Energy Storage Enhancement in Solar Panel

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Abstract—People are in deep concern regarding energy production due to limited natural coal, gas and oil reserve. With respect to this problem, solar energy system appear as the boon to the underdeveloped countries. Maximum use of solar for energy conversion is now a big challenge. Price of the solar panel is another important issue for the poor countries. Considering both issues, we have proposed a solution that use minimum number of solar panel to produce maximum level of energy moving the panel on the line of sight of the sun. The total system will run on its own power produced by solar system. Where a normal solar panel is kept always fixed towards a single position of the Sun, the proposed solution is allowing our solar panel to move at a fixed period of time to align with the position of the Sun. Thats why, the solar panel can absorb more power than the static one.

Keywords—Stepper motor; solar panel; Pic-Microcontroller; storage;

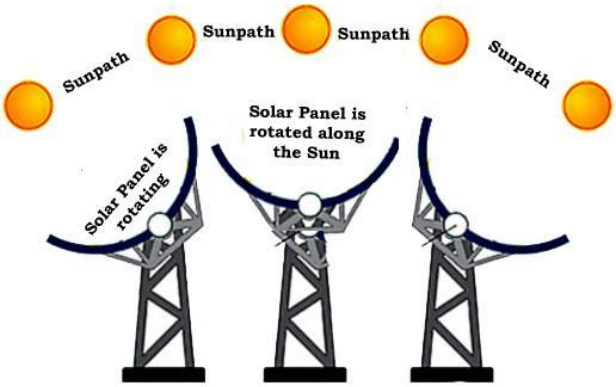

Fig. 1. The solar panel is rotating with respect to the Sun position.

I. Introduction

Like under developed countries, we cannot reach electricity to the entire citizen of Bangladesh. This is due to not only money but also geographical position of different location. Many lands are isolated by paved river from main Upazila, small administrative region. Again, most of the villages are out of motor communication. So, electricity pole cannot be set up in this area due to transportation. The mobile phones as well as network coverage are not active here for electricity missing. People in the coastal area are in vulnerable situation since they are not able to get the short message when natural calamity is worsened.

Electric line establishment makes huge cost for the Government in power distribution. Getting late response from the Power Development Board (PDB), people are buying solar panels [1] and battery with more money in Bangladesh. Different types of solar panel are with various prices. We can reduce the number of solar panel usage by providing more Sun light on the panel removing static position. If we can rotate the panel dynamically with the Sun position, we can store more energy using limited number of solar system. The intelligent solar panel saves more power than a static solar panel. It uses stepper motor to rotate at different angle at distinct time to face at the Sun [7]. In the beginning of the day the solar panel starts to move from one direction to another. The Sun beams hit the solar panel most of the day when the rays fall directly. Getting the ray directly, the panel generates power form the sunlight and charges the battery. The solar panel is mounted on a stepper motor that always rotate on regular duration. Moving the panel, the motor allows us to receive maximum light and heat from the environment.

The collections of photovoltaic cells are used in solar panel. This photovoltaic component can generate and supply elec-tricity in commercial and residential applications. In general, available solar panels are fixed on the roof in a static way. But, the position of the Sun is transitory with time. So, the amount of sufficient light on the panel is different in the day time. Since the electricity production is directly proportional to light and heat transmitted by the Sun, we must align our solar panel towards this natural light source during full day long.

The main goal of the paper is to rotate the direction of the solar panel aligning towards the Sun position efficiently. Here we have developed an embedded system that is used to operate the motor having the intelligence inside the system. Controlling the solar panel on a stepper motor is facing several challenges. The main challenges of the project are illustrated in the following.

1) Operating heavy weight solar panel using mechanical arrangement.
2) Time synchronization with solar system.
3) Run the solar system and motor operation form its pro-duced power.
4) Power distribution for storing and running the stepper motor.
5) Efficiently running the system in different environmental conditions.

II. Problem Statement

People use solar panel to enlighten their home, office and institutions. The price of the panel is not parallel to our

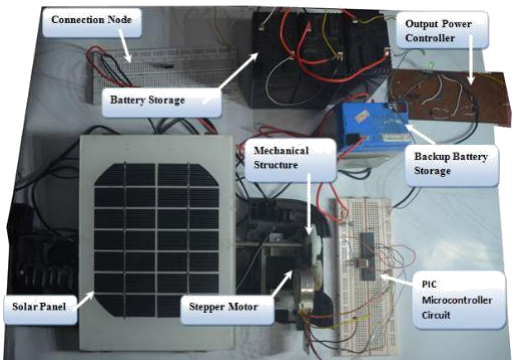

Fig. 2. Solar panel, embedded system and stepper motor connection.

general unit price of Government electricity. Since the central electricity line has not reached to the remote area, people are compelling to buy solar system to get the amenities by electricity. We can reduce the price for solar panel if it is possible to get the same power using minimum number of solar panel.

