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A Novel Method for Solar Energy Harvesting Method Based On Optimization

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Abstract: ***Renewable power production can help countries to meet their sustainable development goals through the provision of access to clean, reliable, secure, and affordable energy. A number of wind, hydropower and solar photovoltaic capacity power projects were installed worldwide every year in a renewable energy market having capacity more than a hundred billion USD annually. In recent years, an impressive reduction is being seen in renewable energy Portability improvement of technological devices has not been followed by energy accessibility of its batteries. Taking into account the low power consumption parameter of a variety of portable devices, the concept of energy harvesting from environmental sources and the human body has gained a new significance. In the search of methods and materials that go with this need, are the energy generated methods from the piezoelectricity, thermoelectricity, and electromagnetism. This research gives the ways and future trend of energy harvesting methods, as well as its mechanisms in portable medical devices with low power consumption. In this research, we will focus on energy harvesting. Total illumination is calculated against the total time of harvesting. The experiment has been carried out in an environment which contains some consuming units with a total number of rooms. The width and height of the room are considered to be identical i.e. 100×100 having harvesting time of 10 hr. There are three environments in which experiment has been done these are***

- ***Sunny***
- ***Cloudy***
- ***Dark and another type.***

Total illumination is calculated with and without optimization. ABC (Artificial Bee colony) algorithm is used for the optimization and the results obtained are compared with the without optimization results.

Keywords: Energy harvesting, Irradiant, Illumination, Artificial Bee Colony.

I. INTRODUCTION

Energy harvesting is a process of electronically bagging and gathering energy from different energy sources which are said to be unusable for any practical purpose. Different examples of target energy harvesting sources contain mechanical energy which is the result of vibration, stress and strain, thermal energy from combustion engines and other heating sources, wind and fluid flow energy resulting from the wind and liquid flow, energy from light emissions, chemical energy from biological occurring phenomena.

As shown in Fig. 1.1, the classic energy harvester system contains energy generator, capture, storage, management electronics that are all to be powered by the harvester. In the diagram, a piezoelectric crystal membrane is referred to as energy generator. This generator transforms mechanical vibrations, strains or stress into electric current. There are different mechanical strains which come from different motions of human, bridge, vibrations, aircraft, noises, vessel vibrations. Many of the piezoelectric sources generate very high voltages but the current is very less so they are too small for most system applications. From PZT, AC energy is put as input into the detector which converts the voltage to DC after which the capture and storage operation is initialized. The detector takes current as input in the form of a stream of pulses in the range of 200nA to 400mA. As the energy is injected into the detector electronics by the energy generating source, the electrical charge impulses are collected, gathered and stored in an internal storage capacitor. The capture mechanism operates between two supply voltage thresholds i.e. Minimum and maximum supply voltage values. When VH is achieved, termination of charging is done; the output can be changed to “On-Demand” to power the load.

Energy harvester/energy generator contains one or two transducers, power conditioning, and storage of energy. These all elements work together for a collection of energy and to deliver power to the end device. Moreover, the energy consuming device should be adaptable to the energy generating device or energy harvesting source.

Piezoelectric Effect is a capability of some material to create an electric charge when mechanical stress is applied to it. It mainly converts mechanical energy into electric current and production of power is in the form of mW. The main part through which this effect can be generated is a human notion, Acoustic Noise, Vibrations, pressure etc. When this whole procedure of production of electric charge occurs, the mechanical deformation occurs. This effect mainly occurs in crystals as they have no center of symmetry.

Pyroelectric Effect is the capability of a material to produce a temporary voltage when heated or cooled. A material generates the pyroelectric effect when the temperature is applied with respect to time and the output is an electric charge. Produced current ip (t) in the process is proportional to the rate of change of its temperature.

$$ip\,(t) = p1A\,\frac{dT(t)}{dt}, \qquad [1]$$

In the equation 1, the p1 is the factor of the pyroelectric coefficient with vector p. Here T(t) signifies the temperature with respect to time.

Biomass [3] refers to the "organic matter" that stores the energy by means of the photosynthesis process. It exists in the form of plants and migrated to animals bodies with their waste through the process of the food chain.

