IOP Conf. Series: Journal of Physics: Conf. Series **803** (2017) 012107 doi:10.1088/1742-6596/803/1/012107

Automated Intelligent Monitoring and the Controlling Software System for Solar Panels

H S Nalamwar, M A Ivanov and S A Baidali

Tomsk Polytechnic University, 30, Lenina Avenue, Tomsk, 634050, Russia

E-mail: hitesh@tpu.ru

Abstract. The inspection of the solar panels on a periodic basis is important to improve longevity and ensure performance of the solar system. To get the most solar potential of the photovoltaic (PV) system is possible through an intelligent monitoring & controlling system. The monitoring & controlling system has rapidly increased its popularity because of its user-friendly graphical interface for data acquisition, monitoring, controlling and measurements. In order to monitor the performance of the system especially for renewable energy source application such as solar photovoltaic (PV), data-acquisition systems had been used to collect all the data regarding the installed system. In this paper the development of a smart automated monitoring & controlling system for the solar panel is described, the core idea is based on IoT (the Internet of Things). The measurements of data are made using sensors, block management data acquisition modules, and a software system. Then, all the real-time data collection of the electrical output parameters of the PV plant such as voltage, current and generated electricity is displayed and stored in the block management. The proposed system is smart enough to make suggestions if the panel is not working properly, to display errors, to remind about maintenance of the system through email or SMS, and to rotate panels according to a sun position using the Ephemeral table that stored in the system. The advantages of the system are the performance of the solar panel system which can be monitored and analyzed.

1. Introduction

One of the most popular renewable & sustainable kinds of energy is solar energy that currently attracting researchers from around the globe due to its minimum impact on environment. The solar power is growing to take up an ever-larger share of the total world's electricity generation, so it becomes important to know what to expect in advance. We can create such insights using only a smart way of generating, monitoring and distributing. Quality performance monitoring should be an essential component of any solar energy system, but it is getting sacrificed in the name of cost-savings. Intelligent monitoring & controlling include analysis, controlling (rotating and elevating) and tracking energy generation to analyze performance of the system [1,2]. The solar system is expected to produce a certain amount of power during each month. A solar monitoring & controlling system can inform if the system is off line or if it is not functioning as it was expected in order to take actions or run diagnostic programs. A solar PV plant where the parameters must be closely monitored and controlled thus requires an adequate data acquisition system (DAQ). The data acquisition system requires a large number of measured data where very frequent recordings need to be automated to eliminate the probability of human error as well as to save time. It is also necessary that the data can be represented in a graphical form for straightforward monitoring and analysis compare from having the data in a numerical format to achieve desire performance. This paper describes the development & working of the software system for monitoring and controlling solar panels remotely [3,5].

2. An architecture of the System

2.1. An overview of the System

We are developing two products with different functions and tasks:

1) Scalable energy-efficient mechatronic devices intelligent control system (SEMD): SEMD allows user to rotate the output gear shafts at a predetermined angle for ease of repair and maintenance.

2) A Solar Energy module (SEM): SEM designed for obtainment, storage, electrical power conversion and distribution of solar energy effectively.

The software system is based on a client server architecture that is implemented for monitoring and controlling both products. The system will have two roles – an operator and a specialist. An operator will be able to view information, whereas a specialist will be responsible for managing and operating the panel through the software system. The software system allows specialist to update the software in SEM and SEMD.

2.2. The Operation of the System

SEM includes SPM (Solar Panel Module), an accumulator, a converter, and SEMD shown in figure 1. SPM is needed for fixing a position of solar panels. An accumulator receives energy from a solar panel (a DC current); it stores energy and then sends it for transformation in the converter. The converter converts direct current to alternating current, and transmits it to the power cabinet with a voltage of 220 volts. Moreover, the main component in researching is SEMD. It needs to monitor the position of solar panels in space, change the parameters of the position by remote control and report about failures and malfunctions. In addition, this information about errors in the work of SEM is sent to hardware for service where a specialist or an operator responsible for maintenance of solar panels can detect an error in the work of the solar module and fix it.