The main problems are behind the current installation system of solar system. From morning to mid-day, the panel receives similar amount of light and produce electricity from it when it is fixed. Afterwards, the position of the Sun is not aligned with the fixed panel. In this case, if the panel is rotated with the position of Sun then the adequate amount of light would be received. In addition, the axis of the panel needs to be changed due to perfect position. In this paper we have considered the rotation of the solar panel on dual axes [6]. Now it is working on single axis.

To rotate the panel we need an electrical circuit as well as the arrangement of equipments. The gear system for motor rotation is very much limited in our country. Along with hardware unavailability, circuit design and the development is another major issue here, especially in our coastal area of Bangladesh. But the maximum numbers of solar panel are used in the coastal area of Bangladesh. We know that the fisher men need to charge their mobile phone, rechargeable battery using electricity before sailing in deep river or the sea. They can get the mobile message or tune their transistor using rechargeable battery if the weather is going abnormal on sail. In addition, the education system, health clinic, hospitals operation theater, social festival, emergency message are also benefited by the electricity from solar system in the unreached location.

It is not only costly but also unmanageable on error if we import the circuit and complete system from foreign countries. So, it makes another burden for our poor people. For this reason, we have designed and developed the system that rotates the solar panel. The system is designed in such a way that we can get the solution with minimum cost. Again, the system is compatible for general users. So, people can use it in their home, clinic, office, different kinds of shops etc. We can also use it to drive electrical instruments that are operated on low power consumption.

A. Related Works

Solar tracker [5] is an example of related work done by Bill Lane, Department of Electrical and Computer Engineering,

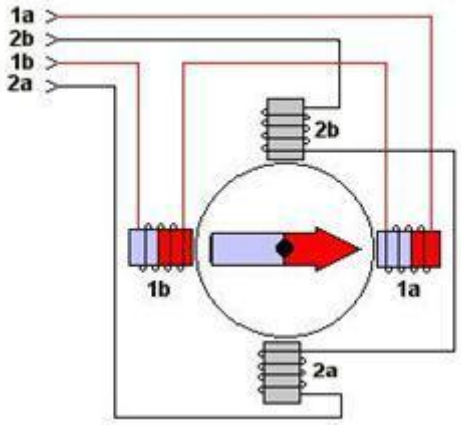

Fig. 3. Bipolar steeper motor.

Cleveland State University. This project is included the design and construction of a microcontroller-based solar panel track-ing system. Solar tracking allows more energy to be produced because the solar array is able to remain aligned to the sun. In this project Bill Lane used light sensor, stepper motor and PIC16F877. Light sensor is used here to sense the sun position. This work attempts to achieve control and velocity tracking for the motor step using optimization techniques. The performance of Dual-Axis Solar Tracker (DAST) and Static Solar System
(SSS) with respect to clearness index in Malaysia is presented in [8]. In the paper [9], the author has presented the design of a mechanism that able to accurately follow the sun motion minimizing the energy consumption during its operation.

III. METHODOLOGY

To accomplish the system we have arranged the equipments related to this project shown in Figure 4. The tools needed to complete the project are listed below:

1) PIC Micro Controller Board
2) MpLabIDE for Pic Microcontroller Programming
3) Programming Language (C)
4) Stepper Motor (Bipolar)
5) Driver IC ULN2003
6) Batteries
7) Voltage guard circuit

A. PIC Micro Controller Board

For embedded system design, PIC1650 microcontroller board is one of the popular technologies. PIC is initially re-ferred as ”Peripheral Interface Controller”. PIC microcontroller board popular with both industrial developers and hobbyists alike due to their low cost, wide availability, large user base, extensive collection of application notes, availability of low cost or free development tools, and serial programming (and re-programming with flash memory) capability. We can also use C programming language and different assembly languages to make PIC more useable.

B. Stepper Motor

A stepper motor is mainly used as motor for robotics or intelligent applications. Stepper motor has no brushes or

contacts and it is a synchronous motor with the magnetic field electronically switched to rotate the armature magnet. The essential function of a stepper motor is to translate switching excitation changes into precisely defined increments of motor position [ADV00]. A stepper motor can be viewed as an electric motor without commutates [DOUCS]. Typically, all the windings in the motor are part of the stator, and the rotor is either a permanent magnet, or in the case of variable reluctance motors, a toothed block of some magnetically soft material.

So its very clear that we can control motor each stepping as our requirements, this features is essential for developing different machine, robot which need accurate movement. Same way intelligent solar panel needs accurate movement for track-ing sun for maximum sunlight.

