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APPLICATION OF PLATAFORMA SOLAR DE ALMER´IA (PSA) ALGORITHM FOR MAXIMIZING EFFICIENCY OF SOLAR PANEL

***Vinuta V. Koluragi**

Assistant Professor, B.L.D.E. A's V P Dr. P G Halakatti College of Engg., and Tech., Vijayapur

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ABSTRACT

The increasing demand for energy, the continuous reduction in existing sources of fossil fuels and the growing concern regarding environment pollution, have pushed mankind to explore new technologies for the production of electrical energy using clean, renewable sources, such as solar energy, wind energy, etc. Among the non-conventional, renewable energy sources, solar energy affords great potential for conversion into electric power, able to ensure an important part of the electrical energy needs of the planet. While the output of solar cells depends on the intensity of sunlight and the angle of incidence, it means to get maximum output; the solar panels must remain in front of sun during the whole day. But due to rotation of earth, panels cannot maintain their position always in front of sun. This problem results in decrease of their output. Thus to get a constant output, an automated system is required which should be capable to constantly rotate the solar panel to receive maximum solar energy.The project is carried out to built automated sun tracking system using Programmable Logic Controller (PLC); sun's apparent position is calculated using Plataforma Solar de Almer´ıa (PSA) algorithm with input as geographical latitude, longitude, year, month, day, and time. With sun angles obtained by PSA algorithm, stepper motor adjusts solar panel so that to obtain maximum output. Programming in PLC is carried out in Ladder Diagram (LD) for stepper motor drive sequence and for calculation of solar angles Function Block Diagram (FBD) is used. Observation for increase in output is carried out for one day for both fixed and tracking system and it is observed that there is increase in power of 35.75%.

****Corresponding author:***

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INTRODUCTION

Modern society is dependent on readily available electrical power. Without a stable source of energy, the continued prosperity of the human population cannot be maintained. As the population grows, so does the demand for electrical energy. As the world enters the new century, the depletion of carbon based fossil fuels is becoming more problematic. In order to prevent catastrophic energy depletion, alternative power sources must be realized. The use of fossil fuels and the finite availability of these resources have shifted a greater emphasis on renewable sources of energy [Romy kansal, 2008]. In recent years, solar energy is a new development way with utilization, and is an ideal green energy with the strategy of sustainable development.

Inexhaustible solar energy and its environmental advantages at home and abroad have become one of the most promising new energy. Interconnected electric power generation of photovoltaic (PV) solar power is the most important application. At present, a lot of solar cell panel arrays are basically been fixed and cannot make full use of solar energy resources, so power generation efficiency is low. According to experiments about solar power generation, the generating power of tracking automatically increases about 35% than fixed one [Weiping Luo, 2009]. As a result, it is a very valuable research about designing and developing control system of automatically tracking the sun light. Thus, project research is being carried out on automatic sun light tracking system based on programmable logic controller (PLC).

It not only can automatically adjust the orientation of the solar cell panels according to sun light direction, but also can member and correct automatically coordinate location with different time during tracking, without human intervention.

Summary of literature survey

- Solar panel tracking is essential as it increases energy output by 20-40% than fixed panel.
- Programmable Logic Controller (PLC) can fit for more complicated changes in weather and unattended state with simple structure and lower cost, and improves effectively the utilization rate of solar energy.
- Energy saving factors should be considered i.e., the sun is not constantly tracked with the same accuracy to prevent energy overconsumption by the motors.

Objectives

This study attempts to achieve the following objectives:

- To develop a solar tracker using PLC.
- To monitor and to record the values during tracking.
- To obtain maximum power from the device with less errors.

METHODOLOGY

The common ways used to solar tracking are photoelectric detection and solar trajectory tracking modes. The former uses a photoelectric sensor to monitor the solar movement, and then it controls the mechanisms to track the sun. This mode has high sensitivity, but it is easy to be interfered by the weather and miscellaneous light. The latter controls the mechanisms of tracking by calculating the solar trajectory. This mode doesn't subject to environment, thus in this project both tracking methods are used to reduce error and improve accuracy.

Photoelectric detection tracking: Figure 1 shows general block diagram for photoelectric detection tracking, which consists of two duplicate photo resistances, motor, Programmable Logic Controller (PLC) and solar panel. When two photo resistances receive same sunlight their values are equal, if there is change in resistance value with sunlight then sensor will give signal to PLC to run the motor until two photo resistance values are equal. This method may be affected by weather conditions thus solar trajectory tracking is also included to improve the tracking performance.

