RESEARCH ON DESIGNING AND DEVELOPING AN AUTOMATED SYSTEM FOR CONTROLLING THE SOLAR PANELS

NEACȘU Ana-Maria, TARBĂ Ioan-Cristian
Faculty: Industrial Engineering and Robotics, Specialization: Applied Informatics in Industrial Engineering, Year of Study: IV, email: neacsuana297@gmail.com

ABSTRACT: This project focuses on developing an automated system for tracking the Sun andusing its energy in order to protect the environment. The Sun will be intercepted by two LDR sensors positioned on the two extremities of the solar panel, to the East and West. Dependingon the direction from which the Sun is registered, a motor will rotate the system automatically. A wind sensor is integrated so that when a value set as threshold is exceeded, the panel is repositioned parallel to the ground, to prevent the wind to cause damage to the system.

KEYWORDS: solar energy, light detection, wind speed, automation

1. Introduction

Solar energy is a supreme source provided by the Sun, which not only generates energy during the day but also powers the planet through solar particles called photons. Due to the rotationof the Earth around its axis, solar energy, although endless, is not consistently received at the sameintensities. Based on calculations, it has been demonstrated that during the winter, solar energy can be captured over a period of 9 hours [1].

The objectives pursued within the project are increasing the production of electricity, protecting the environment through the use of renewable energy and reducing long-term costs for electricity.

Table 1 presents a number of the competing products of the system, both at the prototypelevel and at the complex level.

Table 1. The current stage of work in the field

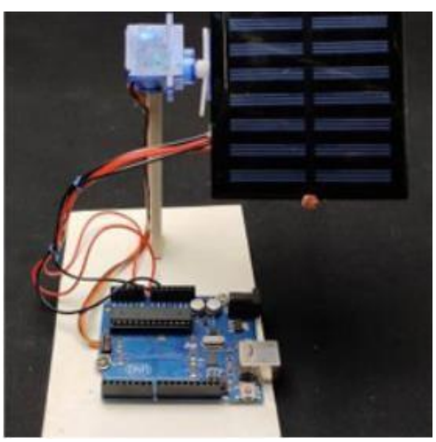
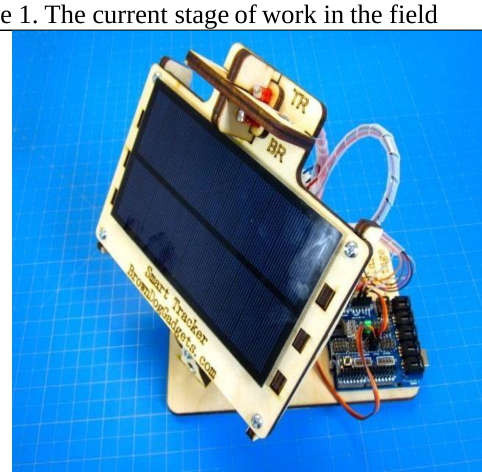
 Fig.1. Solar tracker with one axis - prototype [2]	 Fig.2. Solar tracker with two axes - prototype[3]

Fig.3. Solar tracker with two axes [4]

Fig.4. Solar tracker with two axes and online energy monitor[5]

2. Efficiency analysis

There are several differences between the two types of solar panels used for similar systemsto the one intended to be realized.

Monocrystalline solar panels have higher efficiency, produce more energy on cloudy days but their efficiency decreases by approximately 0.37-0.39% per degree Celsius temperature increase [6].

Polycrystalline panels have a more affordable price, about 10-15% lower compared to monocrystalline panels, their power output is less affected by temperature increases but they produce less energy on cloudy days [6].

Through a website created by the European Commission, the two methods of solar panel installation were analyzed: fixed installation directly on a support structure or with the ability to rotate based on the position of the Sun.

In both cases the location where the system will be installed is set. For the analysis the Polytechnic University of Bucharest was selected and the panel type used was crystalline, encompassing both monocrystalline and polycrystalline categories, with a maximum photovoltaicpower of 5 kWp and a loss percentage of 14%.

For the fixed system, an inclination angle of 35 degrees and an azimuth angle of 0 degreesfacing South (with any interval between -90 and 90, where -90 is East and 90 is West [7]) were chosen. This configuration results in an annual energy production of 6414.5 kWh and a loss of - 22.08% [8]. The performance settings used for the calculations are represented in Figure 5 and themonthly results throughout the year are shown in Figure 6.