C. Solar Panel and How It Works

A solar panel is collection of photovoltaic cells [10]. A panel can be rated by its DC output power under standard test conditions, and typically ranges from 100 to 320 watts. The solar panel is consisting of silicon cells and solar energy is converted into electricity through the use of silicon cell. When sunlight hits a solar panel, it makes flow of electrons in solar cell and it produces electricity. Heat produced by sunlight also important factor for electricity flow.

Now solar panels typically installed as an array, an inverter, and sometimes a battery and or solar tracker and interconnec-tion wiring because such arrangement provide more efficient output.

D. Microcontroller Programming

We have used C language for programming the micro controller. The main reasons to use this programming language are it is easy to understand, and operate the programming variables. If the Pic is connected to the Pic C development software via the debugger it is possible to do some higher level input and output. We can break a bigger problem down into several smaller pieces. C is also capable of handling logical expressions and has a variety of built in operations for performing mathematical calculations. We have used Mplab IDE for programming the micro controller.

IV. Implementation

The implementation of the solar panel is done using two operational style. In the first mode the solar panel is fixed. And in the other process, the panel is rotating using bolstered by embedded system.

A. Static Solar Panel Operation

In general, solar panel is fixed with a single direction. Let the time is 8.00AM in the morning. In the morning, the angle between the sun and solar panel with respect to horizontal line is 45 degree. Getting the sun beam hit, the solar panel starts to produce energy. In each hour, the angle between the sun and panel is increasing. Along the sun position, the light and hit is deviated from the line of sight. At the noon, the sun is on the top of the panel but the panel position is still fixed.

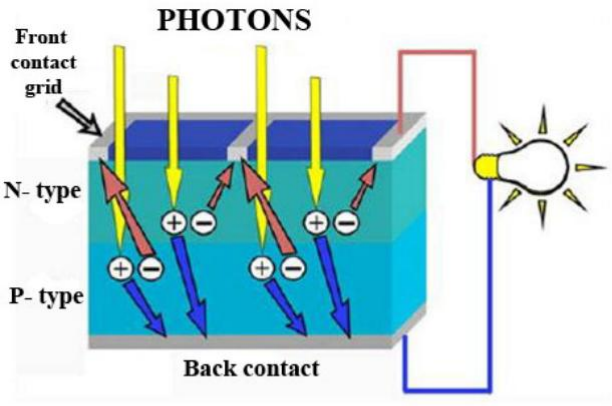

Fig. 4. Battery charging using solar panel.

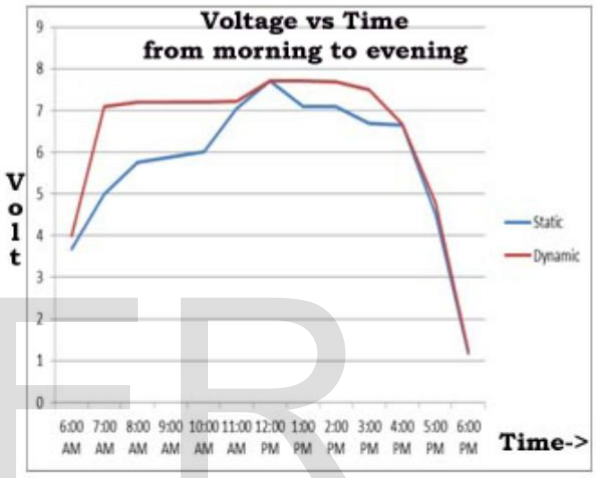

Fig. 5. Voltage storage by dynamic and static solar panel.

B. Intelligent Solar Panel Operation

But in case of our intelligent solar panel we see a pictorial view of sun and the solar position at different time: Fig. 4 is showing how a square mile of the earth receives less heat, the nearer the sun is to the horizon. When the sun is in the zenith, the region BC receives as many of his rays as the region AC, twice as large, receives when the altitude of the sun is 30.

