenanya DC / AC motor rotation is continuous .

Explanation of stepper motor in stepper motor there are 4 stator coils arranged in certain position so that can not produce continuous rotation. Magnetic core will stop rotating if stator give magnet opposite to nucleus of magnet, because both pull pull. If the electric current is flowed to coil 1 then the magnetic core will be faced with coil 1, then if the electric current is shifted to coil 2 then the magnetic core will be faced with coil 2, and so on. The magnetic core can also stop rotating at the position between two stator coils by How to provide electric current on two coils simultaneously. This can be utilized to produce smaller turn angles, and motor rotation becomes smoother.

#### D. Microcontroller and Working Principle of Microcontroller

Microcontroller when interpreted literally means micro-controller in microcontroller is usually embedded in the tool to be controlled. The microcontroller is similar to the microprocessor in a computer. But microcontroller has many components integrated in it like timer / counter while in microprocessor the component is not Integrated. The microcontroller is a mikroprosesor chip equipped with a

CPU, Memory (RAM and ROM) and Input-Output (Sandos Simatupang, 2013). Microcontroller is a computer inside a chip used to control electronic equipment, which emphasizes efficiency and cost effectiveness[9]. Literally can be called a "small controller" where an electronic system that previously required many supporting components such as TTL and CMOS ICs can be reduced and ultimately centered and controlled by this microcontroller. With the use of this microcontroller then:

1. The electronic system will become more concise
2. The design of electronic systems will be faster because most of the system is software that is easy to modify
3. Search disturbances are easier to trace because of their compact system

However not fully microcontroller can reduce TTL and CMOS IC components which are often still needed for high speed applications or simply increase the number of input and output channels (I / O). In other words, microcontroller is mini or micro version of a computer because microcontroller has Contains several directly usable peripherals, such as parallel ports, serial ports, comparators, digital to analog conversion (DAC), analog to digital conversion and so on using only minimum systems that are not complex or complex[10].

facilities. Microcontroller is a microprocessor system in which there are already CPU, ROM, RAM, I / O, Clock and other internal equipment that are connected and well organized (teralamati) well by the manufacturer and packaged in satu Chip that is ready to use so we live program the contents of the ROM according to the rules of preparation by the factory that makes it.

Technically there are only 2 types of microcontroller that is RISC and CISC and each has its own offspring / family of its own. RISC stands for Reduced Instruction Set Computer: limited instruction but has more facilities CISC

stands for Complex Instruction Set Computer: the instruction can be said More complete but with sufficient

Understanding microcontroller is an electronic component in which contained interconnection system between Microprocessor, RAM, ROM, I/O interface, and some peripherals. Microcontroller also called OnchipPeripheral. Based on etymological or micro term is something small, even invisible by the naked eye control is controlling, then the controller is something controller. Microcontroller is a micro sized controller[11].

The easy way to operate the internal equipment of a microcontroller such as (timer / counter, ext, user, etc.) is to learn the equipment control registers. The microcontroller is also an integrated chip that is often part of an embedded system. In microcontroller application there are advantages of system performance by using microcontroller is as follows:

1. The drive on the microcontroller uses assembly programming language based on basic digital rules so that the operation of the system becomes very easy to work in accordance with (assembly language is easy to understand because it uses the assembly language application where the input and output parameters can be directly accessed without using many commands) .Design This assembly language does not use so many requirements for writing programming languages such as uppercase and lowercase for assembly languages still to be taught.
2. Microcontroller arranged in one chip where processor, memory, and I / O integrated into one unit of control system so that microcontroller can be said as a mini computer that can work innovatively according to system requirement.
3. The running system is independent of the computer while the computer parameters are only used to download instruction commands or programs. The steps to download computer with microcontroller is very easy to use because it does not use many commands.
4. On microcontroller available additional facilities for memory development and I / O tailored to the needs of the system.
5. The price to get this tool is cheaper and easier to obtain.

#### E. Sensor Light Dependent Resistor

LDR (Light Dependent Resistor), is a type of resistor that changes its resistance due to the influence of light. When the dark light of the resistance value is greater, while the bright light value becomes smaller. LDR (Light Dependent Resistor) is a type of resistor commonly used as a light detector or gauge Scale light conversion. Light dependent resistors, consisting of a semiconductor disk that has two electrodes on its surface. The LDR resistance changes with the



change in the intensity of light that hit it. In a dark state the resistance of LDR is about 10M and in a light state of 1k or less. LDR is made Of semiconductor materials such as cadmium sulfide. With this material the energy from falling light causes more discharged or electric current to increase. That is, the resistance of the material has decreased. Light Dependent Resistors are used to convert light energy into electrical energy. However, because the response to light is slow enough, LDR is not used in situations where the intensity of light changes drastically. This sensor will change its

resistance value if there is a change in the brightness of the light.