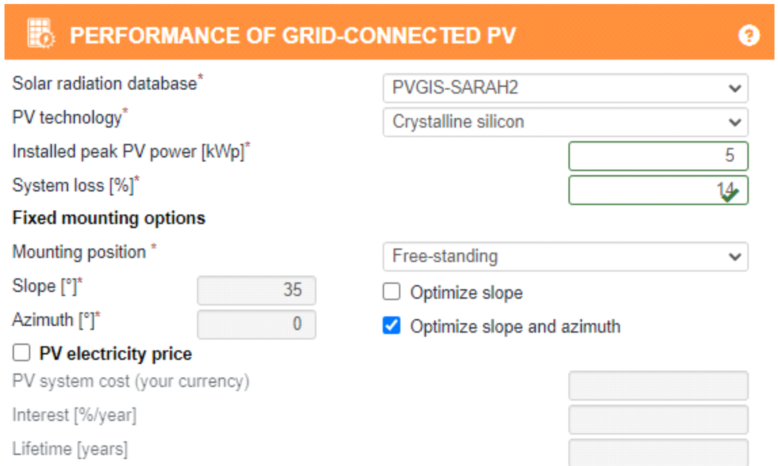


Fig.5. Performances set [8]

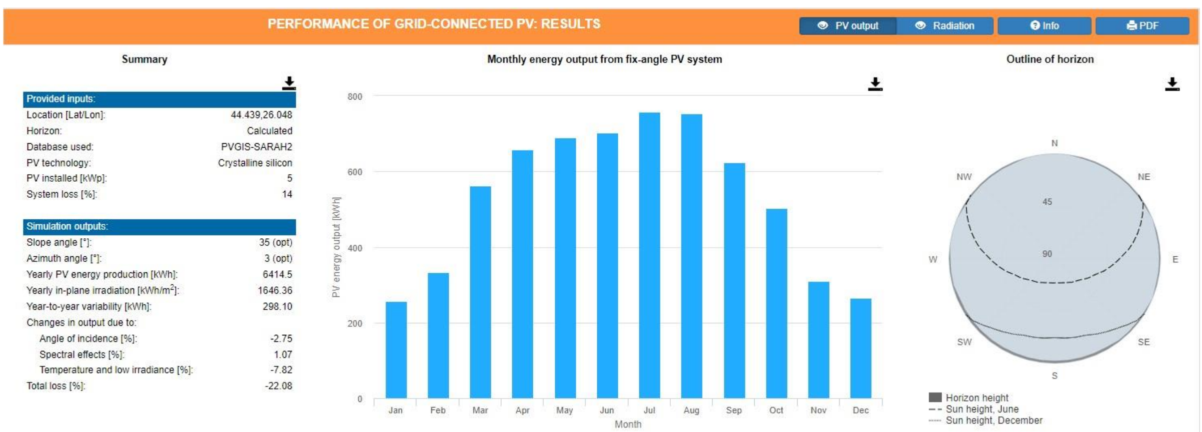


Fig.6. Results [8]

In the case of the solar tracking system, the exact same characteristics as the fixed systemwere set and significant differences were obtained. The annual energy production this time is 8208.24 kWh, with a system loss percentage of -21.48%. This loss is not a critical characteristic, but after several years of both types of systems operating under the same conditions, the percentage will increase and the differences between them will be much greater. The performance settings inthis case are represented in Figure 7, the results obtained and the described earlier are shown in Figure 8.

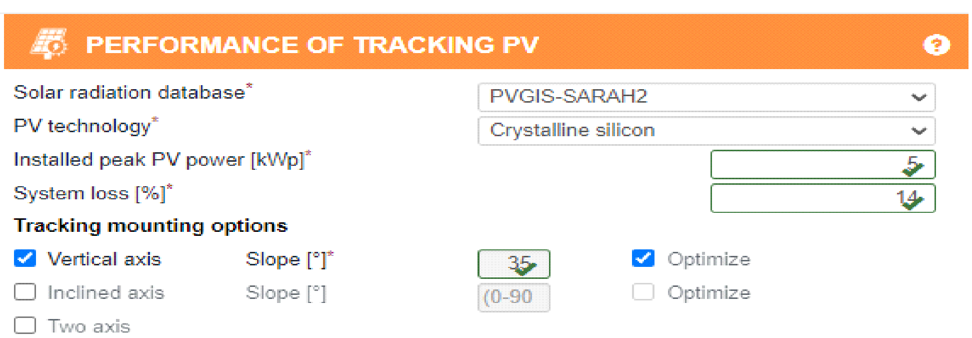


Fig.7. Performances set [8]