Intelligent solar system has three different states that make it efficient than static system. Running State In this state panel rotates along with the sun position after specific time interval. It stores the energy in the battery and the motor uses electricity directly from panel at daytime.

a) Alive State: A backup battery supply electricity to the microcontroller to generate clock pulse. The battery makes alive the system at night when the motor is stopped.

b) Emergency State: In cloudy season some time enough sun light may not available to run the motor, this case it uses backup battery to run the system. This technique does not put extra burden on the main barratry storage that supplies electricity for solar operated devices.

c) Efficient Electricity Distribution: Electricity produce by solar panel is distributed at a time to storage battery,

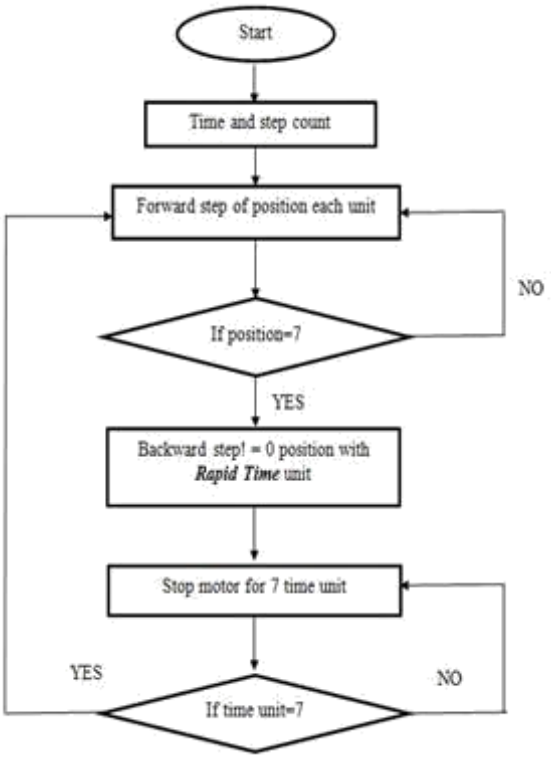

Fig. 6. The solar panel is rotating with respect to the process given in the flowchart.

microcontroller circuit and backup battery. Storage battery may be fully charged within a very short time when the sun beam is strong and available. To keep proper use of energy, we used solar electricity directly to run stepper motor without using from storage battery. Backup battery will be charged if needed because it will support at night to alive the clock. In addition, we can run the motor at emergency time when storage battery is going empty.

The program flowchart is given in the Figure 6. The steps are illustrated herewith.
Step 1: Run the program and start the project.
Step 2: Initialize time delay unit and stepping position.
Step 3: Executing forward step for each time delay unit.
Step 4: Check the forward stepping number is equal to 7 or not. If it is 7 then it executes the next step, else return to step 3.
Step 5: Execute backward step at a time with provided Rapid Time delay.
Step 6: Stop motor rotating for 7 time period.
Step 7: When 7 time period over return step 2.

V. Analysis

We have set up the full arrangement shown in Figure 6. We have also fixed a solar panel on a static position. From morning to evening, we collected the voltage measurement and chart them in the Table I.

We have also drawn the tabular data in graph that shows that the voltage preservation level of dynamic solar panel system is more than the static one. We can easily derived that

TABLE I. Voltage storage by dynamically rotated and fixed solar panel

Time	Dynamic Panel (Volt)	Static Panel (Volt)
6.00AM	4.00	3.68
7.00AM	7.10	5.00
8.00AM	7.19	5.76
9.00AM	7.19	5.88
10.00AM	7.21	6.01
11.00AM	7.23	7.05
12.00AM	7.70	7.70
1.00PM	7.70	7.10
2.00PM	7.68	7.10
3.00PM	7.50	6.69
4.00PM	6.67	6.65
5.00PM	4.79	4.50
6.00PM	1.23	1.18

since the moving solar panel is producing continuous energy since it is collecting copious light and heat aligning with the sun.

We have used three storage batteries and one back up battery where each can store 6 volts. With respect to the static solar system, total voltage consumption in twelve phases is 74.32 volt. So, average voltage output in each phase 6.19 volt. Again in dynamic solar system, total voltage consumption in twelve phases is 83.19 volt. So, the average voltage output in each phase volt. Getting the result we can deduced that a single 3.0 watt dynamic solar panel can provide us 12% efficiency than static panel.

VI. Conclusion

The applications of permanent magnetic stepper motors have grown significantly in recent years in the appliance industry and the automotive industry. On this project we have used stepper motor to rotate the solar panel so that it can achieve much power than a static solar panel. The dynamic rotation of the panel absorb pretty good number of light and heat that ameliorate the energy storage. In the coastal area, our sun light is comparatively strong. For this reason, this innovative process will absolve us from electricity problem in the unreached locations.

d) Future Plan: Our future plan is implement our technology for making dual-axis efficient solar power plant. We would like to develop our technology more economic that it can be used by maximum number of poor family in our country. ACKNOWLEDGMENT We would like to thanks our research mentor Raihan Masud, PhD student of University of Oregon, USA and Ankur International, USA for providing hardware. We also thank Mr. Md. Enamul Haque, Big Energy, Banai, Dhaka for providing us solar panel, light and storage battery. Finally, we are grateful to the department of Computer and Communication Engineering under CSE Faculty that has given us nice environment to continue our project.

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