Design and Implementation of Tracking System for Dual Axis Solar Tracker Using PIC 16F887

Yu Yu Mon Win, Ye Myat Thu

Abstract— The paper describes a tracking system of Dual Axis Solar Tracker using PIC 16F887 microcontroller. Four LDRs are used as sensor to sense the sun light. The sensing signals are applied to the microcontroller as input signals. The controller compares the input signals and directs the two servo motors to track the sun. The two servo motors are attached horizontal and vertical axis of solar panel stand each. The tracker then rotates the solar panel to get the maximum sunlight. Automatic Sun Tracking System is a hybrid hardware/software prototype, which automatically provides the best alignment of solar panel with the sun, to get maximum output (electricity).

Keywords— Dual Axis Solar Tracker, LDR, PIC 16F887 microcontroller, Servo motor, Solar pannel

1 Introduction

THE position of the sun in the sky is varied both with seasons and time of day as the sun moves across the sky.A solar tracker increases how efficient such equipments are over any fixed position at the cost of additional complexity to the system.The two main types of solar tracker are Single axis and Dual Axis Solar Tracker.In this paper, Dual Axis Tracker can track the sun both East to West and North to South.It has two degrees of freedom that acts as axes of rotation.The two axes are typically normal to each other.The advantage of Dual Axis Tracker is catching the position of the sun anywhere in the sky due to seasonal variations automatically.

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2 Block Diagram

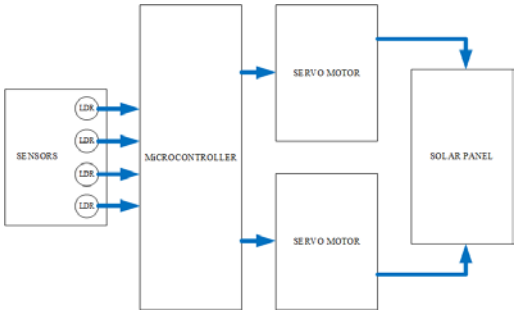

Fig. 1. System Block

3 Hardware components required

The main parts of the system required are PIC 16F887 microcontroller, servo motors, light dependent resistors (LDRs), L 7805 and L7806 voltage regulators and solar panel.

3.1 PIC 16F887 Microcontroller

The PIC 16F887 is a type of microcontroller. The main purpose of the PIC is to control the positions of servo motors. The microcontroller accepts from its input ports/ transducers,processes the input commands and sends out the required output through its output ports to the output devices.

Additional functions may include A-D converters,serial communication, flash program memory and more. The Mikro C programming language is embedded in this PIC to control the overall processes.

3.2 Light Dependent Sensor Design

A light dependent resistor, LDR, photo-conductive cell, is light-controlled variable resistor. The resistance of LDR decreases with increasing incident light intensity.

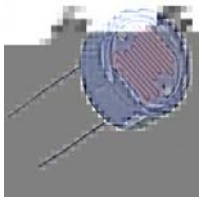

Fig. 3. Light Dependent Resistor

3.3 Servo Motor (MG995)

A servo motor ia a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It has three wires: power, ground and signal.Servo motor accepts the signal from controller that tells it what angle to turn to.

Fig. 4. Servo Motor

3.4 Voltage Regulators (L7805, L7806)

Voltage sources in a circuit may have fluctuations resulting in not providing fixed voltage outputs. A voltage regulator IC (Integrated Circuit) maintains the output votage at a constant value.7805 IC and 7806 IC are members of 78xx series of positive fixed linear voltage regulators.7805 IC provides +5 V regulated power supply with provisions to add a heat sink.Similarly, 7806 IC provides +6 V power supply.

Fig. 5. L7805 and L7806 Voltage Regulators

3.5 Solar Pannel

Solar panels absorb sunlight as a source of energy to generate electricity. Solar energy is the photovoltaic cell which converts light energy received from sun into electrical energy. A photovoltaic system typically includes an array of photovoltaic modules, an inverter, a battery pack for storage, interconnection wiring, and optionally a solar tracking mechanism.

Fig. 6. Solar Pannel

4 Implementation Hardware

To implement the hardware for the complete system, there are three general parts: LDR Sensing circuit part, Servo motor interfacing with Microcontroller and Solar panel charging.

4.1 LDR Sensing Circuit

Four LDR sensors are connected to PIC 16F887 microcontroller analog pin 2,3,4 and 5 (RA0, RA1 RA2 RA3). One sensor consists of one LDR and a complementary Resistor (10 k) Ohm as a sensor as shown in Figure 7.

