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COMPUTER-AIDED DESIGN OF SOLAR POWER PLANT

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Abstract. *The descriptive model based of solar power plant is proposed. The direct power lost due to misalignment and angle of incidence is determined. The control algorithm of solar power plant is developed.*

Keywords: computer-aided design; solar power plant; solar panels; solar tracking algorithm.

Introduction

As known, the actual power of solar panels and their charging current value - are directly dependent on the angle of incidence for these modules on sunlight and the density of incident sunlight. Based on this, solar modules in a fixed position that is relative to the sun – brings a smaller effect than same modules with sun tracking mechanism.

Installation of solar modules on the rotary mechanism allows us to always keep our solar panels toward the angle of inclination and the direction of sun's motion.

Through the use of solar panels on the rotary mechanism and a constant orientation to the sun, by the angle of incidence of sunlight on the solar modules and the direction of movement of the sun across the sky, it is possible to achieve a substantial increase in the efficiency of solar cells.

Such a "modernization" of existing solar installations in comparison with fixed, can increase the production of electricity in the winter about to 10 %, and in the summer up to 40 %.

Descriptive model based on solar power plant

Lets review a general view of solar power plant (fig. 1).

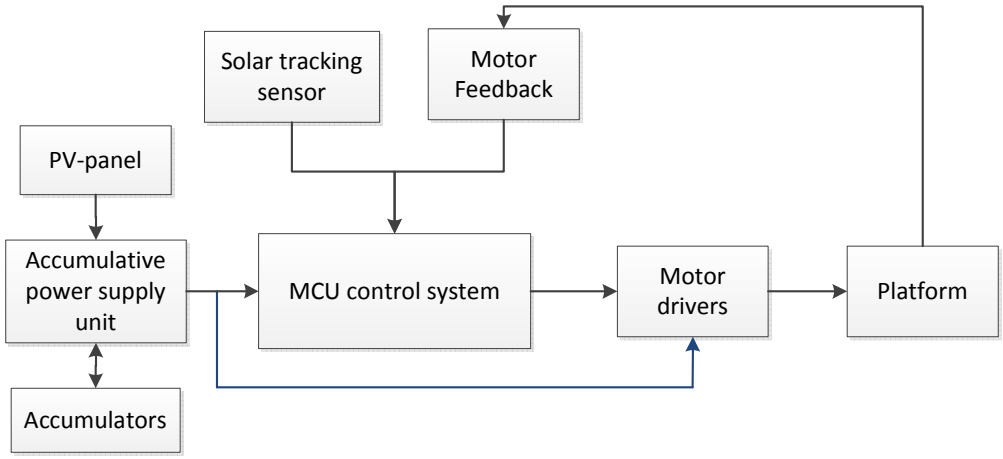

Fig. 1. Structural scheme of solar power plant

Solar power plant consists of such main structural blocks:

– Accumulative power supply;
– microcontroller control system (MCU) subsystem;
– motor drivers;
– feedback subsystem.

Each individual structural block can be considered as an independent component of the system in general, which may at any time be replaced by a more perfect or improved.

Energy of solar cells can be used as energy from other power sources. Each element is designed to support a certain current at a given voltage, but in contrast to other power sources, solar cell characteristics are very dependent on the amount of light falling on the surface.

To justify the use of sun tracking system for automatic positioning in solar power systems, we will display plot of direct power lost due to misalignment and angle of incidence misalignment (fig. 2).

This dependency can be expressed as the general criteria of effectiveness of the system in the form of mathematical formula:

$$P^* = \max_{i \in i_C} P(i),$$

where P^* – power maximum; i – angle of incidence; i_c – set of possible angles of incidence.

