International Journal of Recent Research and Review, Vol. XII, Issue 3, August 2019
ISSN 2277 – 8322

Solar Health Monitoring by Spider Monkey Optimization

[1]Vishesh Arya, [2]Neeraj Kumar Kumawat
[1]M.Tech Scholar,[2] Assistant Professor, Deptt. of EE, YIT, Jaipur, India

***Abstract* - Human dependency on electricity is increasing at a rate that we cannot even imagine our life without electricity. Consequently, Fossil fuel reserves are getting exhausted at a very fast pace. Therefore improving the power generation energy efficiency of renewable resources such as solar and wind energy is a prime research concern. In tropical and developing countries like India solar electricity is a promising solution to the electricity demand especially in rural and isolated areas. India is also located in solar belt region. The aim of our project is to present an Automated Health Monitoring model for PV (Photovoltaic) solar cells based on Spider Monkey Optimization (SMO) technique. Spider monkey is an evolutionary numerical optimization algorithm inspired from the fission fusion food search behavior of spider monkeys.. In our proposed model each array of PV cells is connected to individual Solar Monitoring Unit (SMU) and centralized data acquisition system. After installation automated health monitoring takes place by the centralized data acquisition system, which continuously collects data from individual Solar Monitoring Unit (SMU) via microcontrollers. The data acquisition system is further connected to a computer where SMO based data analysis takes place and health of each PV array is determined. If any discrepancies or abnormalities are noticed then the system flashed warnings to user to take appropriate action.**

***Keywords* - Spider Monkey Optimization, PV solar cells, Solar Monitoring.**

I. INTRODUCTION

India is developing at a very fast pace. Maximization of power generation is essential to sustain the immense growth in various sectors such as industry, urbanization, science and technology etc. As shown in Fig 1, the peak electricity demand is increasing rapidly and is expected to reach 437 GW by year 2027 [1]. Presently there exists about 300 GW of installed power generation capacity in India [2]. About 72% of India's power generation capacity is fulfilled by fossil fuel powered plants (Fig 1). Coal is most widely used fuel for electricity generation in India, followed by natural gas [2].Due to several constraints on domestic fuel supply severe shortage of electricity persists in India, especially during peak hours. This leads to power cuts and energy blackouts. The situation is worse in case of rural areas. The IEA estimated that only 74% of rural households have access to electricity as compared to 96% in urban areas [3]. The rural areas suffer from a frequently more interrupted power supply. It can be concluded that in order to establish a stable and self-independent electricity generation capacity exploration of renewable energy resources is crucial. India is the 7th largest country in the world spanning 328 million hectares and amply bestowed with renewable sources of energy. Due to the global warming, the intensifying climate challenge has made a lot of global disaster; thus the green energy is regarded the important issue in the future.

As an unexhausted clean energy, the development of solar energy is paid more attention by people. Because the translate rate of the sunlight to the electric power is more advance than before, many country have released the policy to promote the solar power. There are three main frameworks of solar power system. The first framework is the On-grid system that only generates power when the utility power grid is available. They can send excess generated power back to the grid. The second framework is the Off-grid system that allows you to store your solar power in batteries for use. The third framework is the Hybrid system. It provides power to offset the grid power whenever the sun is shining, and will even sends excess power to the grid for credit for later use. India lies in solar belt region & has maximum potential for development of solar energy based power generation

A solar photovoltaic array consists of number of sub-systems. Solar cell is the smallest part of a photovoltaic array, these solar cells are arranged together to make a solar PV module. Many solar PV modules form a solar panel. These solar panels are designed in an

arrangement known as solar PV Array. Solar Modules are connected in series and parallel depending on the desired voltage and current. The series connection of module provides the increase in voltage while the parallel connection provides the increase in current [5]. A study performed over a 2-year long period in several PV systems in the United Kingdom indicates that the annual energy losses caused by faults in those PV systems could reach 18.9% of the total capacity of the PV system [6]. Matam Manjunath [7] proposed an algorithm to minimize the tracing-time by performing a pre-defined and small number of perturbations without using specialized equipment. Ching-Chuan Wei and etal [8] developed a solar monitoring system based on Raspberry Pie. Mohd Nafis Akram *et.al* [9] developed a fault diagnostic system for solar panels. In [10], a wide literature review of recent advance on monitoring, diagnosis, and power forecasting for photovoltaic systems is presented in this paper.

