Microcontroller Based Single Axis Solar Tracking Control of Photovoltaic Panels Using Stepper Motor

P. Jagruthi #1, A. Krishna Nag #2, D.R.Ch. Nookesh #3
[1]Assistant Professor, EEE Department, Dadi Institute of Engineering & Technology, Anakapalle, A.P, India
[2] Assistant Professor, EEE Department, Dadi Institute of Engineering & Technology, Anakapalle, A.P, India
[3]Assistant Professor, EEE Department, Dadi Institute of Engineering & Technology, Anakapalle, A.P, India

Abstract : The main aim of this work is to discuss the design and implementation of a polar single axis solar panel tracker which actively tracks the sun light and changes its position accordingly to maximize the energy output with the help of sensors that compare the light intensities of each side and move the panels until the tracker detects equal light on both sides. The entire proposal has been implemented by a hardware fabrication.

IndexTerms **- Solar Tracker, Microcontroller, Stepper motor, PV Control**

I. INTRODUCTION

An Embedded System is a combination of computer hardware and software, and perhaps additional mechanical or other parts, designed to perform a specific function. A good example is the microwave oven. Almost every household has one, and tens of millions of them are used every day, but very few people realize that a processor and software are involved in the preparation of their lunch or dinner.

This is in direct contrast to the personal computer in the family room. It too is comprised of computer hardware and software and mechanical components (disk drives, for example). However, a personal computer is not designed to perform a specific function rather; it is able to do many different things. Many people use the term general-purpose computer to make this distinction clear. As shipped, a general-purpose computer is a blank slate; the manufacturer does not know what the customer will do wish it. One customer may use it for a network file server another may use it exclusively for playing games, and a third may use it to write the next great American novel.

Frequently, an embedded system is a component within some larger system. For example, modern cars and trucks contain many embedded systems. One embedded system controls the anti-lock brakes, other monitors and controls the vehicle's emissions, and a third displays information on the dashboard. In some cases, these embedded systems are connected by some sort of a communication network, but that is certainly not a requirement.

At the possible risk of confusing you, it is important to point out that a general-purpose computer is itself made up of numerous embedded systems.

For example, our computer consists of a keyboard, mouse, video card, modem, hard drive, floppy drive, and sound card-each of which is an embedded system. Each of these devices contains a processor and software and is designed to perform a specific function. For example, the modem is designed to send and receive digital data over analog telephone line. That's it and all of the other devices can be summarized in a single sentence as well.

If an embedded system is designed well, the existence of the processor and software could be completely unnoticed by the user of the device. Such is the case for a microwave oven, VCR, or alarm clock. In some cases, it would even be possible to build an equivalent device that does not contain the processor and software.

This could be done by replacing the combination with a custom integrated circuit that performs the same functions in hardware. However, a lot of flexibility is lost when a design is hard-cooled in this way. It is much easier, and cheaper, to change a few lines of software than to redesign a piece of custom hardware

I. CIRCUIT DIAGRAM & COMPONENTS

The proposed work implemented with the above circuit diagram has the following components:

- Power Supply Unit
- Solar Panel (10 Watts, 12 Volts)
- Stepper motor (28 BYJ – 48 Series), (12V,10 RPM)
- Motor driver IC (l293D)
- Arduino board with ATMEGA328 Micro Controller
- Light Dependent Resistor (12mm)
- 16×2 LCD Display

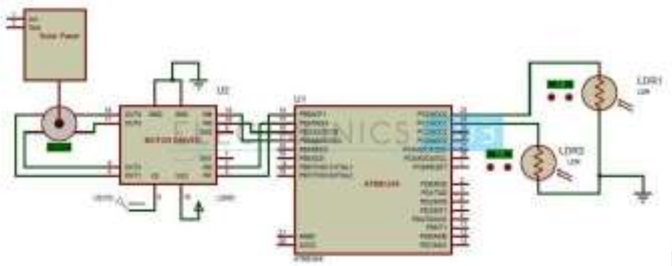

Fig 1: CIRCUIT DIAGRAM

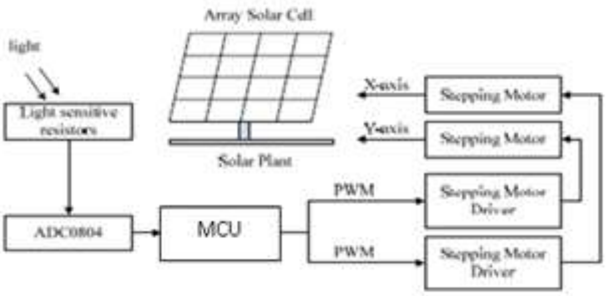

Fig 2: System Architecture of solar tracking system

II. FEATURES OF COMPONENTS USED

Power Supply Unit:

It consists of a bridge rectifier to convert AC to DC and feed the circuit with a supply free from unwanted harmonics with the use of a 100 micro Farad capacitor & a 10k ohm resistor to limit the current flowing along with a 12V battery, which is charged from the solar panel power and fed to motor and motor driver IC and Arduino board unit

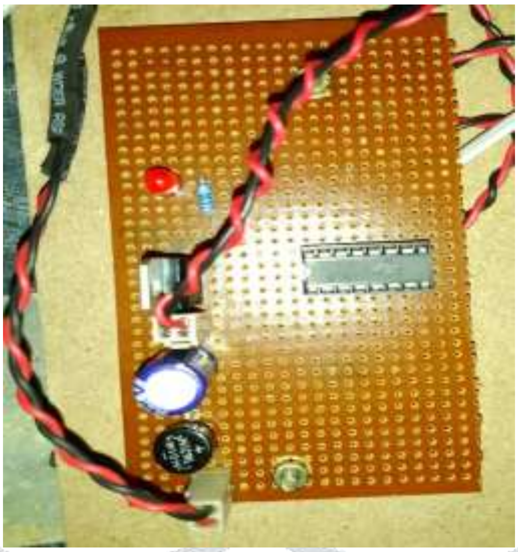

Fig 3: Power Supply unit

Solar Panel:

The solar panel connected to a stepper motor consists of photovoltaic cells arranged in an order (Photo resembles light and voltaic is electricity).

The solar cell is made up of semiconductor material preferably, silicon which when incident with sun light absorbs energy which is sufficient for the electrons to jump from one orbit to another inside the atom. These cells have an electric field that directs the electrons which creates current by placing metal contacts to obtain energy from cells

Fig 4: Solar Panel

Stepper Motor:

Stepper motor is one which rotates the panel with a stepwise angle which essentially is a brushless DC electric motor that divides a full rotation into number of equal steps whose rotor position can be commanded to move and hold at one of these steps without any position sensor for feedback as long as the motor is carefully sized to the application in respect to torque and speed

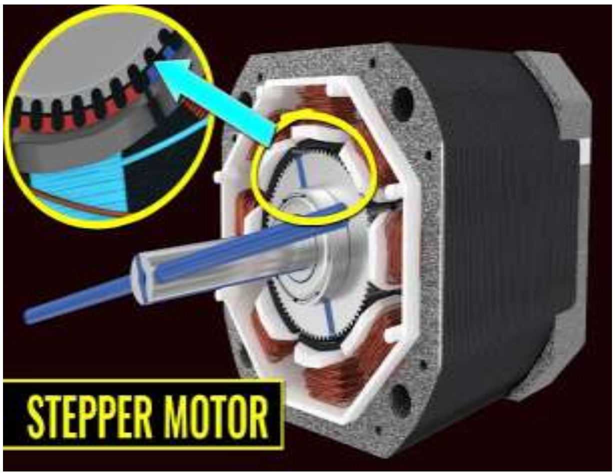

Fig 5: Stepper Motor

Arduino Board with ATMEGA 328 microcontroller:

Arduino board designs uses a variety of microprocessors and controllers equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards or Breadboards (*shields*) and other circuits.

The microcontrollers are typically programmed using a dialect of features from the programming languages C and C++

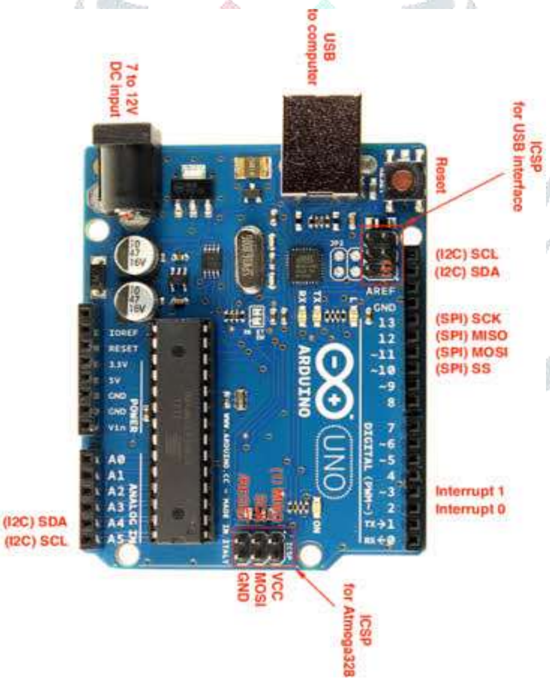

Fig 6: Arduino Board

Pin Diagram of ATMEGA 328 microcontroller:

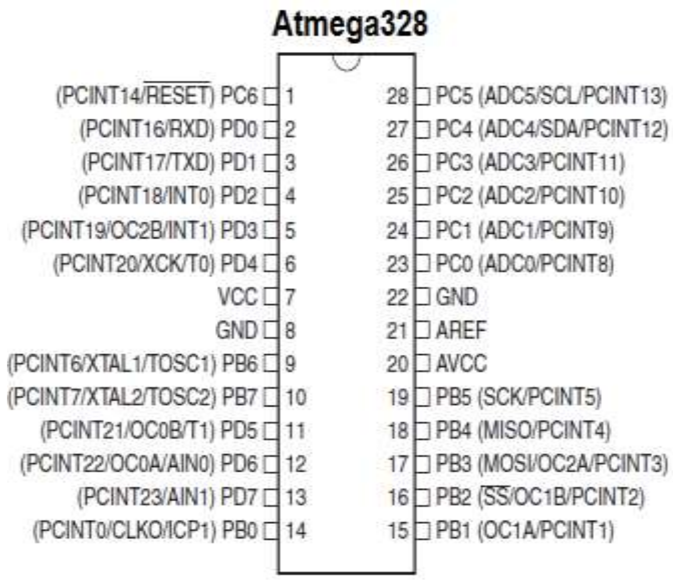

Fig 7: Pin Diagram of Microcontroller

Motor Driver IC (L293ID):

The very purpose of this component is to drive the stepper motor by amplifying the input voltage and protect the microcontroller from the effect of back EMF. It has a h-bridge, which is internally made up of transistors with the IC having 16 pins out of which, the output pins are connected to stepper motor pins and the input pins are connected to controller pins

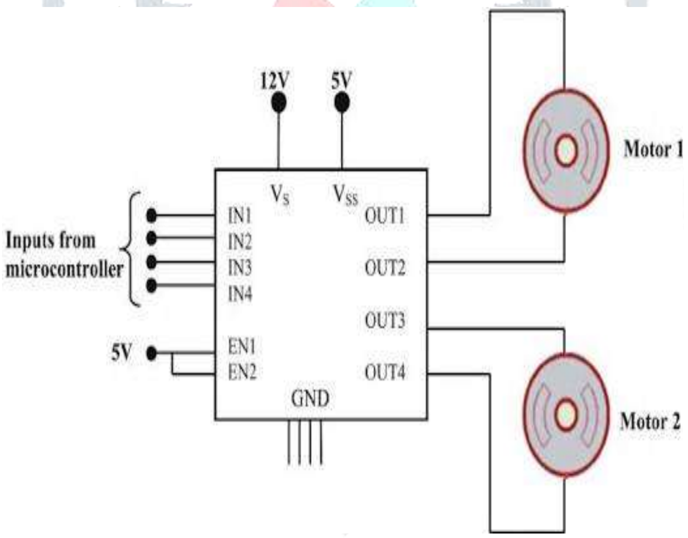

Fig 8: Motor Driver IC:

LDR (Light Dependent Resistor – 12mm):

These are very useful especially in light/dark sensor circuits whose resistance decreases as the amount of light falling on this LDR increases and is used in applications which require a device or circuit to be automatically switched on or off in darkness or light. The light detector itself is just 12mm in diameter with a lens and epoxy sealed metal package.

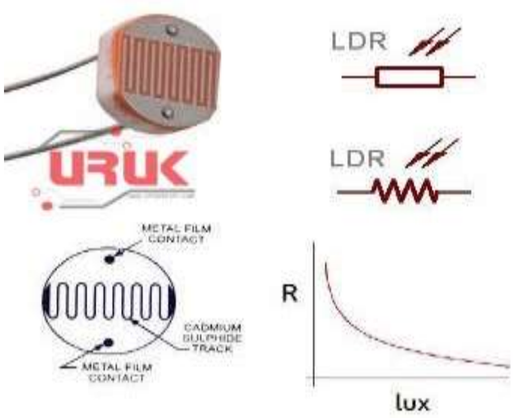

Fig 9: LDR

16x12 LCD Display Module:

This module consists of 16 Characters with 2 Lines, 5x7 Dots with Cursor, Built-in controller, 5V Power Supply and a 1/16 Duty Circle. If the LCD is having Backlight, then it will have two more pins with pin numbers 15 & 16 connected to VCC and GND respectively

