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HELIOSTATS CONTROL SYSTEM FOR TOWER CONCENTRATED SOLAR POWER PLANT

E. Kavitha[*1] & E. Kalpana[2]
[*1&2]ECE Dept, Associate Professor, VJIT, Aziz Nagar

ABSTRACT

Concentrated solar plant also called as concentrating solar power, concentrated solar thermal. These systems generate solar power using mirrors or lenses to concentrated large area of sunlight, or solar thermal energy onto a small area. Electricity is generated when the concentrated light is converted to heat, which drives a heat engine usually steam turbin connected to an electric power generator. Heat storage in molten salts allows some solar thermal plants to continue to generate after sunset and adds value such systems when compared to photovoltaic panels. the only drawback for this system is that the implementation cost if very high. in this paper we made an attempt to reduce the implementation cost by reducing the no of actuators controlling the heliostat.

Keywords: *Concentrated solar power system, Electricity, energy storage system, higher efficiency.*

I. INTRODUCTION

Concentrated solar power systems generate solar power by using mirrors or lenses to concentrate a large area of sunlight, or solar thermal energy onto a small area. Electricity is generated when the concentrated light is converted to heat, which drives a heat engine connected to an electrical power generator or powers a thermo chemical reaction. Heat storage in molten salts allows some solar thermal plants to continue to generate after sunset and adds value to such systems when compared to photovoltaic panels. A solar power tower consists of an array of dual-axis tracking reflectors (heliostats) that concentrate sunlight on a central receiver atop a tower; the receiver contains a fluid deposit, which can consist of sea water. The working fluid in the receiver is heated to 500–1000 °C (773–1,273 K (932–1,832 °F)) and then used as a heat source for a power generation or energy storage system. An advantage of the solar tower is the reflectors can be adjusted instead of the whole tower. Power-tower development is less advanced than trough systems, but they offer higher efficiency and better energy storage capability.

1.1 Concentrated Solar Power

A solar power plant is based on the conversion of sunlight into electricity, either directly using photo voltaic, indirectly using concentrated solar power. Concentrated solar power systems use lenses, mirrors, and tracking systems to focus a large area of sunlight into a small beam. The solar power tower, also known as 'central tower' power plants or 'heliostat' power plants or power towers, is a type of solar furnace using a tower to receive the focused sunlight. It uses an array of flat, movable mirrors to focus the sun's rays upon a collector tower. Concentrated solar thermal is seen as one viable solution for renewable, pollution-free energy. Early designs used these focused rays to heat water, and used the resulting steam to power a turbine. Newer designs using liquid sodium have been demonstrated, and systems using molten salts (40% potassium nitrate, 60% sodium nitrate) as the working fluids are now in operation. These working fluids have high heat capacity, which can be used to store the energy before using it to boil water to drive turbines. These designs also allow power to be generated when the sun is not shining.

Concentrated solar power and CSP systems generate solar power by using mirrors or lenses to concentrate a large area of sunlight, or solar thermal energy, onto a small area. Electricity is generated when the concentrated light is converted to heat, which drives a heat engine connected to an electrical power generator or powers a thermo chemical reaction. Heat storage in molten salts allows some solar thermal plants to continue to generate after sunset and adds value to such systems when compared to photovoltaic panels. Concentrating Solar Power technologies use mirrors to concentrate the sun's light energy and convert it into heat to create steam to drive a turbine that generates electrical power.

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CSP technology utilizes **focused sunlight**. CSP plants generate electric power by using mirrors to concentrate (focus) the sun's energy and convert it into high-temperature heat. That heat is then channelled through a conventional generator. The plants consist of two parts: one that collects solar energy and converts it to heat, and another that converts the heat energy to electricity. Within the United States, CSP plants have been operating reliably for more than 15 years. All CSP technological approaches require large areas for solar radiation collection when used to produce electricity at commercial scale.CSP technology utilizes three alternative technological approaches: trough systems, power tower systems, and dish/engine systems.

1.2 Heliostat

A heliostat is a device that includes a mirror, usually a plane mirror, which turns so as to keep reflecting sunlight toward a predetermined target, compensating for the sun's apparent motions in the sky. The target may be a physical object, distant from the heliostat, or a direction in space. To do this, the reflective surface of the mirror is kept perpendicular to the bisector of the angle between the directions of the sun and the target as seen from the mirror. In almost every case, the target is stationary relative to the heliostat, so the light is reflected in a fixed direction. Nowadays, most heliostats are used for day lighting or for the production of concentrated solar power, usually to generate electricity. They are also sometimes used in solar cooking. A few are used experimentally, or to reflect motionless beams of sunlight into solar telescopes. Before the availability of lasers and other electric lights, heliostats were widely used to produce intense, stationary beams of light for scientific and other purposes.