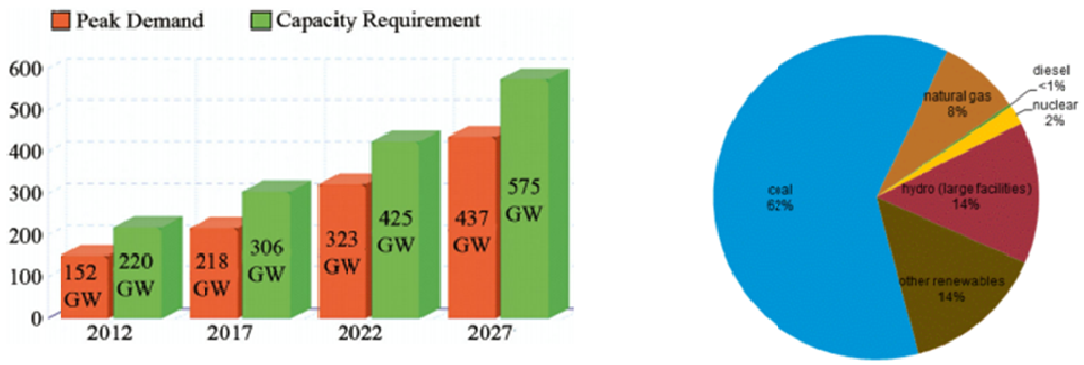

Fig. 1. Increasing Power consumption and used fossil fuels

II. RESEARCH METHODOLOGY

The aim of this research is to make a solar health monitoring system using spider monkey optimization algorithm.

2.1 System Model:

Fig.1 shows the block diagram of the proposed health monitoring system. In our proposed model each array of PV cells is connected to individual Solar Monitoring Unit (SMU) and centralized data acquisition system. After installation automated health monitoring takes place by the centralized data acquisition system, which continuously collects data from individual Solar Monitoring Unit (SMU) via microcontrollers. The data acquisition system is further connected to a computer where SMO based data analysis takes place and health of each PV array is determined. If any discrepancies

2.2 Software Analogy:

The propose system is modeled mathematically by computational software. MATLAB is used for modeling PV arrays as shown in Fig. 2. Simulation developed in PROTEUS ISIS provides mathematical model of Solar Health monitoring Units. More details can be found in sections given below.

2.2.1 Modelling PV Array in Simulink: Fig.3 shows the developed model of solar panel in simulink.

2.2.2 Modelling Solar Health Monitoring Unit in PROTEUS : Fig. 4 depicts the developed solar health monitoring system in PROTEUS. The model consists of four Arduino UNO microcontrollers that act as data acquisition system for individual PV array. The Arduino UNO microcontroller acquires data from four sensors that are attached to each PV array. The senors are two temperature sensors and two irradiance sensors (LDR sensors).The sensors are placed strategically such that one temperature and irradiance sensor measures the temperature and irradiance of panels and other pair measures the ambient conditions.

2.2.3 Modelling Central Data Monitoring unit in MATLAB GUI: The central data monitoring unit is modeled in MATLAB in form of the graphical user interface. The central data unit maintains

communication with Solar Health Monitoring Unit (Proteus ISIS) and also checks the power produced by PV panels. In this unit spider monkey optimization (SMO) algorithm is deployed .In the Spider monkey optimization algorithm the objective function is the sum of power produced by the PV module which is the sum of power produced by each PV array. SMO is a nature inspired algorithm which is based on foraging behavior of spider monkeys. The pseudo code of algorithm is mentioned in Fig. 4.