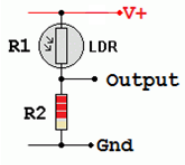

Fig. 7. LDR Sensor Model

The four input voltages sent to the PIC are calculated as:

$V_1 = V_{cc}\{ R_1 / LDR_1 + R_1 \}$,

$V_2 = V_{cc}\{ R_2 / LDR_2 + R_2 \}$,

$V_3 = V_{cc}\{ R_3 / LDR_3 + R_3 \}$, and

$V_4 = V_{cc}\{ R_4 / LDR_4 + R_4 \}$.

The built-in analog to digital converter will convert these values into digital values. The ADC conversion for 10 bits is calculated as follow:

$$Vout = (value * 5)/1024$$

It can be tested using Proteus Simulation and is shown in Figure 8.

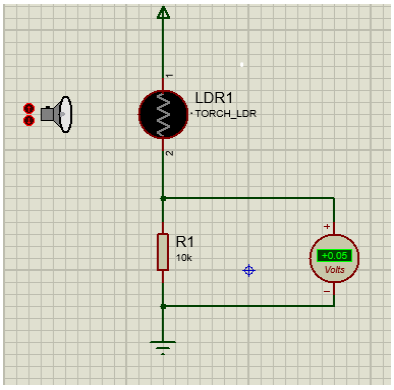

Fig. 8. LDR Sensing Circuit

4.2 Interfacing Servo Motors and PIC 16F887

Interfacing servo motor with PIC is very easy. It has three wires coming out of them, one for positive voltage (5V), another is for Ground and the last one is for position setting. Servo motor can be controlled using microcontroller with Pulse Width Modulation signals on the control wire as shown in Figure 9.

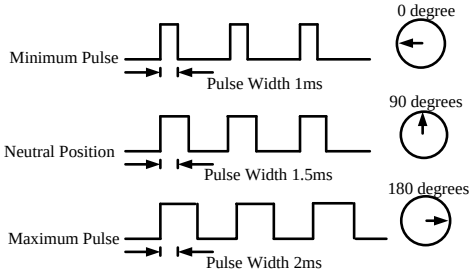

Figure 9. PWM controlled Servo Motor rotation

It can be tested as Proteus Software and then seen in Figure 10. The result is acceptable.

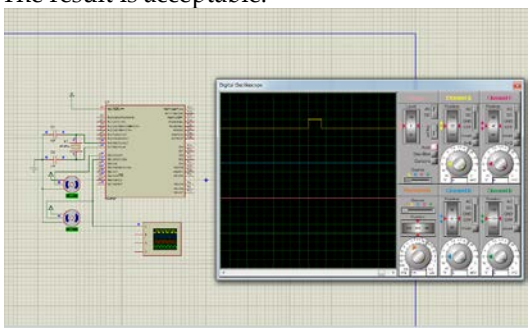

Figure 10. Interfacing Two Servos and MCU

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4.3 Complete Circuit Diagram

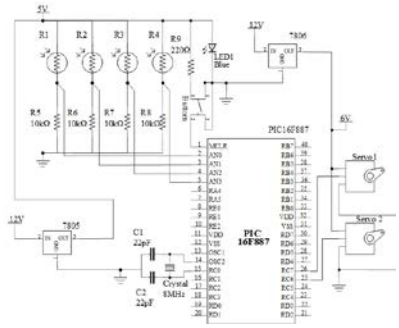


Figure 11. Circuit Representation

Table 1. Pin Assignment for Complete Circuit

PIC16F887 Pin		Components
Pin 2	RA0	LDR1 , R1
Pin 3	RA1	LDR2 , R3
Pin 4	RA2	LDR3 , R2
Pin 5	RA3	LDR4 , R4
Pin 25	RC6	Horizontal Servo Signal Pin
Pin 26	RC7	Vertical Servo Signal Pin

4.4 Principle of Complete Circuit

The working principle of Dual Axis Solar Tracker is described at below:

- Solar tracking system is done by Light Dependent resistor (LDR)
- Four LDR sensor are connected to PIC A6F887 analog pin 2,3,4,5,
- LDR analog voltage values set to the PIC
- Analog-to-Digital Converter will convert the analog value of LDR to digital values,
- According to this digital values PIC direct the movement direction of the two servo motors.

4.5 Algorithm of Flow Chart

Step 1 : Start Tracking Mode,
Step 2 : Read Input from LDR Sensors,
Step 3 : Convert From Analog to Digital,
Step 4 : Compare the Reading Value of Four LDR Sensors,
Step 5 : if LDR3 > LDR4, vertical servo motor rotate counter clockwise,
Step 6 : if LDR3 < LDR4, vertical servo motor rotate clockwise,
Step 7 : if LDR2 > LDR1, horizontal servo motor rotate counterclockwise,
Step 8 : if LDR2 < LDR1, horizontal servo motor rotate clockwise, and
Step 9 : End the Program.