Most modern heliostats are controlled by computers. The computer is given the latitude and longitude of the heliostat's position on the earth and the time and date. From these, using astronomical theory, it calculates the direction of the sun as seen from the mirror, e.g. its compass bearing and angle of elevation. Then, given the direction of the target, the computer calculates the direction of the required angle-bisector, and sends control signals to motors, often stepper motors, so they turn the mirror to the correct alignment. This sequence of operations is repeated frequently to keep the mirror properly oriented.One of many components of a CSP Power Tower facility; a large, nearly flat mirror, usually on a tracker, pedestal, or other support structure, that allows it to continuously reflect the sun's rays onto a central receiver at the top of a centrally positioned tower over the course of the day. *See also* Flat-plate reflector. The reflecting element of a heliostat is typically a thin, back (second) surface, low-iron glass mirror. This heliostat is composed of several mirror module panels rather than a single large mirror. The thin glass mirrors are supported by a substrate backing to form a slightly concave mirror surface. Individual panels on the heliostat are also canted toward a point on the receiver. The heliostat focal length is approximately equal to the distance from the receiver to the farthest heliostat. Subsequent "tuning" of the closer mirrors is possible.

Fig 1.1 Heliostat

1.3 Central Receiving System

The central tower technology, in which a receiver located at the top of a tower, absorbs the solar energy concentrated by thousands of mirrors on the ground. This technology is as efficient for the heating of molten salts or another heat transfer fluid and for direct steam generation, this is in fact the most promising technology to compete with low cost photovoltaic, thanks to its ability to economically store high quantities of energy and so allow dispatch ability and overnight electricity production. The central receiver concept for solar energy concentration and collection is based on a field of individually sun-tracking mirrors that reflect the incident sunshine to a receiverat the top of a centrally located tower. Typically 80 to 95 percent of the reflected energy is absorbed into the working fluid which is pumped up the tower and into the receiver. The heated fluid returns down the tower and then to a thermal demand such as a thermal electrical power plant or an industrial process requiring heat.The basic difference between the central receiver concept of collecting solar energy and the trough or dish collectors discussed previously is that in this case, all of the solar energy to be collected in the entire field, is transmitted optically to a small central collection region rather than being piped around a field as hot fluid. Because of this characteristic, central receiver systems are characterized by large power levels (1 to 500 MW) and high temperatures (540 to 840°C).

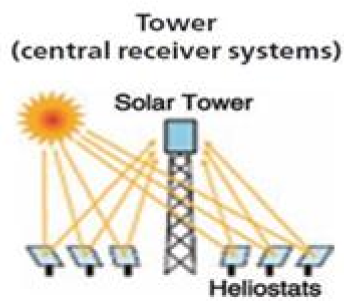

Fig 1.2 Central Receiver System

II. BLOCK DIAGRAM DESCRIPTION

In this block diagram the paper and design aspect of independent modules are considered.

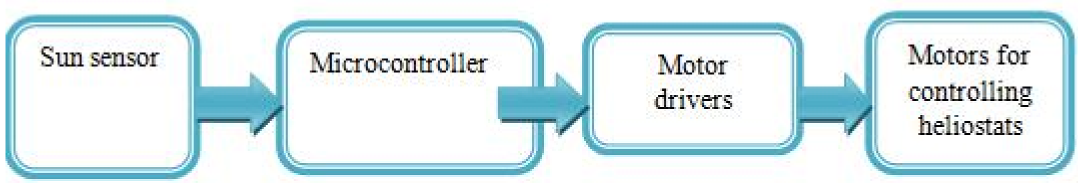

Fig 2.1 Block diagram

III. FLOW CHART

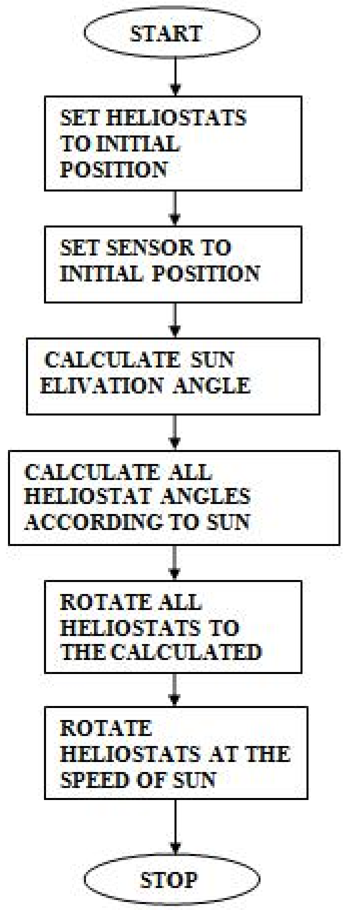

Figure 6.1 FLOW CHART

IV. RESULTS

The paper "HELIOSTAT CONTROL SYSTEM FOR TOWER TYPE CONCENTRATED SOLAR POWER PLANT " is intended to use sun's renewable heat energy efficiently. The CSP power plant is a field of controlled mirrors called heliostats. Generally in real time application this controlled field is of thousands of kilometers. The primary goal of this project is to track the sun position and close and accurate control of mirrors according to the movement of sun. Secondly, to concentrate the disperse sun rays at a single point so as to produce large amount of heat. This heat energy is used to produce electric power.

Design challenges

The challenges we have faced in implementation of this paper are

1. To design a mechanical system where mirrors track sun's position.
2. To design a sun sensor to calculate the elevation angle of sun.
3. To design a efficient circuit so that it works accurately without errors.

