Automatic Solar Tracker Robot

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***Abstract*— The objective of this project is to design and develop an Automatic Solar Tracker Robot (ASTR) which is capable to track maximum light intensity. The solar tracker system that follows the sun direction for producing maximum voltage out is mounted on the robot and the DC motors utilizes this energy for robot movement. The robot base can be controlled through computer using wireless Zigbee technology. The efficiency of the solar energy conversion can be optimized by receiving maximum light on the solar panel. The main components of the robot consist of two PIC16F877A microcontroller, LDR sensors, DC motors and digital compass. This robot is programmed to detect sunlight by using Light Dependent Resistors (LDR). DC motor aligns the solar panel to receive maximum light. Digital compass is used to detect the position of the robot. Two modified DC motors will move the robot base in all directions and another two DC motor is used for tracker- base and tracker. It keeps the tracker-base always in north-south direction and tracker in east west direction. If tracker – base is not in North-east direction buzzer will be activated to produce sound. The digital compass fitted on the robot senses the direction and this information is passed onto the PIC microcontroller. LCD used to display the measured voltage generated from solar panel. The robot is programmed using Embedded C language.**

***Keywords* — Automatic Solar Tracker Robot; Solar Panel; Sunlight; DC Motor; Digital Compass.**

I.INTRODUCTION

Due to the limited supply of non-renewable fuels, scientists nowadays are searching for alternative energy resources. Besides, fossil fuels have many side effects, since the combustion products produce pollution which can cause acid rain and global warming. Therefore, conversion to clean energy sources such as solar energy would enable the world to improve the quality of life throughout the planet Earth.

Solar energy is an unlimited supply and nonpolluting source; solar power is being moderately used compared to hydro and wind power. This can be attributed to the low conversion efficiency of solar cells and high cost. There are two ways for maximizing the rate of useful energy; optimizing the conversion to the absorber level by properly choosing the absorber materials, and increasing the incident radiation rate by using tracking systems [1].

Solar cells are traditionally fixed on rooftop or fixed on ground. As a result, solar cells unable to receive maximum light as position of sun changing varying with time. The research to date has tended to focus on the efficiency of the solar cell. This paper will present the STR which is designed to improve the efficiency of solar power by allowing solar cells to align with the sun movements to track optimum sunlight. The tracking system was designed as a normal line of the solar cells which will always run parallel within the ray of the sun. The orientation of the photovoltaic panels may increase the efficiency of the conversion system.

This project does not need any installation; since it is portable and can be located in a free space exposed to direct sunlight. The ASTR will adjust the position automatically. This task will accurately be done with the aid of digital compass. The solar panel moves in one axis, rotates from east to west, while the tracker-base of the robot can move in any direction.

II.LITERATURE REVIEW

Previously, there are many projects related to solar tracking system that improve the solar tracking system. Following are the previous projects.

A. Microprocessor Based Solar Tracking System Using Stepper Motor

The microprocessor is being used to control the tracking system by interfaced with others components. The advantage using microprocessor is that many functions can be added on to it by adding extra components [7]. However, it requires external components to implement program memory, RAM and ROM memory, input and output port, and ADC. This will cause high cost of the project, besides increasing the complexity of the project.

B. Miniature Solar Tracker

This solar tracker was microcontroller based and single- axis tracking systems using DC motor. The single-axis tracking systems spins on their axis to track the sun, facing east in the morning and west in the evening. This project is cheap and simple in terms of controlling, since the solar tracking system is supported by a tripod [8]. This project does not have an intelligent feedback to control the position of the solar tracker if it is out of position, so it cannot track the maximum sunlight.

C. Different Tracking Strategies for Optimizing the Energetic Efficiency of A Photovoltaic System

This project was a fuzzy logic neural controller and dual-axis tracing systems. The two-axis tracking systems are able to follow very precisely the sun path along the period of one year [9]. Therefore it is more efficient than the single-axis tracking systems, yet more expensive. This is because they are using more electrical and mechanical parts. Another disadvantage is the difficulty and complexity of the control part increases.

D. Automatic Solar Tracker Robot

It is microcontroller based robot where the base of the robot can move in all direction and tracker-base itself will align the solar panel to track the sun exactly with the help of digital compass. Tracker-base aligns itself in north-south direction and tracker moves from east to west. This tracker can be implemented on any moving objects. Because of this system efficiency will be increased and it is easy to implement.

III.METHODOLOGY

In this project, the tracking system of the robot will be controlled by two Light Dependent Resistors (LDRs) act as input signals, and DC motor as an actuator to rotate the solar panel. Besides, the navigation of the robot most of the time will be controlled by using digital compass data to correct the error. Meanwhile, the digital compass data will give feedback to the microcontroller using Inter Integrated Circuit (I^2C) interfacing. In the controller part, it consists of PIC16F877A chip. The whole circuit includes the LDR, DC motors, and the digital compass will be controlled by this chip.