4.5 Flow Chart

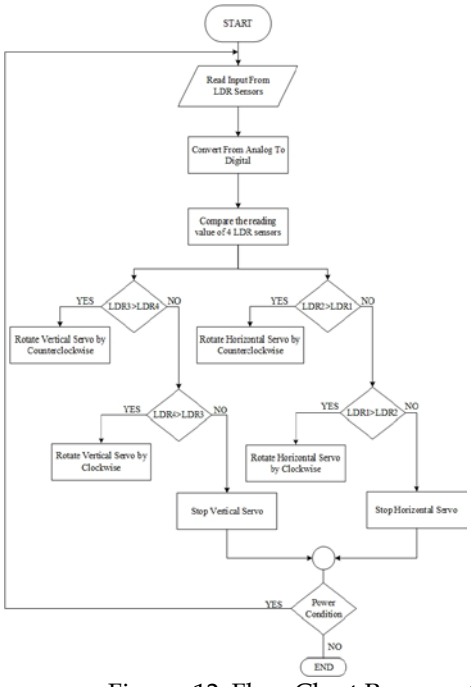


Figure 12. Flow Chart Representation

5 Tests and Results

5.1 Main Frame Construction

Figure 13.Screwing Servos and Fitting Four LDRs at Coners

5.2 Hardware Test with Phone Flash Light

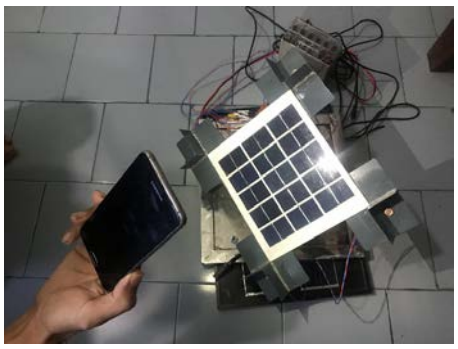
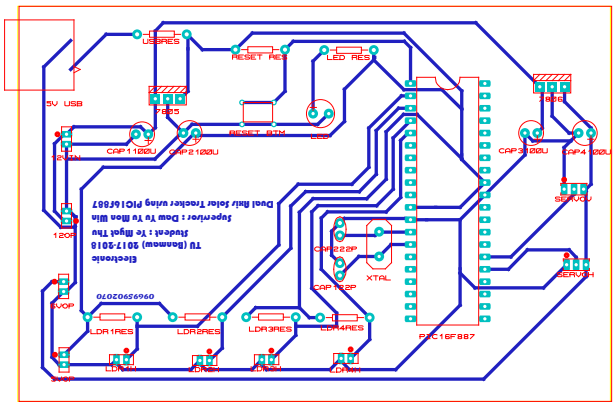
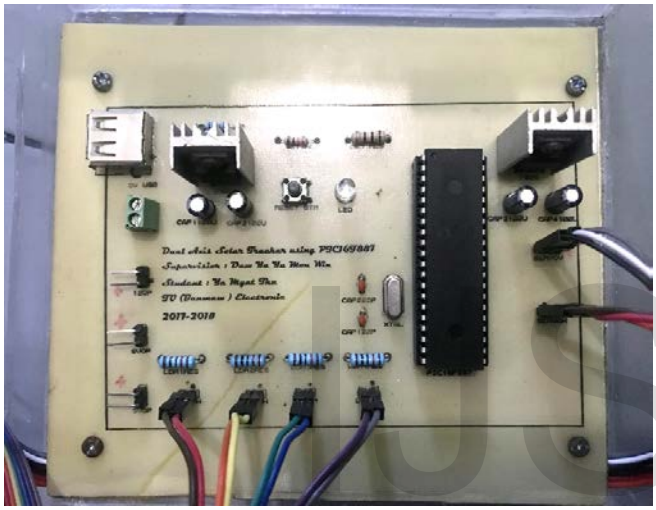


Figure 14. Hardware Test Representation

5.3 PCB 2D Track Line using Proteus



5.4 Top View of Main Circuit PCB(Printed Circuit Board)



6 Conclusion

The controller circuit used to implement this system has been designed with a minimum number of components and has been integrated onto a single PCB for simple assembly. The use of servo motors enables accurate tracking the sun's position. The program specified the various actions required to wor properly. As a result, successful tracking is achieved.

.**Acknowledgment**

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