**F. Load Resistance**

Battery voltage is the operating voltage of the solar cell panel module, when the battery is connected directly to the solar cell panel module. For example, generally 12Volt battery, voltage / battery voltage is usually between 11.5 to 15Volts. Untuk can charge the battery, solar cell panels must operate on voltage Which is higher than the battery voltage of the bank. The highest efficiency is when the solar panel cell operates close to the maximum power point. In the example above, the battery voltage should be close to Vmp voltage. When the battery voltage drops below Vmp, or increases above Vmp, then Its efficiency is reduced. Temperature Solar Cell Panel

As the temperature of the solar cell panel rises above the normal temperature standard of 25 degrees Celsius, the efficiency of the solar cell panel efficiency and voltage modules will decrease. The figure below illustrates that, as, the cell temperature rises above 25 degrees Celsius (solar cell panel module temperature, not the temperature Air), the shape of the IV curve remains the same, but shifts to the left in accordance with the temperature rise of the solar cell panel, resulting in a smaller voltage and power. The heat in this case, is the electrical resistance to the flow of electrons. For that airflow around the solar cell panel module It is important to remove the heat that causes the high temperature of the solar cell panels.

**Drying**

Drying is a simultaneous process of heat transfer and water vapor, requiring heat energy to evaporate the water content removed from the surface of the material, which is dried by a typically hot drying medium. The purpose of drying itself is to reduce the water content of the material to the extent that the development of microorganisms And the enzyme activity that can cause decay is inhibited or stalled. Thus the dried material can have longer shelf time. Solar driers are a drying system that utilizes solar energy. The solar drying system consists of two main parts namely the solar collector and the drying chamber.

**G. Collector**

The solar collector is a tool that can collect or absorb solar radiation and convert it to heat. Solar collectors can be defined as heat transfer systems that generate heat energy by utilizing solar radiation as the primary energy source. Solar collectors operate without sound (unlike wind turbines Large) so it does not cause noise pollution. Solar coils usually have a very long lifespan, and maintenance costs are very low as there are no moving parts. Solar collectors are also quite easy to install. Solar energy is one of the best energy options for remote areas , When the

power distribution network is impractical or impossible to install. Given the electrification ratio in Indonesia only 55-60% and almost all areas that have not been electricity is a rural area away from the power plant.

**III. RESEARCH METHODS**

**A. Research Stages**

1. Library study is a study conducted to gain knowledge by collecting data both from the internet and from books.
2. Field study is to collect the components needed for designing, assembling components and performing phased tests.
3. Observation is the observation of the tool made, by experimenting either directly or indirectly.
4. Design method that is design stage made, about simulation of circuit planning, PCB layout, layout of required components and mechanical planning of circuit.
5. Analysis and Evaluation, after collecting data either based on literature study or field study.

**IV. DESIGN METHOD**

Designing is the initial activity of an effort to realize a product whose needs are needed by society. The way of designing consists of 4 stages or phases, each consisting of several stages as follows; 1. Fase Formulation. (Formulation Phase); 2. Functional Phase (Functional Phase); 3. Phase Design (Design Phase); 4. Result (Result). The planning of this solar cell traker model is applied to the dryers with the aim to help the coffee farmers. Therefore considerations that need to be considered in planning the modeling of solar traker simulation on apilkasi dryer are: economical, high productivity, easy to manufacture, strong and easy to operate.

**V. RESULTS**

**A. Overview of research location**

Geographically Gunung Teritit village is located between 2,233 North Latitude and 96.45 East Longitude with an area of ± 1850 hectare, 0.1% of Bener Meriah district, and is an area with terrain topography to wave with altitude of 900-2600 dpl. The average rainfall is 1,087 mm and the highest is 2,405 mm. The basic physical condition of the village is as follows:

No	Land Utilization	Large (Ha)
1.	Patio Area	1
2.	Residential Area	6
3.	Coffee Plantation Area	1150
4.	Areas of Paddy field	60
5.	Education Area	0,1
6.	Road and Lane Areas	-
7.	Culvert area	8
8.	Plot	2
9.	Other Infrastructure Areas	-
10.	Recreation / Sports area	0,1



Based on the above table, it can be concluded that the utilization of land in the kampong Gunung Teritit more dominant in planting or coffee plantation. This is because the coffee is one of the main sources of community livelihood. This can be seen from the vast area of coffee plantations that have an area of 1150 Ha. Selain coffee plantations in the rice fields also become a source of community livelihood, which for this area of paddy fields have land area around 60 Ha. The obstacles in the village of Mount Teritit is the lack of provision of land for roads and other infrastructure.