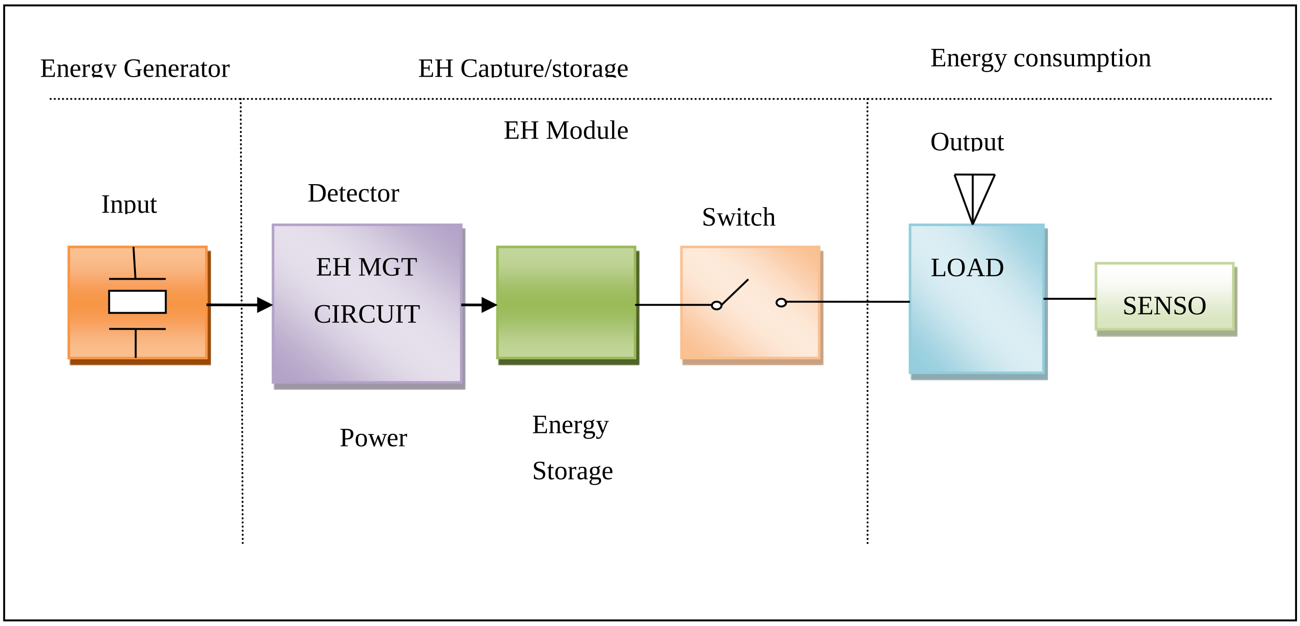

Fig. 1: Energy Harvesting

Solar Energy is a renewable energy source distinct to non-renewable energy sources like fossil fuels [2]. The technologies of solar energy mainly use sun's energy for generating hot water, light homes, heat homes plus electricity.

RF radiation is the radiation employed to power ID by guiding high power electromagnetic energy to the devices from the incoming source. The information needs to be sent with energy. This all starts with rectifying of the antenna and build up with Schottky diode which is situated between dipoles of the antenna. The energy level is very low that it cannot be used for everyday life for electronic devices.

The photovoltaic (PV) system [1] can supply the electric energy to provide load by converting solar energy by photovoltaic effect and its structure is very flexible. The PV modules are taken as the main building blocks that can be arranged in arrays for increasing the production of electric energy.

PV effect is the main physical process by which a PV converts the sunlight into the electricity. Sunlight consists of energy accumulations, photons, and solar energy particles.

With regard to electric distribution by photovoltaic, the main significant task is in the phase of establishing essential data which is the estimation of the electricity necessary for distribution. Electrical distribution has integrated solutions as per the loads [7]. One of the necessary elements in the load distribution system planning is the location of the load. For the load distribution of the photovoltaic system, the types of loads are the main factors by means of electricity power.

Kinetic energy needs a transduction mechanism to generate electrical energy from the movements and from the mechanical systems that pair the environment movement to the transduction machine. The design should be as to maximize the coupling between the kinetic energy source and transduction machine, as a whole process that depends upon the environment motion or movement.