A. System Architecture

Fig.1 shows the architecture of base of Automatic solar Tracker robot.Fig.3 shows the architecture of tracker-base and tracker Automatic solar Tracker robot. Whole system including light sensors, digital compass, limit switches, four DC motors, and DC motor driver. Two major parts, from the figure are tracker and the base. The PIC16F877A chip on the control circuit is the main processor where it will control the whole system. I^2C is used in this architecture to interface with the slave devices (Digital Compass Module HMC6352).

B. Sensor Arrays

The LDR sensors will be setup as Fig. 2. When both sensors are equally illuminated, their respective resistances are approximately the same. When both sensor falls in shadow, its resistance increases beyond the range and the PIC microcontroller will activate the motor to drive both sensors under even illumination [6]. When west cell (W) is in shadow, tracker rotates to east, while when east cell (E) in shadow, tracker will rotate to west.

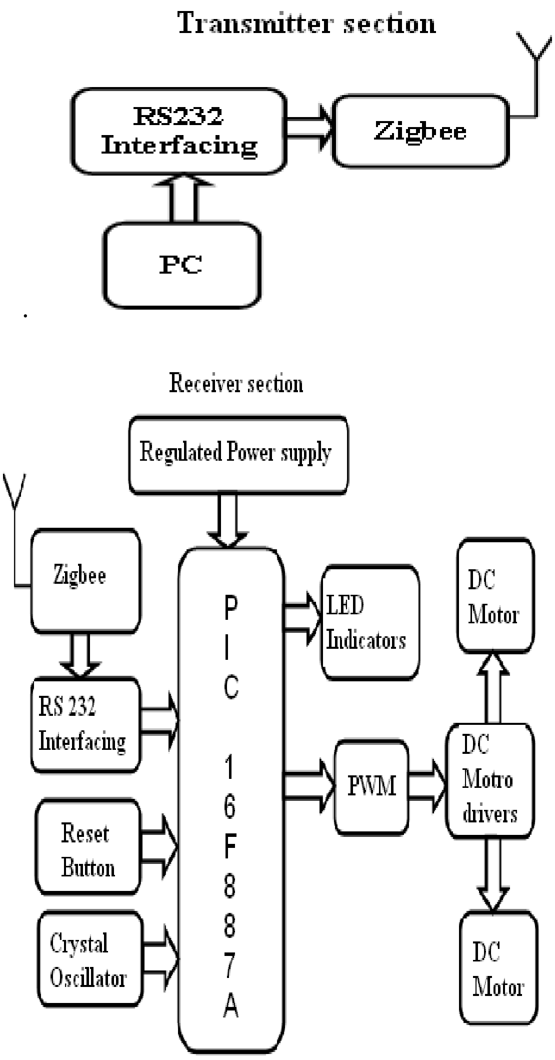

Figure1. Automatic Solar Tracker Robot Base Architecture

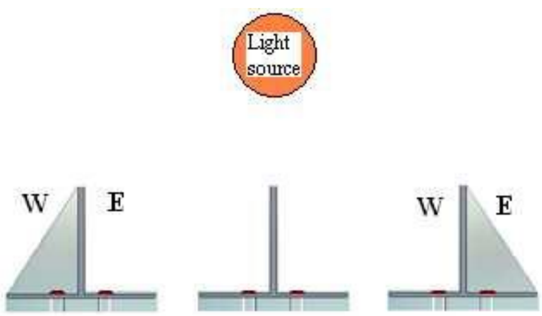

Figure2. Condition of sensors array

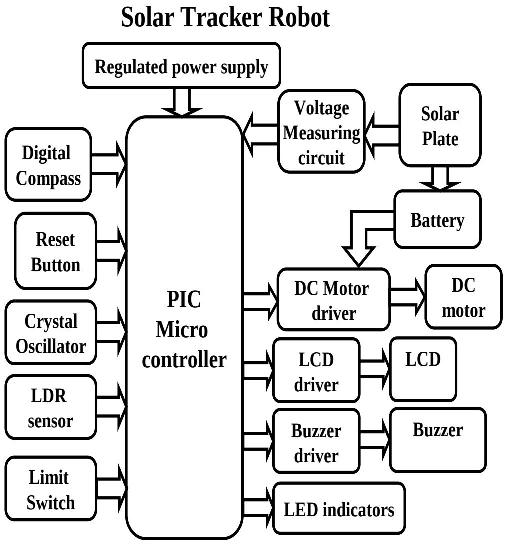

Figure3. Automatic Solar Tracker Robot Tracker-Base and Tracker Architecture

C. Digital Compass

Digital compass is used to read the current position of the tracker-base of robot. The STR is set to heading north, which is 0° so that solar panel will track the sunlight form east to west. Once the STR is not in the set point feedback is given to controller so that it will be in north-south direction irrespective of motion of base of automatic solar tracker robot.

D. Main Board Control Unit

Fig. 4 shows the schematic diagram for the base of Automatic solar tracker robot system .Fig. 5 shows the schematic diagram for the Tracker base and tracker of Automatic solar tracker robot system The system consists of microcontroller, two LDR sensors, digital compass, motor driver L293D, servo motors, limit switches, and others components.