**B.Light Dependent Resistor**

Light dependent resistor which is one kind of electronics component that is resistor. This component is a resistor whose resistance value or resistance is very sensitive to light intensity. Light Dependent Resistor (LDR) component is usually also called photo resistor, or photocell. Many people use this component instead of light sensor. Because besides being effective, the price is cheap.

Simulated solar cell truck simulation results starting at LDR receive light from the upper right LDR side, upper left LDR, lower right LDR, lower left LDR directs the servo to move the panel vertically from east to west or vice versa automate and move Panel toward horizontally from north to south or vice versa. These four LDRs are enabled to move the servo in a vertical and horizontal direction with the smallest movement angle of 0° and the maximum movement angle of 180°.

The ability of this simulator can move the panel horizontally or vertically with angle 0° to 180°. LDR resistance in solar cell truck system design will be influenced by the intensity of sunlight received so that automation is able to move the servo to rotate in accordance with the movement Direction of the sun. The simulation view of solar cell traker is in the stationary position as shown in Figure 1.

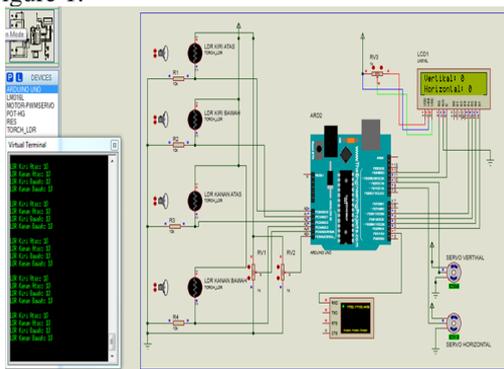


Figure 1. Simulation of Solar Cell Tracker.

**C.Servo**

The design of this solar cell truck prototype simulation is equipped with vertical servo and horizontal servo that serves to move solar panels in accordance with the programmed in the microcontroller to follow the movement of sunlight. Vertical servo is enabled to move solar panels on the east to the west or west to the east. The horizontal servo is simulated to move the solar panel towards the north south or south direction to the north. Servo motors are DC

motors that move in the direction of voltage ranging from 6V-24V. The servo display is shown in Figure 2.

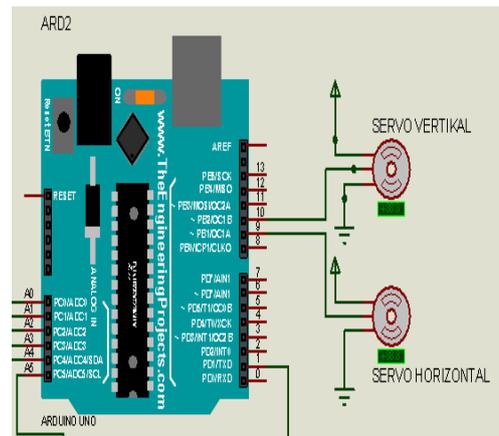


Figure 2. Vertical servo and horizontal servo

**D.Virtual terminal**

Virtual terminal functioned as a medium of communication between software with software or between applications with applications. Another function to display the work hardware that we display on the computer. It can be used in this simulation to monitor LDR, vertical servo and horizontal servo and tolerance values that occur in the solar cell traker. Virtual terminals allow host terminals on multi-user networks to interact with other hosts regardless of terminal type and characteristics. Virtual terminals allow remote log-on by the local area network manager for management purposes. Another function of the virtual terminal is that it allows users to access information from other host processors for transaction processing and also functions as a backup facility. Virtual terminal as shown in figure 3.