Thermal energy is the internal energy which exists in the system due to its changing temperature or constant high temperature. The internal energy can be changed even if the temperature does not change.

A. Load balancing

It is frequently automated to implement the failover, the continuance of a service if any part gets affected. The components are observed regularly and if any of the components is in responsive than the load balancer is up and will not send traffic to it. This can be an inherent feature from grid-based computing. The concept serves low cost and also puts less stress on the circuits of each source design for more energy and works efficiently.

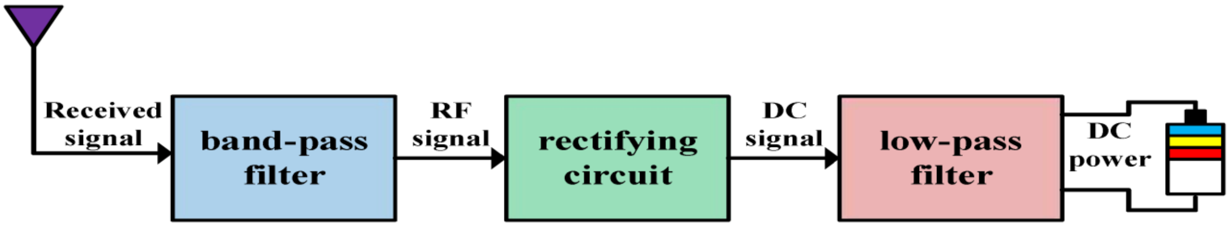

Fig.2: Load Balancing

Biomass is considered as a useful resource of energy. Energy wastage is one of the very serious issues in the modern world. In day to day life, people often forget to switch off lights and fans even air conditioners. Few steps have been taken in this direction like automated refrigerators which can adjust the temperature of the appliances as per the content kept.

This leads to huge amount of energy wastage. In the existing work, storage of energy, time to maintenance of time is considered as a major issue in energy harvesting techniques. Therefore, a system is required that can maintain the harvesting technique itself using optimization. Previously, the small amount of energy was not stored; therefore, by using the optimization technique, the energy can be the store.

The problem of this research work is to generate an automated system for energy harvesting using Artificial Bee Colony.

II. A GLANCE OF EXISTING TECHNIQUES

J. M. Belman-Flores et al has proposed a hybrid system for the present and growing global interest in energy resources search for energy resources for decreasing fossil fuels usage for generation of power. The systems are coupled to conventional as well as non-conventional sources. A survey of hybridization of energy systems for photovoltaic solar energy is presented. It has been observed that the varied incentives, policies, and conditions are established by the Mexican government for the energy sector and renewable sources are projected for the constructive outlook for hybrid system implementation. Peter D. Lund et al has reviewed varied approaches, strategies, and technologies for managing the large-scale schemes of different renewable electricity like wind and solar power. Demand and supply sides are considered as the measures. The importance of renewable electricity is discussed with the addition of presenting the energy system flexibility measure that ranges from traditional ones like grid extension and pumped hydro storage for more advanced strategies like demand side linked and management approaches. More of the energy system flexibility could be handled by power system and energy system. Haslenda Hashim et al has discussed an IBS model and explanation for self-sufficient eco-village electricity with plus without load shifting (LS). Energy storage (ES) is included for reducing the demand for electricity during exact periods and smooth variations into a generation of power by solar power variable generation. LS is utilized for increasing the demand when the high supply period and load intervals shifting for low demands takes place. Reduction of ES size is recorded with high competitive electricity prices. The work has also shown the competitive high prices of electricity with the economic growth and environmental protection by improvement of energy efficiency and low-carbon technologies deployment. Tara M. Jackson et al has used PV (Photovoltaic) system for storage of battery energy by distribution network that is necessary for allowing regular uptake of domestic Photovoltaic system installation. The incorporated renewable energy sources into power networks across the world are the key for sustainable future when the concerns for the environment and climate change occur. GridLAB-D as a simulator tool with typical SEQ (South East Queensland) model 11 kV distribution feeders is used. PV and storage combination is more effective for mitigating the issues discussed. Cottone has reviewed the concept of energy harvesting and its techniques. The energy harvesting technique for wireless sensor networks and its vast applications are discussed. Discussion of benefits of energy harvesting and the power needs for the different type of devices from vast ambient sources are discussed. Working on vibration energy harvesting and its principles are briefly explained. After that, the piezoelectric conversion is explained which are done through the piezoelectric material with a different set of examples are discussed. Xie, J, has discussed the pyroelectric materials such as PZT-5A and thin films for energy harvesting. Model is used to forecast the power to be generated based on measured temperatures of material with respect to time. The peak power density measured is of 0.23 µWcm-2 for 15 ºCs-1 temperature rate. A thin-film with high pyroelectric coefficient gives three times more magnitude improvement using the proposed model. Rani, reviewed the different energy sources as biomass, solar energy, and biogas, a combination of heat and distributed power generation systems and demand-side management using PV generation. The effort delivers a renewable technology and new approach with the use of biogas, solar energy, and biomass as a source of plant based power generation. This whole process is for producing electricity from the environment sources or green technology. Abbood, concentrated on the applications of Demand side management using PV generation, Load shifting, and peak clipping methods that are used to supply powers by means of PV system for each consumer of the residential sector. In summers, the panels are slanted by an angle of 10^0 and for winters tilt angle is48^0. Mainly annual demand is increased in summer.