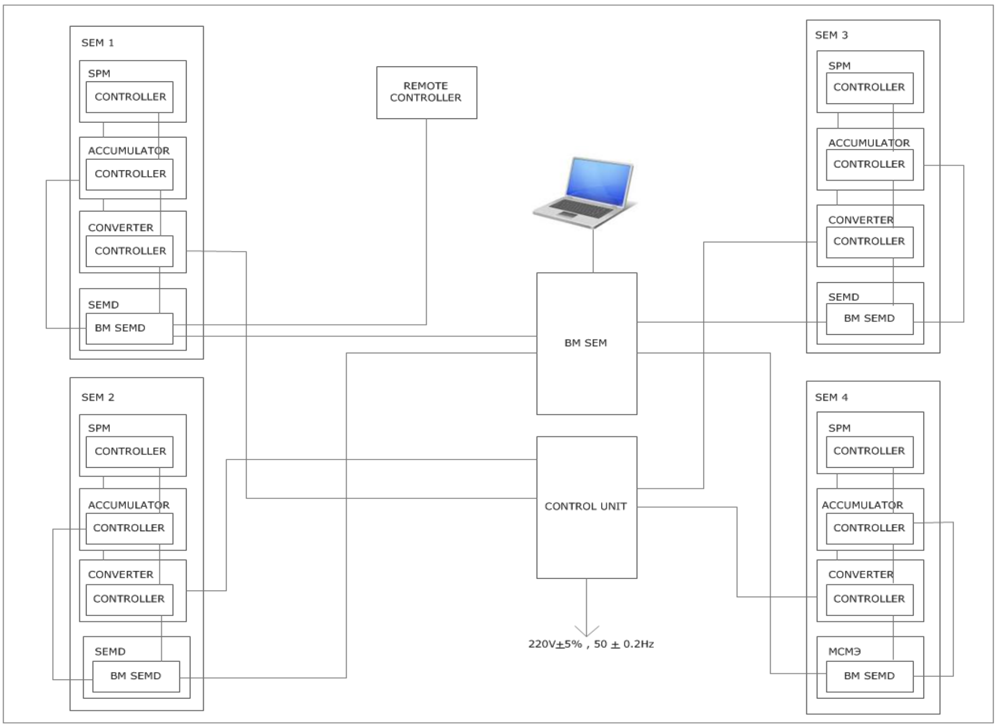


Figure 1. The Block Diagram for SEM (Solar Energy Module)

SEMD includes two main components: a mechatronic module with a sensor of elevation and a mechatronic module with a sensor of azimuth shown in figure 2. Both modules include an engine, a brake, an encoder and an engine controller that are controlled by a remote controller which controls the position of the solar panel in space.