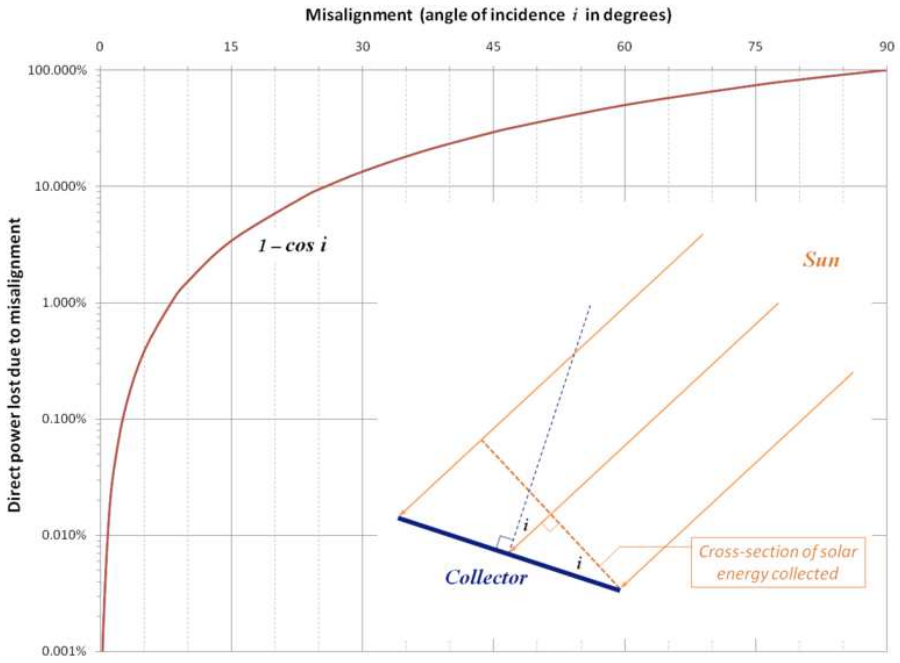

Fig. 2. Plot of direct power lost due to misalignment and angle of incidence (misalignment)

Review of control methods

To achieve the goal of minimizing the error angle between the sun and the normal platform solar panels can be used by different management techniques [1; 2].

Method of tracking by calendar. The propose of this method is that the automatic control system can lead to a certain constant route/path, which may be initially set. This method relies on the fact that the sun has a constant path in the sky, which, depending on the region and time of year may vary.

Main disadvantage is the requirement for the actuator system, namely the characteristics of precision of motor feedback sensors, which can raise the price of the system.

Method of tracking solar intensity sensor is that the system relies on "external observer", which may at any time suggest any disagreement on panels position.

The principle of operation of the sensor is taking the differential signal between photodiodes arranged at right angles to the axis of the one visible based on their characteristics, which subsequently provides conditional information mismatch.

Control algorithm

To minimize the misalignment angle and improve the current-voltage characteristics we will further consider the structure and we will propose method of controlling a solar power plant.

We will map the general mechanism of control system in block diagram form (fig. 3).