III. SIMULATION MODEL

In this research, the existing concept of energy harvesting is analyzed. The proposed energy harvesting system, ABC (Artificial Bee Colony) algorithm is applied for the optimization. The performance of the proposed work, parameters, namely, Illumination and irradiance are evaluated.

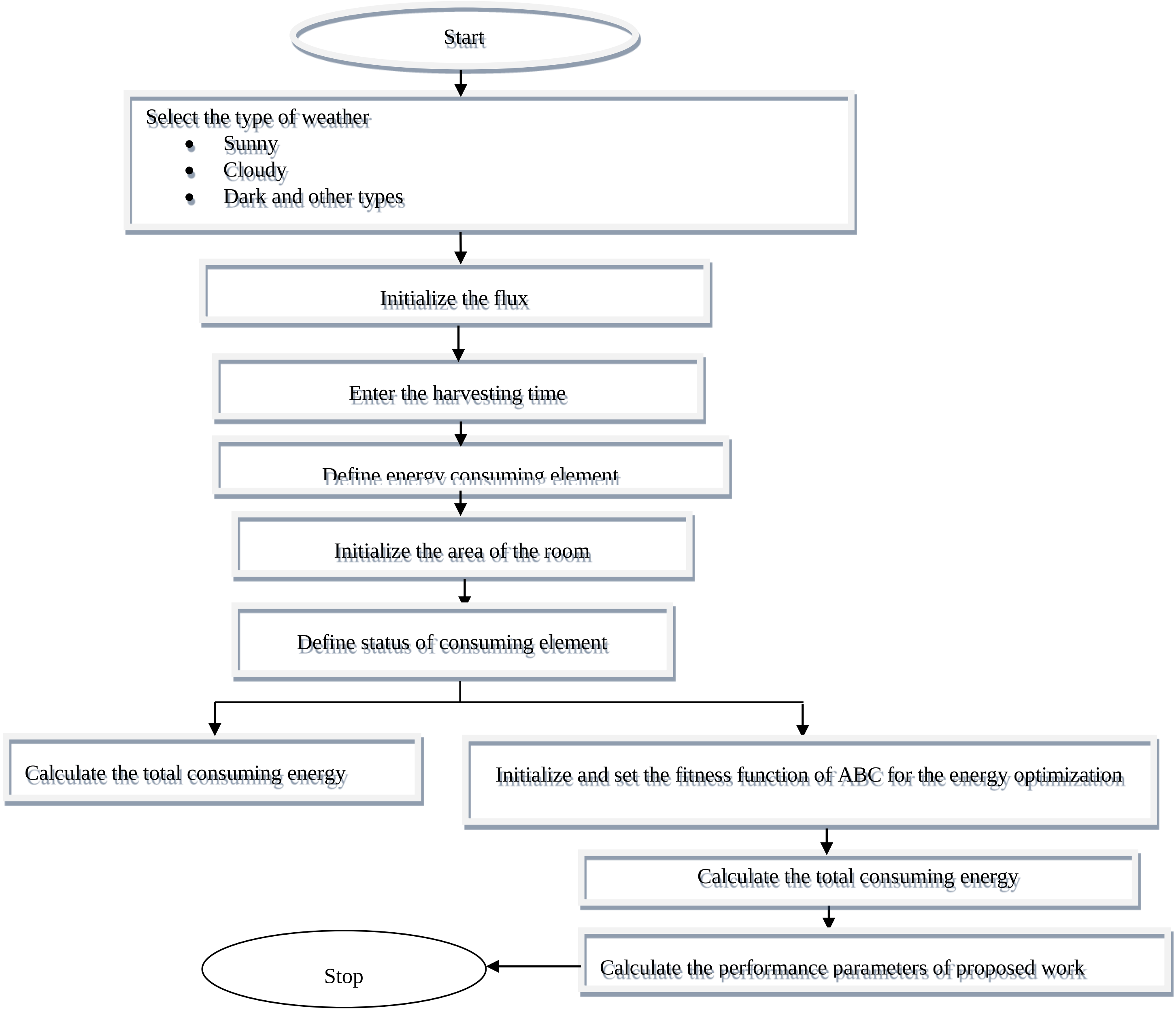

Fig.3: Simulation Model

Following are the steps that have been carried out for the proposed work:

Step I. Creation of an environment which contains some consuming units with a total number of rooms.

Step II. The width and height of the room have been assumed to be identical.

Step III. There are three types of the environment which have been assumed to be present.

- Sunny
- Cloudy
- Other types

Step IV. Initial flux being generated and is taken to be 13000.

Step V. Flux distribution is completed on the type of whether being chosen

Step VI. To optimize the energy, ABC (Artificial Bee Colony) algorithm is used and the fitness function of the optimisation algorithm is being set.