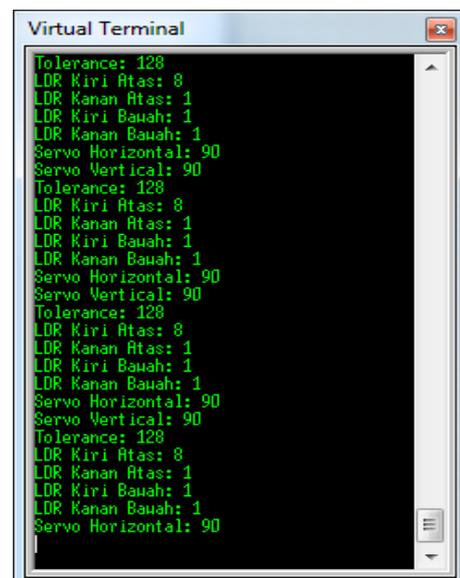
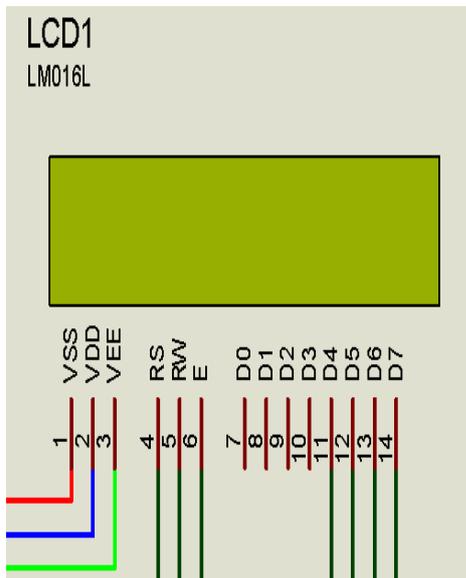


Figure 3. Virtual terminal

### E. Liquid Crystal Disc

LCD (Liquid Crystal Disc) functioned for display on hardware to ensure data we input valid or invalid, to know the results of a process, monitor a process, debug programs and display messages. LCD display as shown in figure 4.



Gambar 4. Liquid Crystal Disc

### F. Arduino

Arduino prototype automation control is a single-board micro-controller that is open-source. The hardware has an Atmel AVR processor and the software has its own programming language. The language used in arduino is not a relatively difficult assembler, but the simplified C language with the help of arduino libraries .Arduino also simplifies the process of working with a microcontroller, while offering a variety of advantages including: cheap, simple and easy programming, open source software, open source hardware, no need for chip programmer device because there is already a bootloader that will handle the upload program from computer.

It already has a USB communication device, so that laptop users who do not have serial port / RS232 can use it. Adobe also has a ready-made module (shield) that can be plugged in arduino board like shield GPS and Ethernet. In this study arduino functioned to control the hardware automation of solar panels and solar collectors by moving the servo motor. Display the shape of the arduino as shown in figure 5.

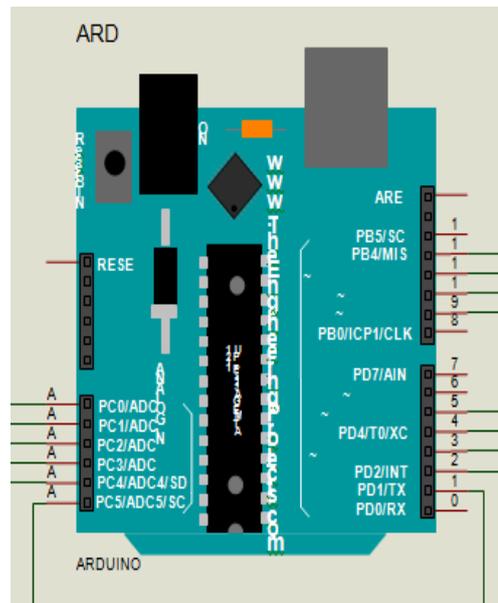


Figure 5. Arduino

## VI. CONCLUSION

After the simulation of solar cell tracker system can be concluded as follows:

1. The solar cell tracker system has been successfully simulated using 4 LDR, 2 SERVO functionalized to drive the integrated solar panels and solar columns in an automated manner.
2. Use of LCD and also virtual terminal to monitor every corner of the smallest direction of movement of sunlight and also the value of servo speed either in the vertical direction or horizontal direction.
3. The ability of LCD response to sunlight and relationship with servo movement has a good accuracy value so that the response obtained by servo faster to improve the energy efficiency of solar and calor energy to be obtained.
4. The conclusions for the overall prototype of the research design up to now are still at the earliest conclusions that have not yet been fully taken due to the unintegrated set of all modeling sequences in one prototype system. The conclusion will be achieved if the research is continued in the second year of the study.

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