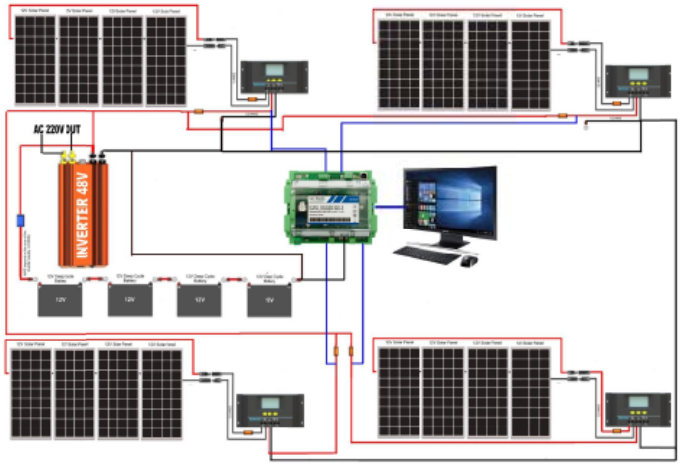

Fig. 2. Proposed System Model

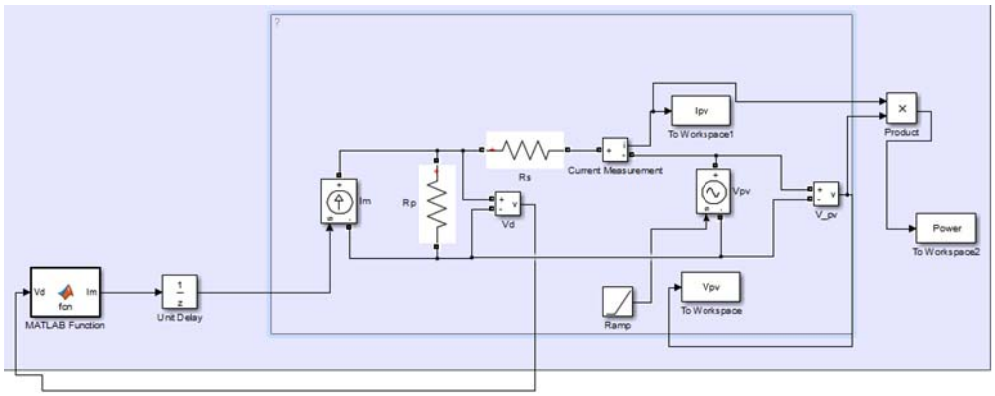

Fig. 3. Developed model of solar array in MATLAB Simulink

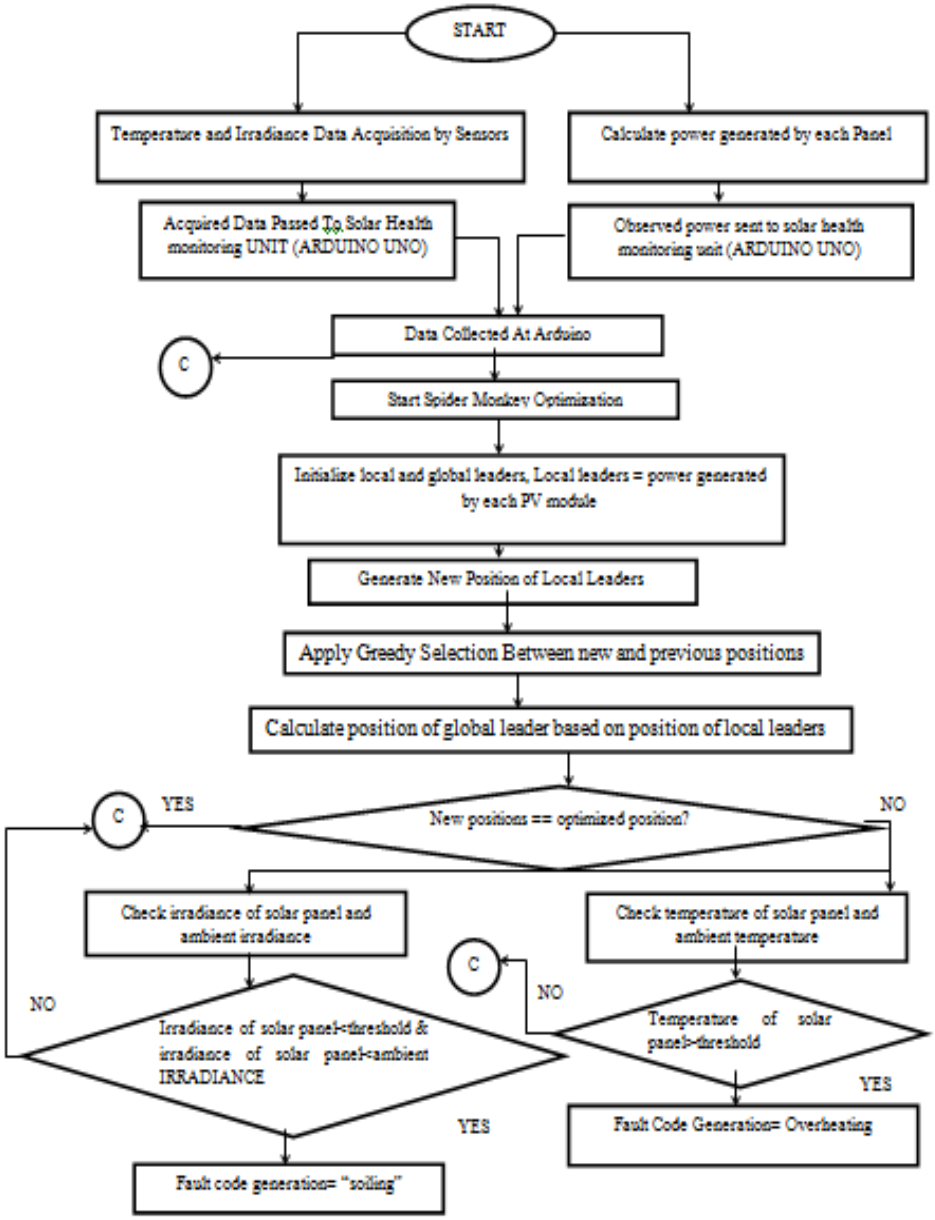

Fig. 4. Process flow of proposed algorithm

III. RESULTS AND DISCUSSION

Fig. 5 shows the simulation model of four PV arrays in Simulink. Fig. 5 shows the developed health monitoring system in Proteus ISIS. Fig.6 shows the central data acquisition system developed in MATLAB. Fig. 7 shows the working of system in real time. The temperature and irradiance values are provided in PROTEUS simulation and according to these values the central data unit applies SMO and check for fault and notifies the user.