Step VII. To check the performance of the proposed work, the parameters of energy harvesting model are calculated.

IV. SIMULATION RESULTS

This section describes simulation results obtained after the implementation of the proposed work.

TABLE I
RESULT SIMULATIONS

Time of harvesting	**10 Hr**
Area of room	100×100
Simulation Tool	MATLAB
Authentication Parameter	Energy Consumption
Evaluation Parameter	Illumination in flux and Irradiant

Above table is showing the time for harvesting taken as 10 hours, the area of the room is 100*100, the authentication parameter is energy consumption. Illumination flux and Irradiant are taken as the parameters for evaluating the simulation work.

A. Results of Sunny Weather

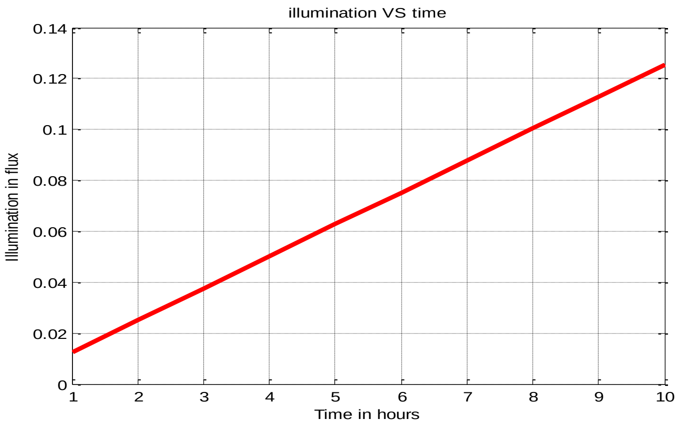

Fig. 4: Illumination vs time graph for sunny weather

The above figure Depicts that with the increase of time, illumination is also increasing for sunny weather. The graph obtained for the same is linear. The average value obtained for illumination is .07 flux.