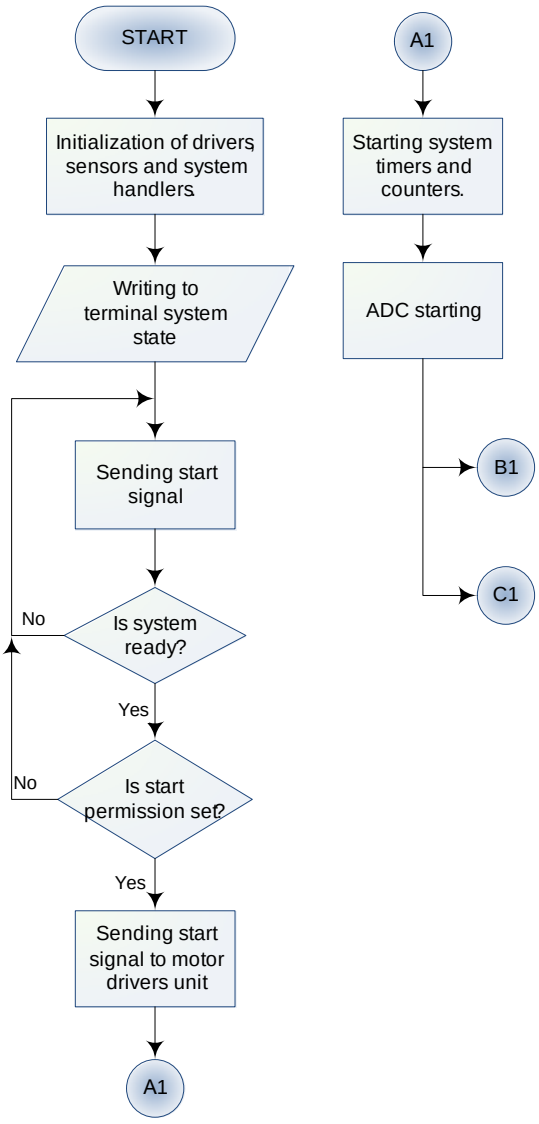

Fig. 3. Block diagram of the general mechanism of control

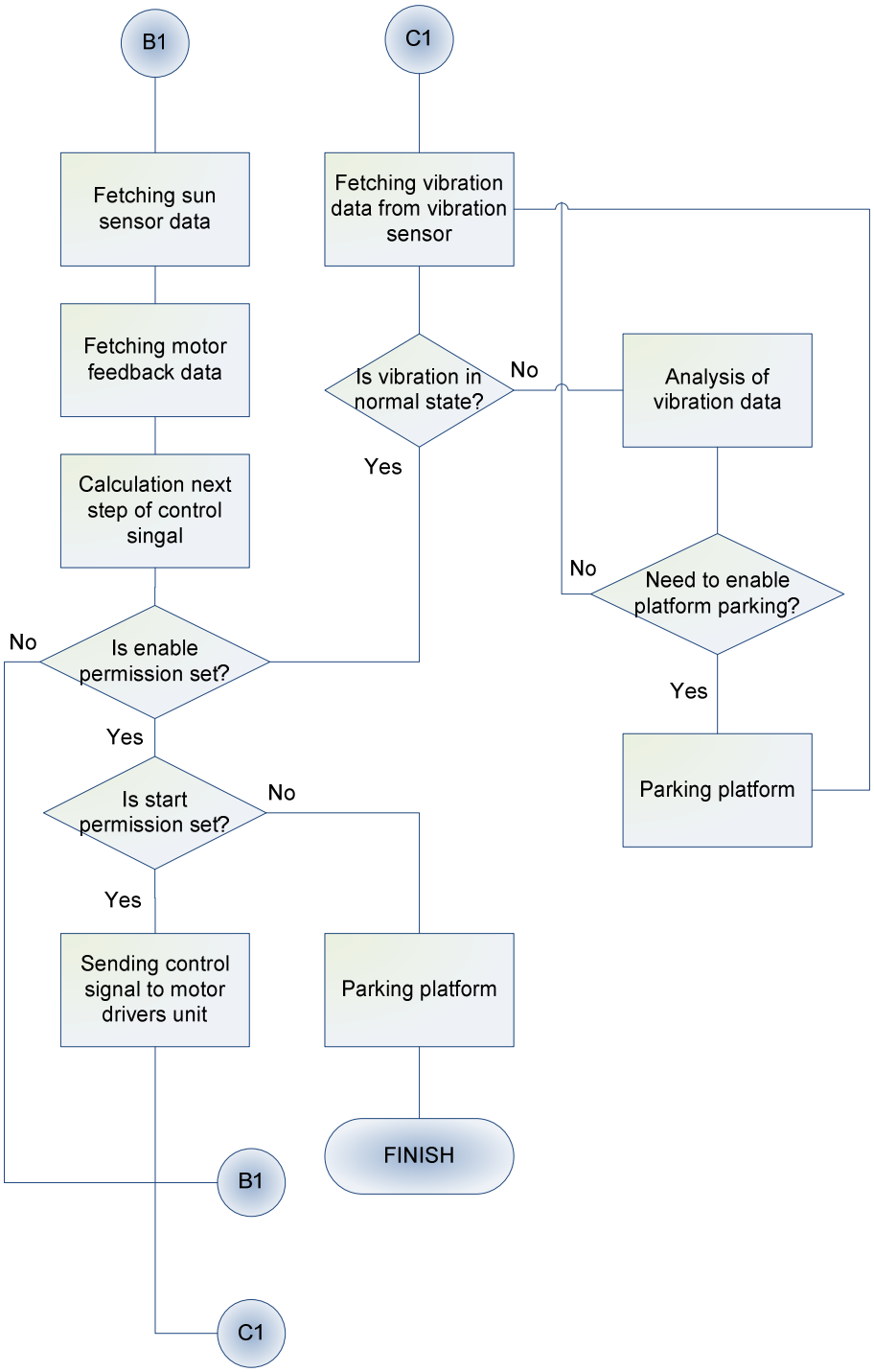

Fig. 3. Ending. (See also p. 91)

The second phase begins to initialize the system configuration and move control system units in standby mode (motor driver units, periphery of the MCU etc). After completion of the initialization phase, the control program runs.

Conclusions

The control system will collect all the supporting data to calculate the new position of the platform at the end of this stage system will request enable signal from the vibration sensor. This sensor is used to determine the external conditions for the correct operation of the platform, namely vibrations of the panels because of the wind. If there are no issues with wind, control system begins regulation of mechanical platform according to the criterion of efficiency. If control system identified issues to work correctly, it runs the emergency management cycle with isolated parking platform at a fixed time. Operation of the system will continue work as long as enable signal set. When enable signal diactiveted power plant goes to service mode.

References

1. *Adrian Catarius, Mario Christiner*. Azimuth-Altitude Dual Axis Solar Tracker, Worcester Polytechnic Institute.

2. *Joe-Air Jiang, Tsong-Liang Huang, Ying-Tung Hsiao and Chia-Hong Chen*. 2005. Maximum Power Tracking for Photovoltaic Power Systems. Tamkang Journal of Science and Engineering, Vol. 8, No 2. P. 147E153.

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В. М. Синєглазов, Д. П. Карабецький. Системи автоматизованого проектування сонячної електростанції
Запропоновано описову модель сонячної енергетичної установки. Визначено прямі втрати потужності в залежності від кута неузгодженості. Розроблено алгоритм керування сонячної електростанції.
Ключові слова: система автоматизованого проектування; сонячна електростанція; сонячні батареї; алгоритм стеження за сонцем.

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В. М. Синеглазов, Д. П. Карабецкий. Системы автоматизированного проектирования солнечной электростанции
Предложена описательная модель солнечной энергетической установки. Определены прямые потери мощности в зависимости от угла рассогласования. Разработан алгоритм управления солнечной электростанции.
Ключевые слова: система автоматизированного проектирования; солнечная электростанция; солнечные батареи; алгоритм слежения за солнцем.

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