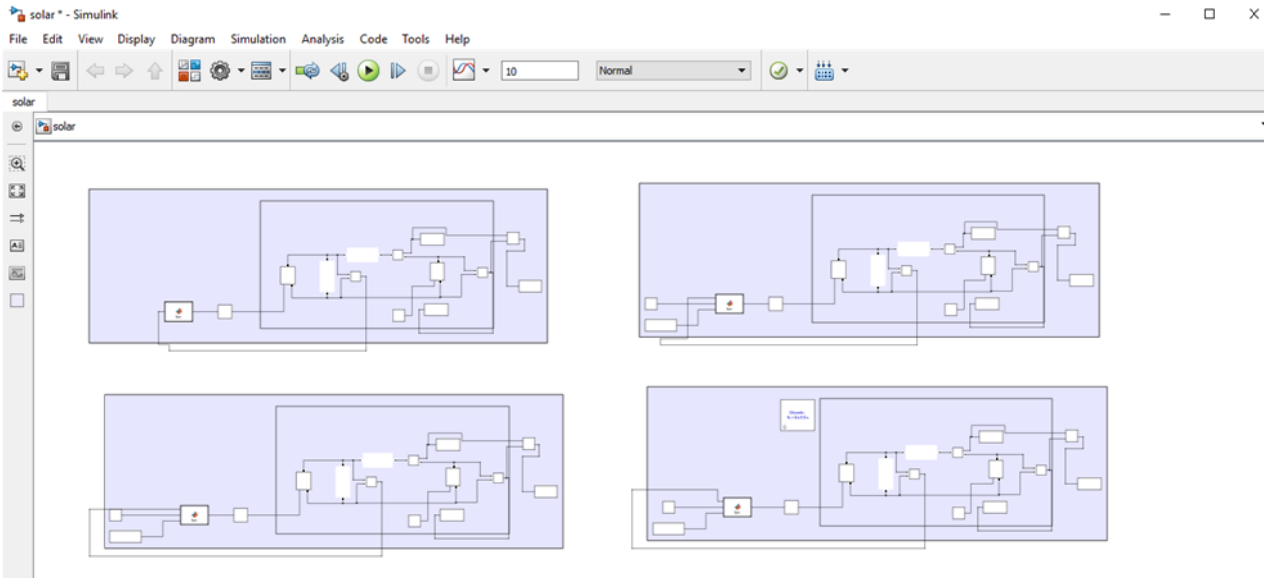

Fig. 5. Solar module consisting of four PV arrays

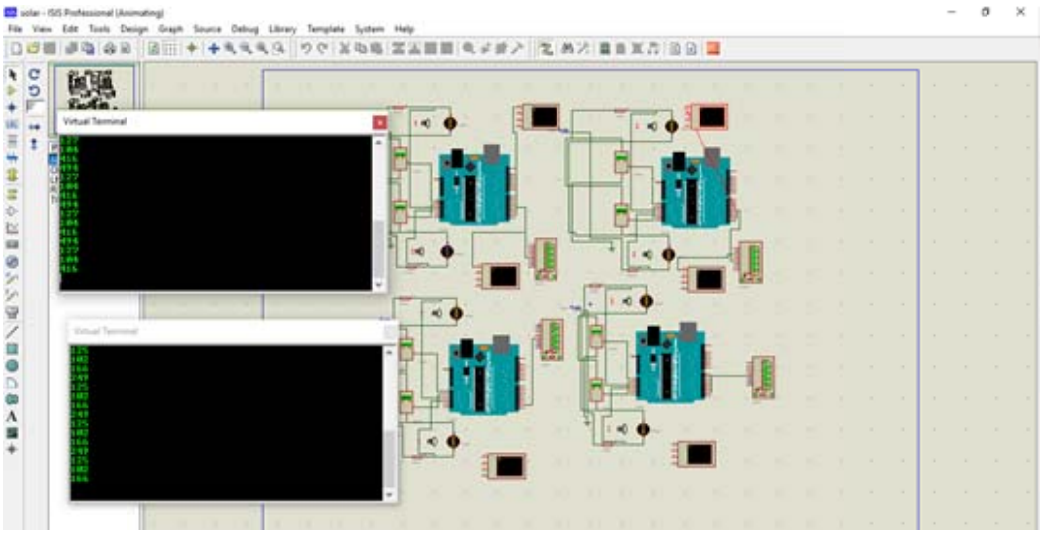

Fig. 6. Solar Health Monitoring unit

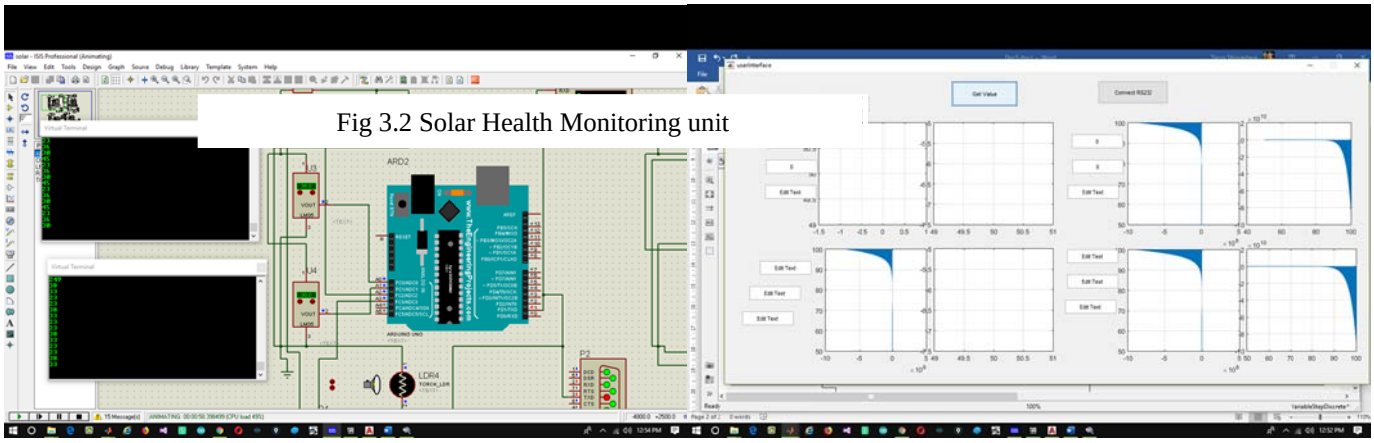

Fig 3.2 Solar Health Monitoring unit

Fig. 7. Real time implementation

IV. CONCLUSION

The developed automatic solar health monitoring unit is deployed in real time. The system is capable of identifying faults related to temperature and irradiance. The system is also able to distinguish between environmental changes and actual fault to prevent false alarms.

V. REFERENCES

[1] S. Kumar, B. Bhattacharyya, V. K. Gupta, “Present and Future Energy Scenario in India”, J. Inst. Eng. India Ser. B, Springer, 2014.

[2] Country Analysis Brief: India, U.S. Energy Information Administration, 2016.

[3] https://www.iea.org/publications/freepublications/publication/2013_AnnualReport.pdf

[4] Héctor Ulloa-Godinez, H & García Guadalupe, Mario & Ramirez-Sanchez, Hermes & Jorge Regla-Carrillo, C & Fajardo-Montiel, Aida, Solar Radiation Data for the State of Jalisco and Guadalajara Metropolitan Zone, Mexico;Computational Water, Energy, and Environmental Engineering, Vol. 6, pp. 205-228. 10.4236/cweee.2017.63015.