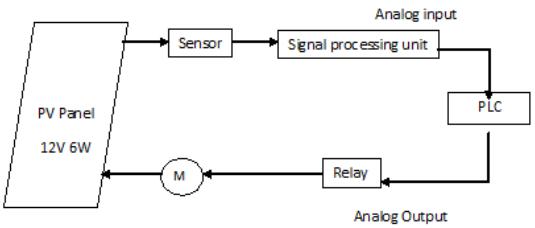

Fig 1: The composition system block diagram (Weiping Luo, 2009).

Solar trajectory tracking

This tracking method includes determining sun position by calculating solar azimuth, solar elevation and other angles by algorithms.

There are several algorithms for calculating the position of the sun based on the date and time provided by an auxiliary clock and geographical data (longitude and latitude of the point used to estimate the position of the sun). This work used the PSA algorithm, developed by the Plataforma Solar de Almeria, which has improved the calculation of universal time as well as the treatment of leap years and which also makes the calculation more quickly and robustly.

Proposed system for project

Figure 2 shows combination of both tracking system. In figure 2, u represents the position (azimuth and elevation) the tracking system assumes is the location of the sun. It can be seen that this estimated position of the sun is obtained by adding two values: ū, which is the position obtained from the equations that model the sun's movement, and ũ, which is a correction of that position based on the estimated position of the sun, Y. There are several algorithms for calculating the position of the sun based on the date and time provided by an auxiliary clock and geographical data. They are Cooper, Spencer, Pitman and Vant-Hull, Michalsky algorithm and Plataforma Solar de Almeria (PSA) algorithm.

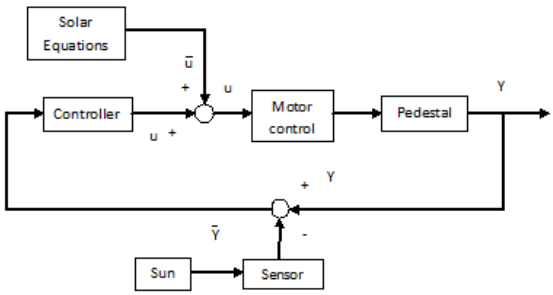

Fig. 2. Combined tracking system (Rubio *et al*., 2007)

PSA Algorithm

Study of PSA Algorithm: To compute solar vector, Plataforma Solar de Almeria (PSA) algorithm is used which combines these two characteristics of accuracy and simplicity. Following are characteristics of algorithm:

- Its ease of use has been improved by incorporating an efficient method of computing the Julian Day from the calendar date and Universal Time.
- Memory management has been improved by controlling the scope and life span of variables.
- Speed and robustness have been improved by eliminating unnecessary operations and using simple robust expressions for calculating the solar azimuth, which are valid for both hemispheres.
- Accuracy has been improved by modifying the simplified equations of the Nautical Almanac used by Michalsky with the introduction of new coefficients and new terms, and including parallax correction.

Programming in PLC: Ladder diagram for photoelectric detection tracking is written in Indralogic Rexroth bosch PLC.

Description: Two motors for two axis rotation (horizontal and vertical) will be operated when respective photo resistances value differs. Figure 3 shows sequence operation block diagram.