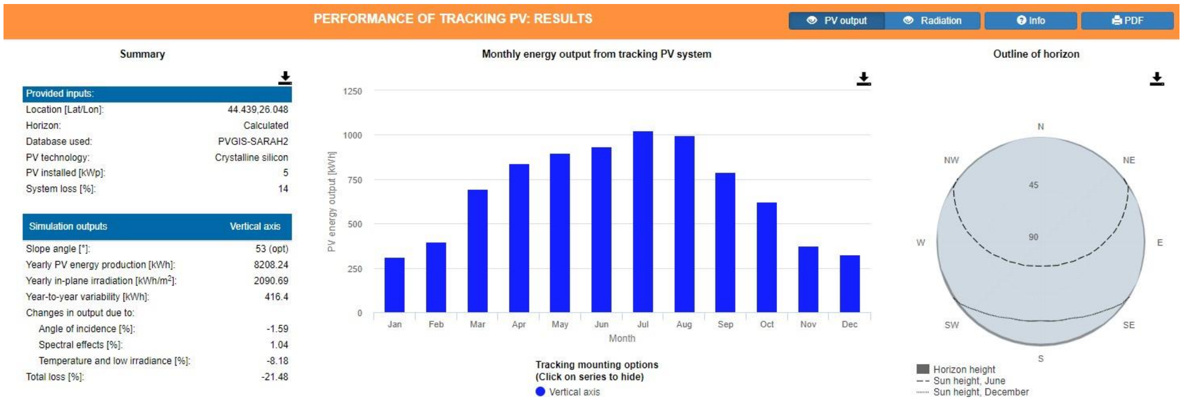


Fig.8. Results [8]

3. Actual state

3.1. Logic scheme

Figure 9 represents the operating principle of the automatic control system for the solarpanels. The wind speed is constantly monitored and if it exceeds a certain threshold, the system will position the solar panel parallel to the ground to prevent damage during strong storms. If thisthreshold is not reached, the system can operate under normal conditions and start recording light.If both sensors receive light, it means that the solar rays are perpendicular to the solar panel, so there is no need to change its position relative to the Sun. However, if only one sensor detects light,the motor will rotate the panel towards the light-dependent resistor (LDR) until both sensors simultaneously register light. If neither sensor detects light for a predetermined period, it indicatesthat it is night-time and the system needs to prepare for the next day by rotating back to the initialposition.

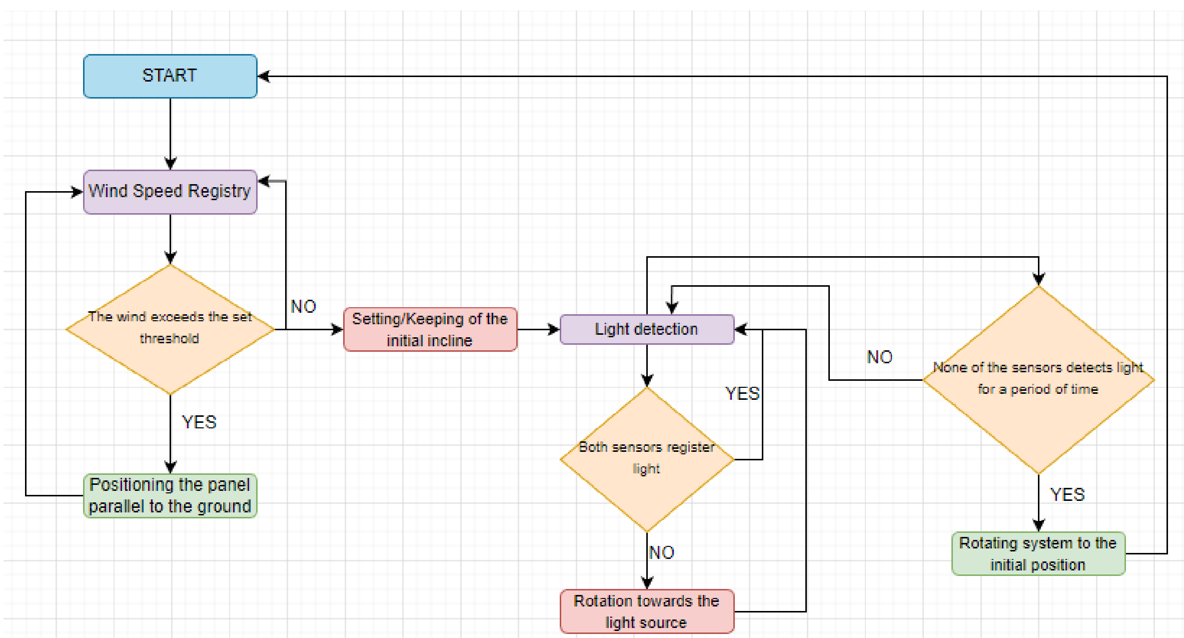


Fig.9. Logic scheme of the system

3.2. Designed device

The system consists of the motors that will perform the two movements, rotation and translation, mechanical components that support the assembly, the two light sensors positioned on the two sides of the panel (East and West) and an anemometer that will measure the wind speed.