[5] Jager, K., Isabella, O., Smets, A.H.M., et al., “Solar Energy: Fundamentals, Technology and Systems”, 1st Version, Delft University of Technology, Netherland, Typeset in DejaVu Sans Condensed and URW Palatino, pp. 219-254, 2014.

[6] S. K. Firth, K. J. Lomas, and S. J. Rees, “A simple model of PV system performance and its use in fault detection,” Solar energy, vol. 84, no. 4, pp. 624–635, Jan. 2010.

[7] Matam Manjunath ; B. Venugopal Reddy ; Y. Zhao ; Brad Lehman , “On-line health monitoring of PV plants”, IEEE, 2017.

[8] Ching-ChuanWei ; Chi-Han Yu ; Lawrence Chiang ; Hei-Ming Gong ; Yung-Fa Huang, “Implementation of an Integrated Mobile Solar Power Monitoring System for Images and Battery Parameters”, IEEE, 2016.

[9] Mohd Nafis Akram, Saeed Lotfi fard, “Modeling and Health Monitoring of DC Side of Photovoltaic Array”, IEEE Transactions on Sustainable Energy, Vol. 6 , Issue: 4 , Oct. 2015

[10] S. Daliento, A. Chouder, P. Guerriero, A. Massi Pavan, A. Mellit, R. Moeini, and P. Tricoli, “Monitoring, Diagnosis, and Power Forecasting for Photovoltaic Fields: A Review ”, International Journal of Photo energy, article ID 1356851, 2017