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USE OF PROGRAMMABLE UNITS IN PHOTOVOLTAICS

Abstract: This paper deals with the use of Arduino platform for applications in photovoltaics, especially the issue of search MPPT (maximum power point) of photovoltaic panels using the open-source platform Arduino. With the given platform there was created a physical model of tracker with control and the MPPT searching algorithm was compared with the measurement without the tracker.

Keywords: photovoltaic panel, MPPT, Arduino

Introduction

Nowadays, the development of solar systems is focused primarily on aspects related to the development of materials and processes relating to the conversion of solar energy into electrical energy. For better efficiency of the entire system it is suitable to use the pointing devices (trackers), which can increase the energy yield up to 50 %.

Model of solar tracker

Worked out model of solar tracker is a smart tracking device that tracks the sun through fully automatic control unit that uses motion control program of the sun by the timer RTC DS1307 and two modeling stepper motors that make the photovoltaic panel always rotated towards the most intense sunlight, so the solar panel generates the maximal amount of energy. Tracker is also equipped with 2-line LCD display that informs the user about the size of the power and voltage supplied by solar panels. Further it shows the current time and specifies in what mode the device is currently working. LED indicates the status when the solar panel is operating in MPP mode. Solar tracker works with platform Arduino Uno R3 (programmable unit). For its correct operation the tracker must be placed in coordinate system (to the north) as specified auxiliary image.

Fig.1 Solar tracker model

Technical parameters:

- type of positioning: biaxial
- dimensions: 205 × 160 × 180 mm
- horizontal shooting range: 180 °
- vertical shooting range: 180 °
- supply voltage: 9 V to 12 V
- output power: max. 3 W
- controller: Arduino platform
- positioning: timer, manual
- power supply: 9 V battery, USB port, ext. 12 V supply

Construction

The main structure for positioning of the solar panel consists of movable and stationary parts. Movable part includes a stepper motor which rotates along a horizontal axis and solar panel. This part is made of duralumin. It is sufficiently strong and lightweight, so that does not burden the vertical stepper motor in their activities. Fixed, stationary part, is integrated in the device housing and is made of iron. This makes the tracker harder and can withstand stronger weather conditions. Within this part there is a built-in stepping motor, which turns the panel through the vertical axis. A more detailed view is shown in Fig. 2.

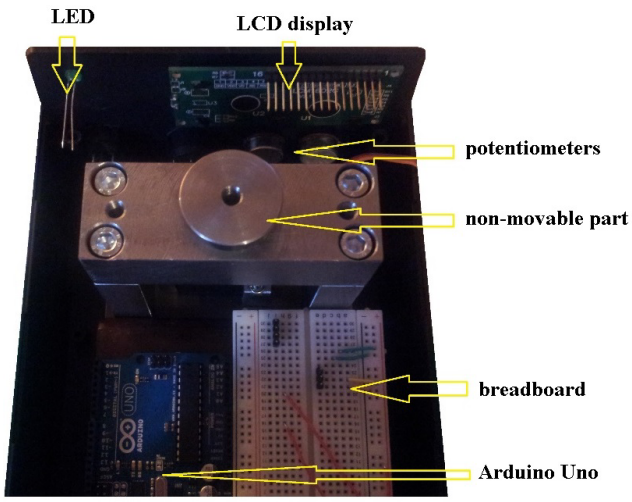

Fig.2 Insight into the solar tracker

Controls

Solar tracker control is mediated by several controls. There is a switch (MANUAL/AUTO), which commands the device to operate in automatic or in manual mode. Operations in the manual regime ensure two potentiometers, which are intended for the positioning of the vertical or horizontal axis. Automatic mode is controlled by the algorithm. Tracker is switched on or off by switch ON/OFF.

Fig.3 View of the front panel controls

Solar panel

In the model of the tracker there is used photovoltaic cell made of polycrystalline silicon (c-Si), which is embedded in polymerplastic. It is resistant against the water and UV-radiation. That cell does not reach high power, therefore there are only used for a variety of experiments and testing, battery charging, eventually for powering of small electronic devices and LED lights. Its output

parameters differ from the weather, but produces energy even when there are cloudy or cloudy days.

Characteristics of solar PV panel:

- dimensions: 180 × 178 × 3 mm
- PV panel output power (PMAX): max. 3000 mW
- panel output voltage (VOC): 6,0 V
- output current of the PV panel (IMP): 500 mA
- recommended operating temperature: – 20 °C to + 60 °C
- number of silicon cells: 48 cells = 12 (cells) × 4 (row)
- power tolerance: ± 3 %