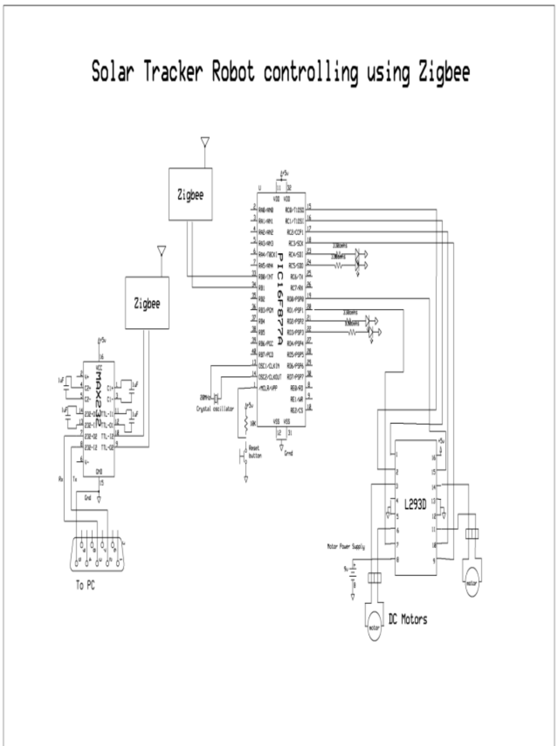

Fig. 4The schematic diagram for base of Automatic solar tracker robot system.

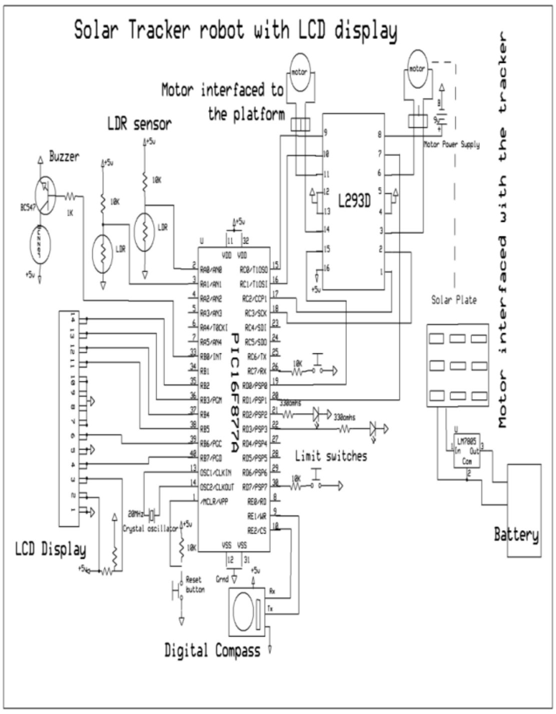

Fig. 5 shows the schematic diagram for the Tracker base and tracker of Automatic solar tracker robot system.

IV.RESULT AND ANALYSIS

A. Analysis on Solar Panel

Data is collected using Fluke 1750 power quality recorder for one day, which is on 11 March 2012. Data is taken from 9 a.m. to 5 p.m. for 8 samples data. The power efficiency of solar panel can be calculated using (1), while the average power efficiency can be calculated using (2).

A=(P2-P1/P1)100% ------ (1)

B=(∑P2-P1/∑P1)100% ------ (2)

Where *P1* = Power produced by the fixed solar panel (Watt) and *P2* = Power produced by the solar panel attached to solar tracker (Watt).The increments of power efficiency are shown in Table I. The average power efficiency for 11 March 2012 is 26.07%. Referring to Table I, the increments of efficiency are significant from 9 a.m. to 11 a.m. This is because STR is tracking the maximum sunlight compared to the fixed solar panel. However, from 12 p.m. to 4 p.m., there is only a slightly increase in efficiency due to the fixed solar panel is receiving almost the same intensity of sunlight as solar panel on STR.

DAY1 12/3/2012	9 am	10 am	11 am	12 pm	1 pm	2 pm	4 pm	5 pm
FIXED SOLAR PANEL								
VoltageV1(v)	5.7	11.5	12.5	10.6	12.54	11.7	9.45	7.17
Current,I1(A)	0.16	0.16	0.15	0.15	0.15	0.14	0.13	0.18
Power,P1(W)	0.91	1.84	1.86	1.59	1.88	1.63	1.22	1.29
AUTOMATIC SOLAR TRACKER ROBOT								
VoltageV2(v)		11.26		12.85	12.99	12.5	11.25	10
Current,I2(A)		0.2		0.17	0.15	0.15	0.14	0.18
Power,P2(W)		2.25		2.18	1.94	1.87	1.57	1.8
Increase in η (%)		22		37	3	15	29	39

C. Digital Compass

The position of the tracker- base is adjusted automatically. The front of the STR is installed with an digital compass to show the actual position of the robot.

V. CONCLUSIONS

Integrating features of all the hardware components used have been developed in it. Presence of every module has been reasoned out and placed carefully, thus contributing to the best working of the unit. Secondly, using highly advanced IC's with the help of growing technology, the project has been successfully implemented. Thus the project has been successfully designed and tested.

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