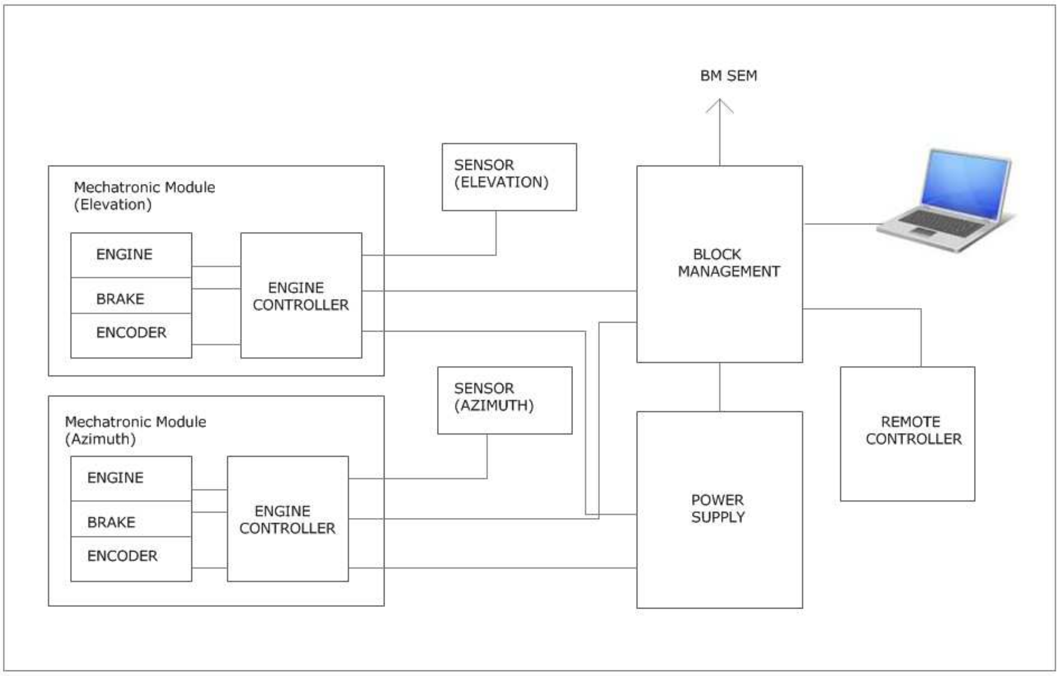
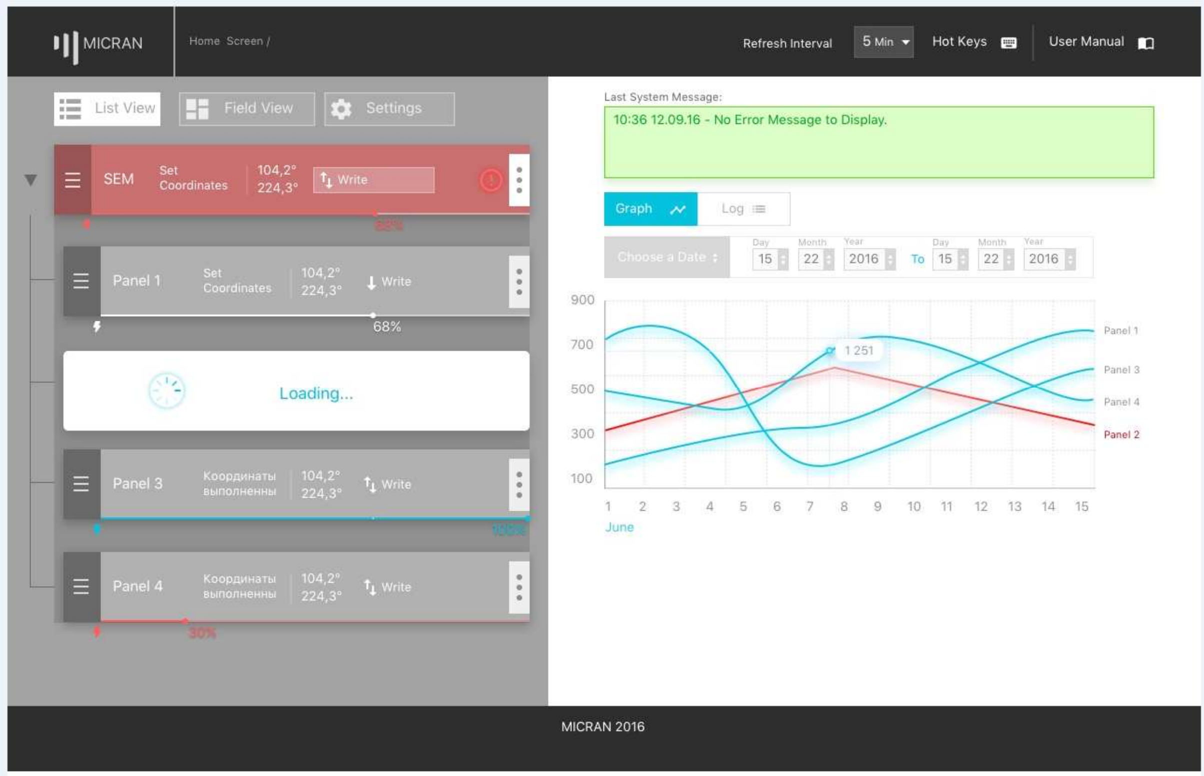