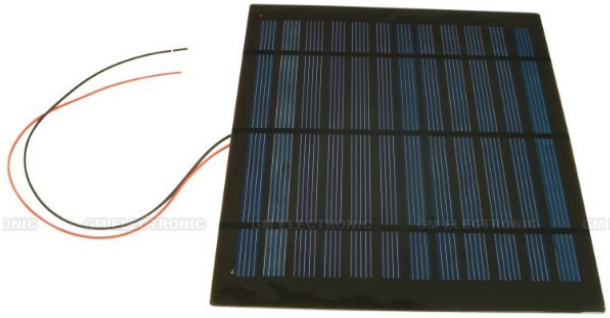

Fig.4 Used solar cell

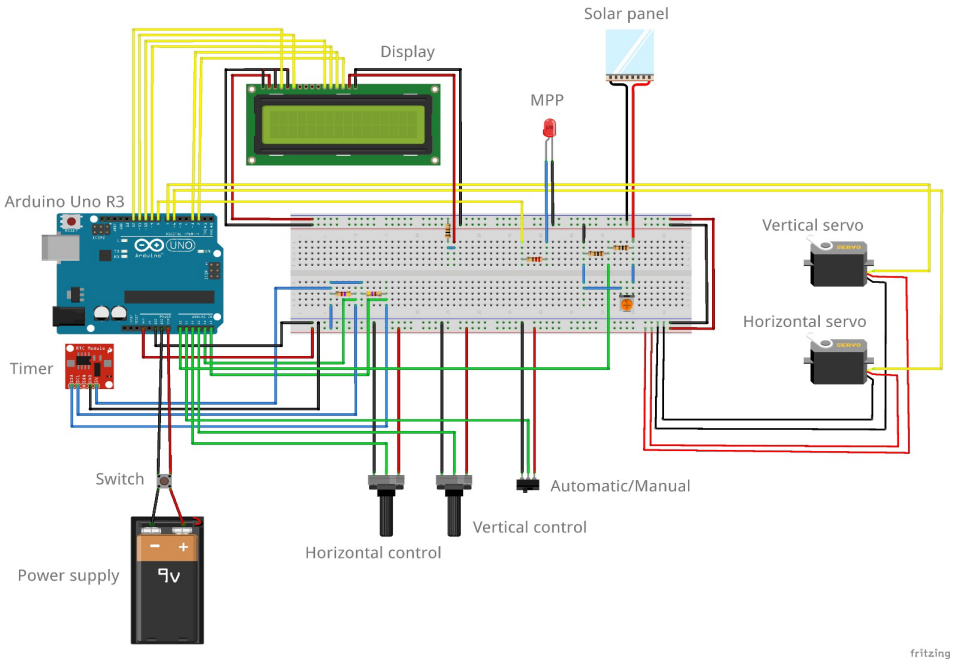

Fig.5 Block diagram of the solar tracker

Results of test measurement

In order to test the functionality of created tracker algorithm, there was implemented full-day measurement, the results of which are shown in the following figures.

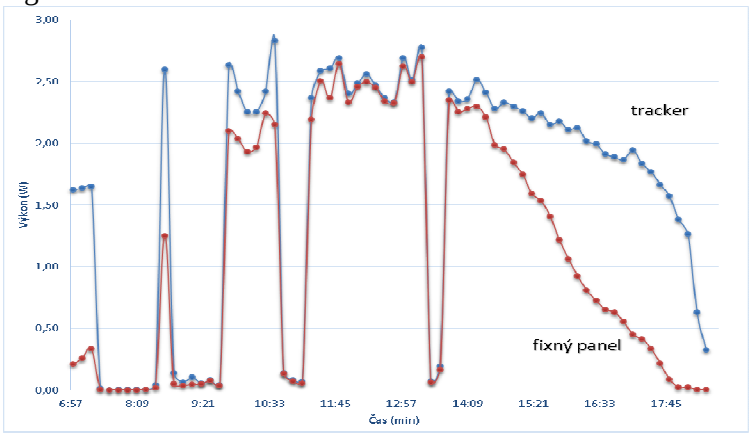

Fig.6 Power dependence *P* of the PV panel on time *t*

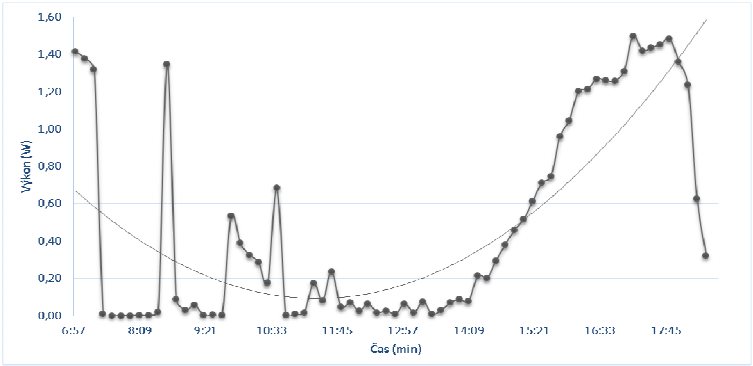

Fig.7 Difference power dependence *P* of the PV panel (fixed PV panel and tracker) on time *t*

Conclusion

The aim of the measurement was to determine the electrical output power of the photovoltaic panel during the day and the energy efficiency of a solar tracker. Data were obtained from the display of the solar tracker. There was stored time and voltage, from which there was calculated the amount of obtained power. There were measured two states simultaneously. In the first state the solar panel was constantly kept in position facing to south in the horizontal inclination of 45°. In another case, the panel was automatically (by the algorithm) tracks to the sun. These conditions were manually toggled by switch “MANUAL/AUTOMATIC” at regular intervals of 10 minutes. Voltage (U_{FIX}) and power (P_{FIX}) in manual state was different from the voltage (U_{TRACK}) and power (P_{TRACK}) in automatic mode.

The average power measured by fixed panel was P_{FIX} = 1,13 W and by the tracker P_{TRACK} = 1,61 W, so the output power using of tracker is higher like with fixed panel.

Acknowledgment

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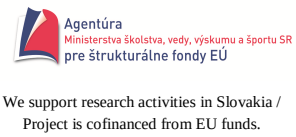

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