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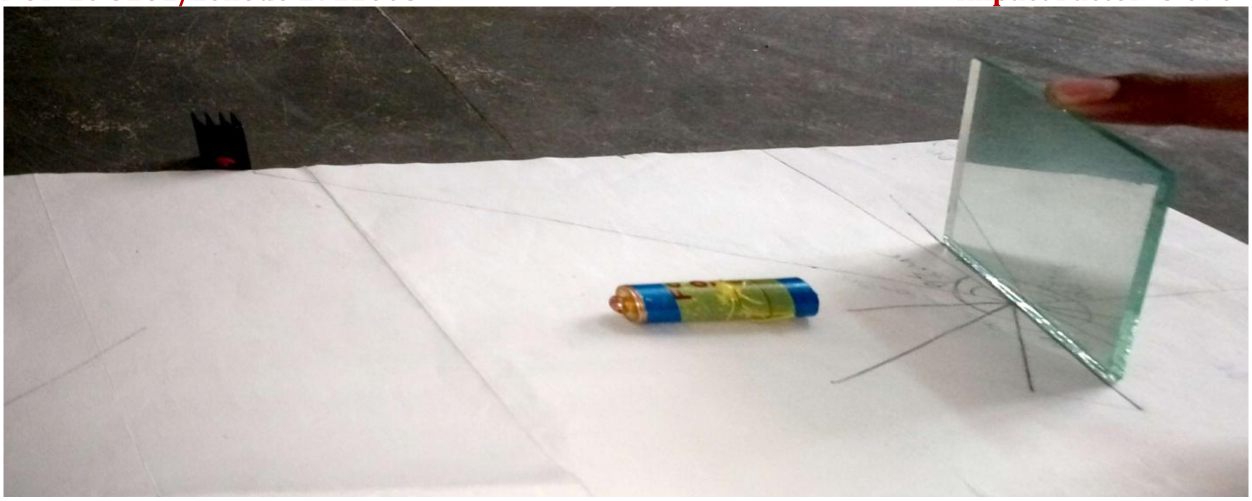

Fig 4.1 Testing calculated angle

Fig 4.2 Project Prototype

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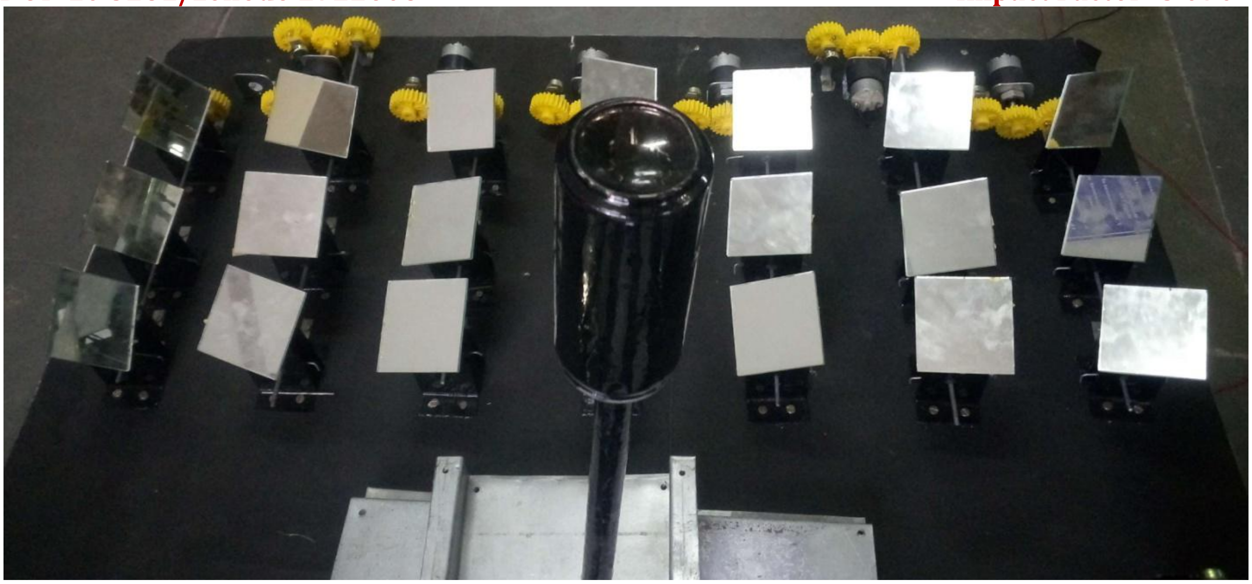

Fig 4.3 Mirror reflecting light on tower

V. CONCLUSION AND FUTURE SCOPE

Integrating features of all the hardware components used have been developed in it. Presence of every module has been reasoned out and placed carefully, thus contributing to the best working of the unit. Secondly, using highly advanced IC's with the help of growing technology, the paper has been successfully implemented. Thus the project has been successfully designed and tested. In this paper, The sun light incident on all of the mirrors is reflected to concentrate at single point on the central receiver where large amount of heat is obtained. It is to be further developed so that the obtained heat can be used to generate electricity or as furnace to melt metals at industries.

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