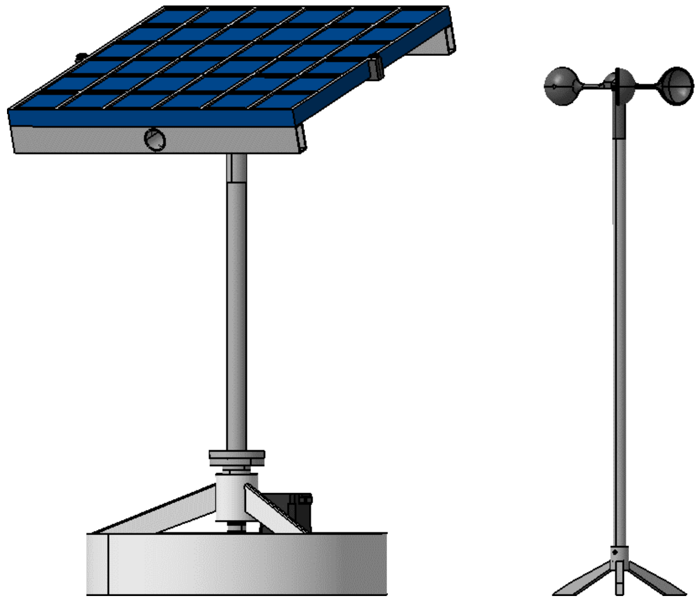


Fig.10. Design of the system

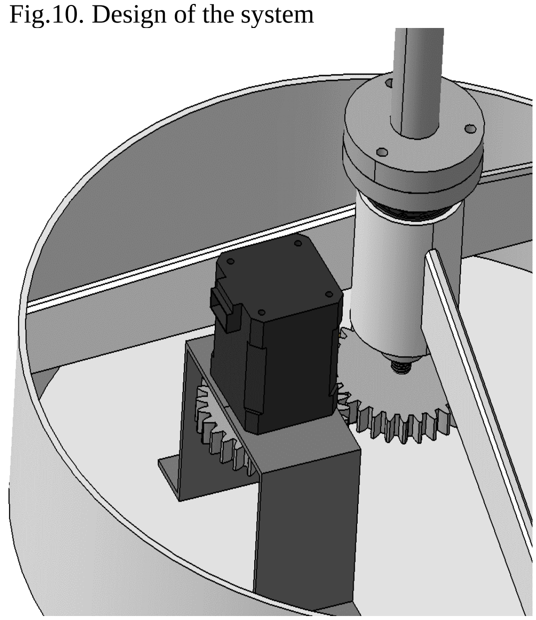


Fig.11. System rotation method

4. Conclusions

From the conducted research, it is notable that an automatic solar panel control system can achieve an energy production up to 12.8% higher than fixed systems, offsetting the initial costs.

Future research focuses on integrating a telescopic arm support, so that when the anemometer detects high wind values, the entire assembly can lower to a safe level.

5. Bibliography

[1]. https://ro.wikipedia.org/wiki/Energie_regenerabil%C4%83

[2].https://circuitdigest.com/microcontroller-projects/building-your-own-sun-tracking-solar-panel-using-arduino

[3]. https://www.instructables.com/Simple-Dual-Axis-Solar-Tracker/

[4]. https://www.instructables.com/Dual-Axis-Transistorized-Solar-Tracker/

[5]. https://www.instructables.com/Dual-Axis-300W-IOT-Solar-Tracker/

[6]. https://ecowindsolar.ro/fotovoltaice-mono-sau-policristaline/

[7]. https://www.youtube.com/watch?v=qLb1oEwhdP8

[8]. https://re.jrc.ec.europa.eu/pvg_tools/en/tools.html

[9]. Stefan C.W. Krauter (2006), *Solar Electric Power Generation – Photovoltaic Energy Systems*, Editura Springer

[10]. A. Awasthi, A.K. Shukla, C. Dondariya, K.N. Shukla, D. Porwal, G. Richhariya (2020), "Review on sun tracking technology in solar PV system", volumul 6, paginile 392-405