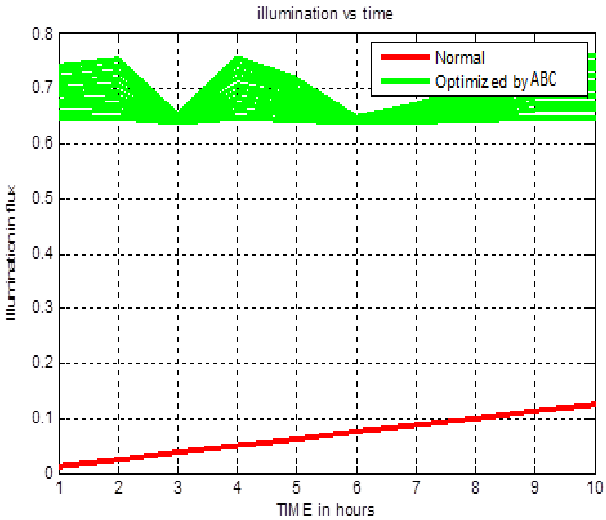

Fig.5: Comparison graph for sunny weather

The above graph represents the comparison between illumination in flux and time in hours. In the above Fig., the red line indicates the illumination obtained without optimization whereas, the green part of the graph is obtained when optimization of the proposed work is executed by ABC algorithm. It is clear from the graph that for sunny weather value of illumination is more than without optimization.

B. Results For Cloudy Weather

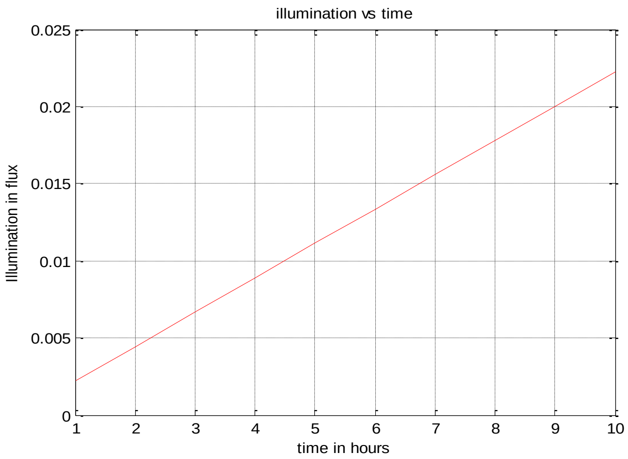

Fig.6: Illumination vs time graph for cloudy weather

The above graph represents that with the increase of time, the illumination flux is also increasing and the graph obtained for the cloudy day is linear. The average value obtained for illumination is .012 which is less than the value obtained for sunny weather. This is because; in a sunny day the intensity of light is more than the cloudy days.

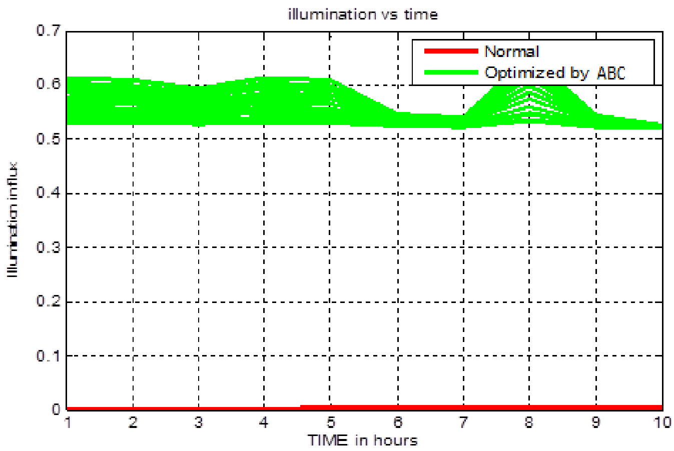

Fig.7: Comparison graph for cloudy weather

Above Fig. shows that without optimization, poor results has obtained as shown by red line. Whereas, with optimization i.e. when ABC is used, energy harvesting is more which as shown by green lines. The approximate average value obtained from the above graph with and without optimization are .585 flux and .001flux respectively.