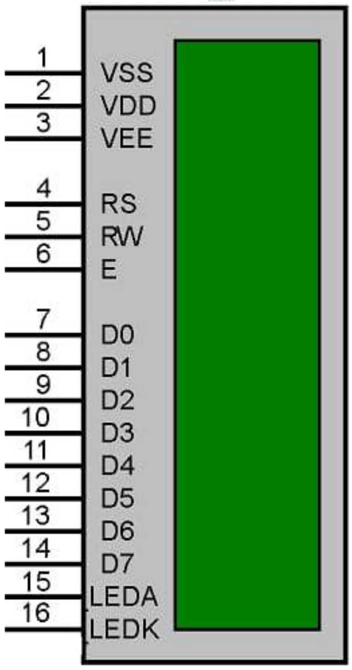

Fig 10: LCD Display

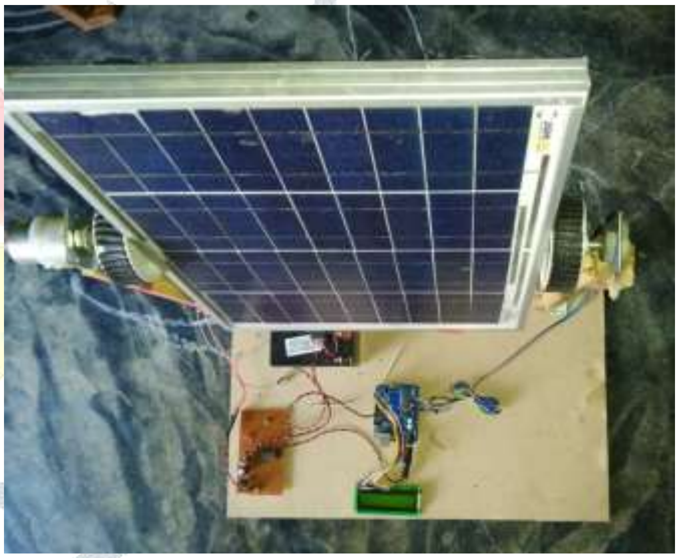

Fig 11: Hardware implementation

IV. HARDWARE IMPLEMENTATION

V. RESULTS & DISCUSSION

- When the light incident on the LDR1>LDR2 Motor 1 rotates in forward direction and Motor 2 in rest position
- When the light incident on the LDR1<LDR2 Motor 2 rotates in reverse direction and Motor 1 is in rest position
- When the light incident on the two LDRS is equal. i.e., LDR1=LDR2 then both motors i.e., Motor 1 and Motor 2 are in rest position

The corresponding readings of both the LDRs at different situations on a given day corresponding to available light have been tabulated in the following table shown below:

Tabular Data: 1

S No	TIME	LDR1 (lux)	LDR2 (lux)
1	9AM	1002	993
2	10AM	1006	998
3	11AM	1011	1004
4	12PM	1014	101
5	1PM	1017	1014
6	2PM	1007	1012
7	3PM	998	1008

VI. ADVANTAGES & APPLICATIONS

The proposed technique is highly sensitive, works according to the sun direction, night – day mode sensing, low cost and reliable circuit, elimination of manpower and an increased efficiency of up to 40-50% which is more than conventional Solar Panels with the following applications:

- Street lights
- Garden Lights
- Solar water heater
- Hotels, hostels and house hold applications
- Offices
- Industries

VII. CONCLUSION & FUTURE SCOPE

This project presents a solar tracking power generation system. The tracking controller based on the closed loop algorithm is designed and implemented with Atmega328 Arduino unit in embedded system domain. Set up on the solar tracking system, the light sensitivity resistors are used to determine the night – day vision. The proposed solar tracking power generation system can track the sun light automatically. Thus, the efficiency of solar energy generation can be increased. Experimental work has been carried out carefully. The result shows that higher generating power efficiency is indeed achieved using the solar tracking system. The proposed method is verified to be highly beneficial for the solar power generation

FUTURE SCOPE:

The main Aim of this project is to improve efficiency of the Solar System which is done up to 40% in this project and can be increased to 65-70% if we implement the "Parabolic Solar Dish" instead of a flat Solar Panel

VII. REFERENCES

[1] Energy Engineering and Management – Amlan Chakraborti – PHI.

[2] Energy: Management, Supply and conservation – Dr. Clive Beggs.

[3] Energy Conservation: Success and Failures – John C. Sawhill, Richard Cotton – Brookings Institution Press.

[4] Handbook of Energy Conservation – H.M. Robert, J.M. Collins – Alken Publishing Unit.

[5] Electric Machines – D.P.Kothari, I.J. Nagrath – Tata Mc.Graw Hill Education.

[6] Electrical Machines – M.V.Deshpande – Jain Book Agency.

[7] Electrical Machines (AC & DC Machines) – J.B.Gupta – Jain Book Agency.

[8] Digital Electronics And Logic Design – B. Somanathan Nair – PHI Learning Pvt. Ltd.

[9] Digital Electronics And Microprocessors – R.P.Jain – Mc. Graw Hill Education.

[10] Digital And Microprocessor Fundamentals: Theory And Applications – William Kleitz – Prentice Hall

[11] https://en.wikipedia.org/wiki/Solar_tracker

[12] R.Condit and D.W. Jones, "Stepping Motor Fundametals", Microchip Inc. Publication An907, pp. 1-22,2004

[13] Toby Peterson, Justin Rice, Jeff Valane, "Solar Tracker", ECE 476, Spring 2005