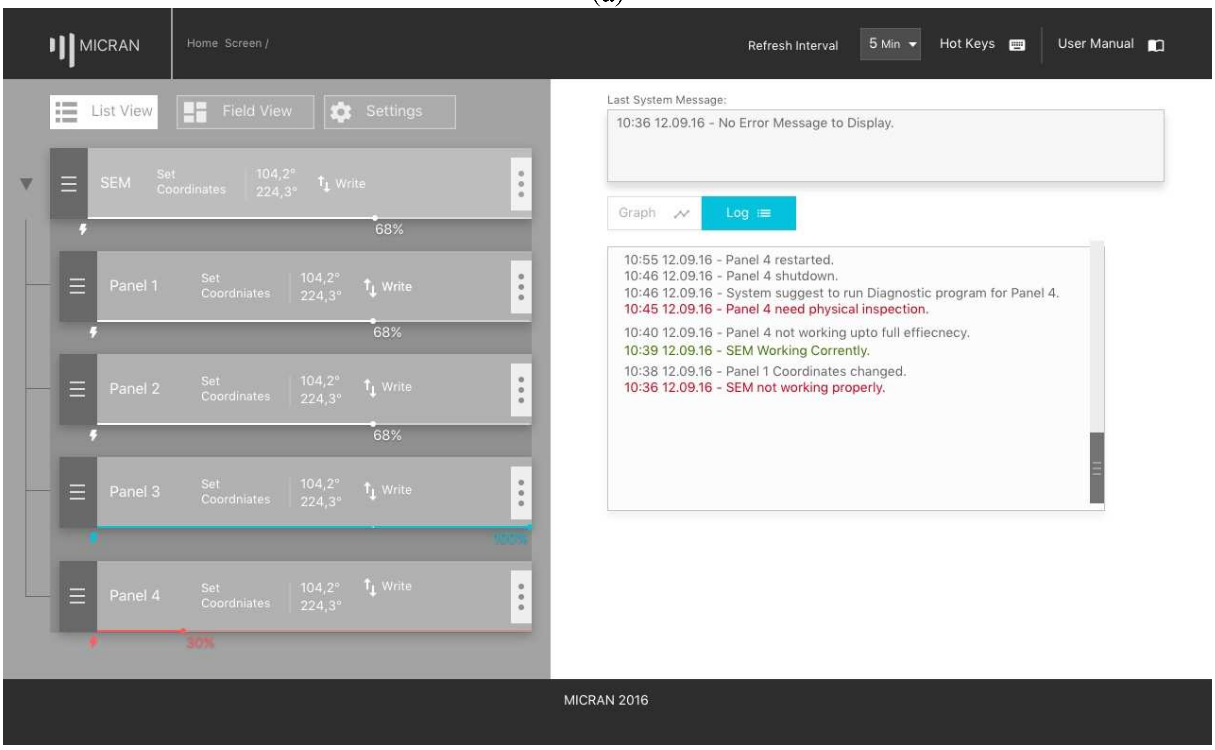
Figure 2. The Block Diagram for SEMD (Scalable Energy Efficient Mechantronic Device)

3. The Implemented Software System

The Implemented Software system successfully determines failure and errors occurred in the system, and suggest preventive measures for efficient working of the system. The software system displays the solar energy generated for a particular period of time along with performance of each panel. The generated data will be stored in block management that can be view anytime and anywhere. The stored data can be used for future research in the solar panel. The actual screenshots of the working software are given below**:**



(a)



(b)

Figure 3. The Home Screen of the Software System displaying the status of the panel and parameters of panels: a) Display Graphical representation of energe generated by Panels b) Log generated by the panel that is important in event of failure of the system. (Note: currently, the Software interface is implemented only in the Russian language)

4. Applications

The proposed Software system allows a specialist and an operator to monitor the performance of the system remotely at any time. The system allows specialists to control rotation and elevation of solar panels; it is necessary to get best out of the system. The system support user operations like shutdown, pause and restart of panels will help during maintenance of panels. The system display generated logs of system it important to determine exact reason of malfunctioning of the system during failure. The system allows users to monitor important variables of the system, such as the temperature of panels, the percentage of electricity generated, hours of operations of panels, and to display all data in charts and graphs for analyzing performance of the system.

5. Conclusion

The user of the automated intelligent monitoring system is capable of automatically identifying defects and monitoring parameters (temperature of panels, PV state, DC voltage and amperage, operating time etc.) that can certainly enhance the efficiency of the PV system and reduce maintenance costs. The system has an advantage in flexibility, in the case of complementing the plant with more panels, and also shows the collection of data for long periods of time without being interrupted by users. It can also be monitored remotely via the Internet through an embedded GSM module. With the collected data, more research on Solar PV can be done in the future.

6. Acknowledgments

The work was funded under contract №02.G25.31.0190 by the Ministry of Education and Science of the Russian Federation due date at 04.27.2016, performed in accordance with Government Resolution №218 dated 09.04.2010. The financial assistance of the university is also gratefully acknowledged.

References

[1] Bakos G C 2009 Distributed power generation : A case study of small scale PV power plant in Greece *Applied Energy* **86** 1757-1766
[2] Iacob M, Andreescu G D, and Muntean N 2009 SCADA System for a Central Heating and Power Plant *5th International Symposium on applied Computational Intelligence and Informatics* 159-164
[3] Chan F , Calleja H 2006 Realiability: A New Approach Design of Inverters for PV Systems *10th IEEE International Power Electronics Congress* 2006 498-506
[4] Hamoud, Chen G, Bradley R L 2003 Risk Assessment of Power Systems Performance Monitoring *IEEE Transactions on Instrumentation and Measurement* **2**
[5] Wang H, Hu S 2009 Energy Saving Analysis of Supervisory Control and Data Acquisition System Applied in District Heating *ICIEA* 3245-3247