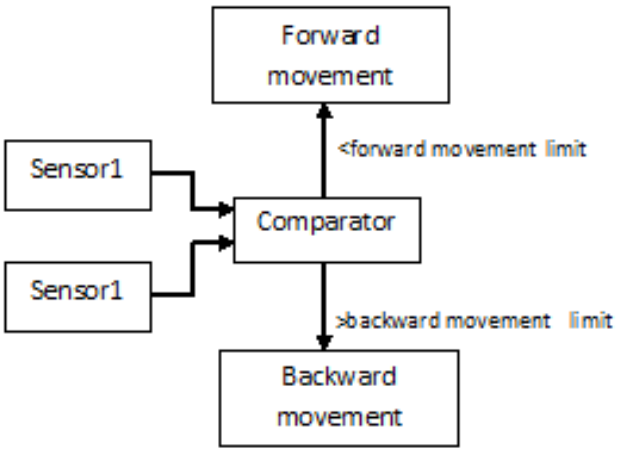

Fig 3. Block diagram of sequence operation

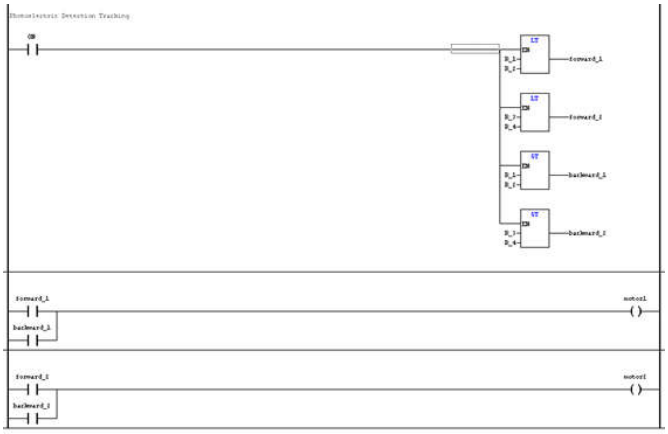

Fig 4a: Program in offline mode

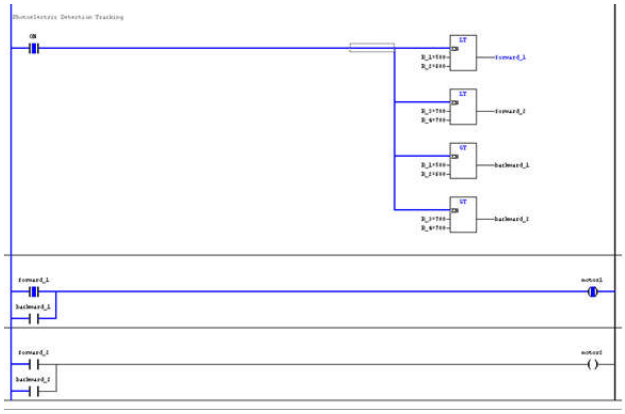

Fig 4b. Program in online mode

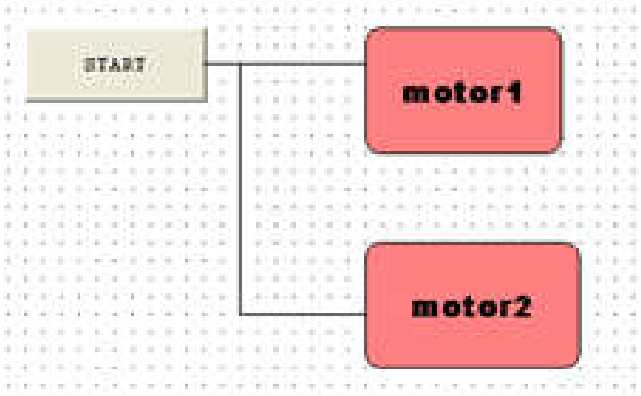

Fig 4c. Monitoring screen

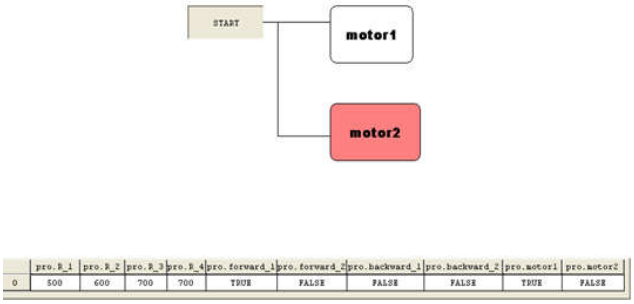

Fig 4d: Monitoring screen displaying values

Monitoring screen for tracking project is written in Indralogic's visualization section. Coding of PLC is shown in figure4.

Conclusion

Sun tracking strategy reduces error, and improves power. Thus sun tracker with both photoelectric detection tracking and solar trajectory tracking will be combined to reduce error of tracking. PLC is used for controlling and monitoring; as it is advanced tool and it suits for all weather conditions. Photoelectric detection tracking ladder diagram is build and it is compared with the solar trajectory for given time and location, so that panel is set perpendicular to sun rays to generate maximum power. Improving the efficiency of solar photovoltaic power generation is an important path which can deal with the global energy crisis at present.

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Website

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