C. Results For Dark Or Other Type Of Weather

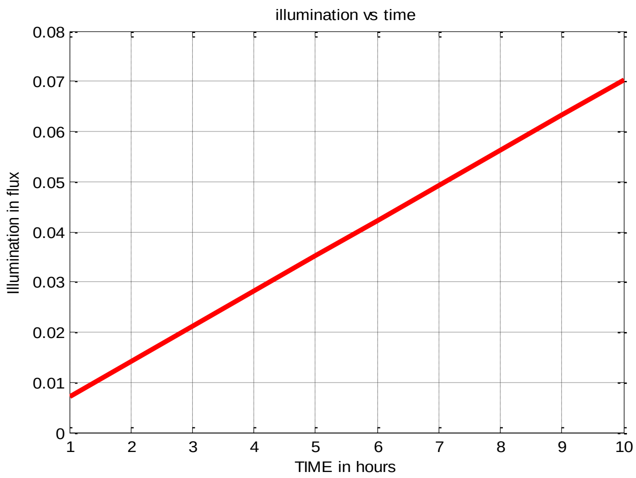

Fig. 8: Illumination vs time graph for dark and other type of weather

The graph obtained for dark and other type of weather is linear having average value approximately equal to .035 flux. The value obtained for these weathers lies between the value of illumination obtained for sunny and cloudy weather.

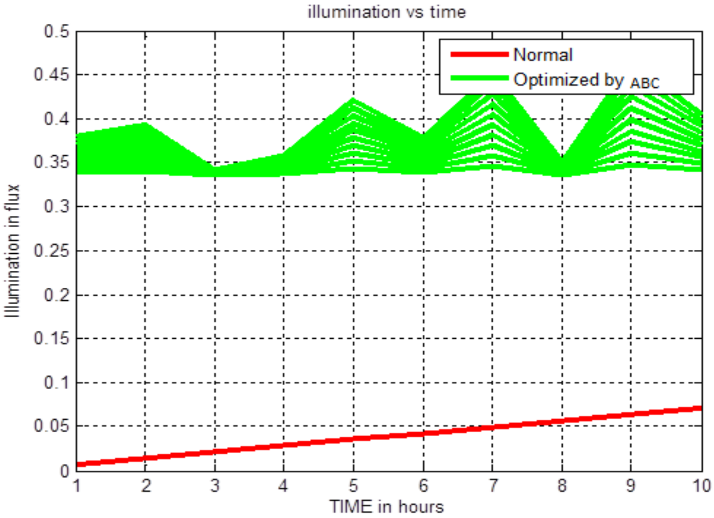

Fig.9: Comparison graph for dark and another type of weather

In the above figure, poor results are obtained when the optimization is not used. Whereas, with optimization i.e. when ABC is used energy harvesting is more which is shown by green lines. The approximate average value obtained from the above graph with and without optimization are .395 flux and .035 flux respectively. When these values are compared with the graph obtained for sunny and cloudy weather, it is concluded that the value obtained from the above graph lies between the values obtained from these two kinds of weather.

CONCLUSION

This study provides a validation for the need to modify current solar energy performance models to better estimate the influence of snow on solar panels for installation in climates where snowfall is common. As we know that Energy harvesting is the process by which the energy is derived from outside sources like solar power, thermal power, wind power, hydro power etc. and storing these energies for a period of time and process them so that they can be used later. Energy harvesting holds great promise for both low-voltage and low-power applications in a large range of portable or mobile markets like medical equipment, consumer devices, transportation, industrial controls, and military. The aim of the research work is to harvest energy. ABC algorithm is applied as a forecasting model to measure the total illumination against the total time of harvesting. The total time of harvesting taken in the proposed work is 10 hr. whereas the size of the room is 100×100 and the initial flux generated is 13000. The total energy harvesting has been observed for three type of environment namely: Sunny, Cloudy, for the dark and another type of weather. From the experiment, it is concluded that the illumination obtained for sunny weather is higher than the cloudy weather.Whereas the illumination obtained for the dark and another type of weather lies between sunny and cloudy weather, Illumination value obtained for sunny weather, cloudy weather, dark and another type of weathers are .07 fluxes, .012 fluxes, and .035 fluxes respectively. Also, the total energy harvesting obtained for all these three environments has been shown in the form of graph and it is concluded that in sunny weather energy harvesting is higher than the cloudy weather whereas, for dark and another type of weather energy harvesting obtained lies in between these two kinds of weather.72 illumination influx has been harvested for sunny weather. Whereas, for cloudy weather, .585 illuminations influx has been harvested for the dark and another type of weather, .395 illuminations influx has been harvested. Also, irradiance has been determined during fuzzy logic and the value of irradiance obtained is .132 for the inputs of -4.73 of employ bee and 20 of onlooker bee.

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