Khulna University of Engineering & Technology, Khulna

Department of Computer Science & Engineering

Course No. - CSE 3104

Project Report on

"Smart Solar Panel Control & Obstacle Detection System"

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Objectives:

The main purposes of this project are given below:

- To increase the electric power produced by a solar panel.
- To control the solar panel automatically by using some peripheral equipment.
- To detect obstacles on the solar panel preventing power production.
- To alarm when detecting obstacles on the solar panel.

Introduction:

An automated solar panel is a device that orients the panel surface towards the sun.

For solar panels, the sun trackless are used to minimize the angle of incidence between the incoming sunlight and solar panel surface. This increases the amount of energy produced from a fixed amount of installed power generating capacity. Sunlight has two components the “direct beam” that carries about 90% of the solar energy, and the “diffuse sunlight” that carries the remainder, the diffuse portion is the blue sky on a clear day and is a larger proportion of the total on cloudy days. As the majority of the energy is in the direct beam, maximizing collection requires the sun to be visible to the panels for as long as possible.

i	Lost	i	Hours	Lost
0°	0%	15°	1	3.4%
1°	0.015%	30°	2	13.4%
3°	0.14%	45°	3	30%
8°	1%	60°	4	> 50%
23.4°	8.3%	75°	5	> 75%

Fig 1: Direct Power loss(%) due to misalignment(angle i)

Fig. 2: diffuse sunlight in the left and direct sunlight in right

Block Diagram:

Block diagram of our proposed system is given below:

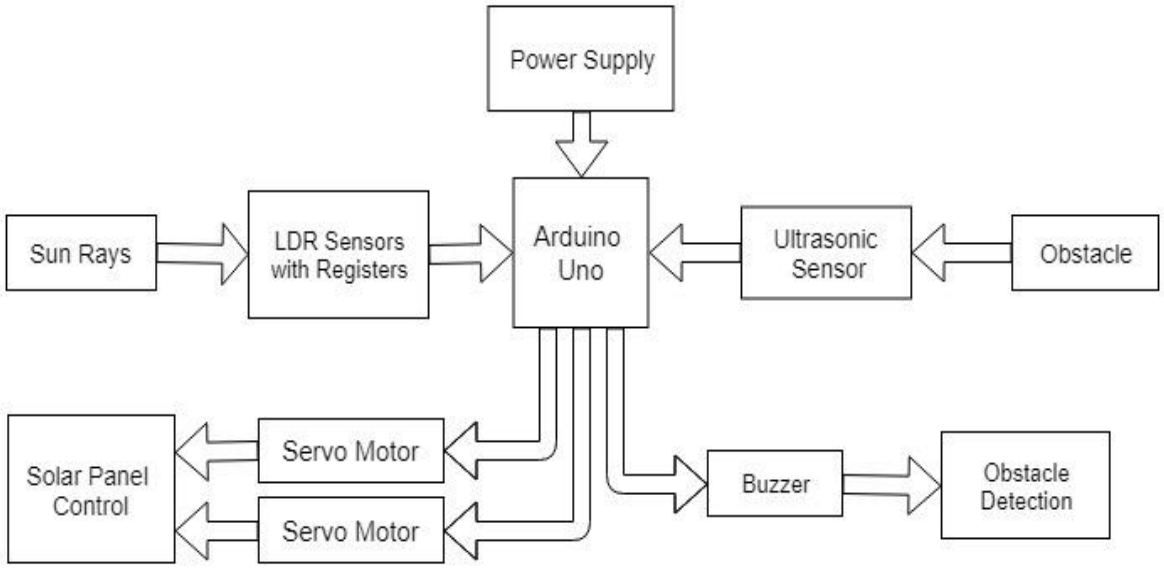

Fig. 3: Block Diagram of Smart Solar Panel Control & Obstacle Detection System

Flowchart: Flowchart of the system will be like this:

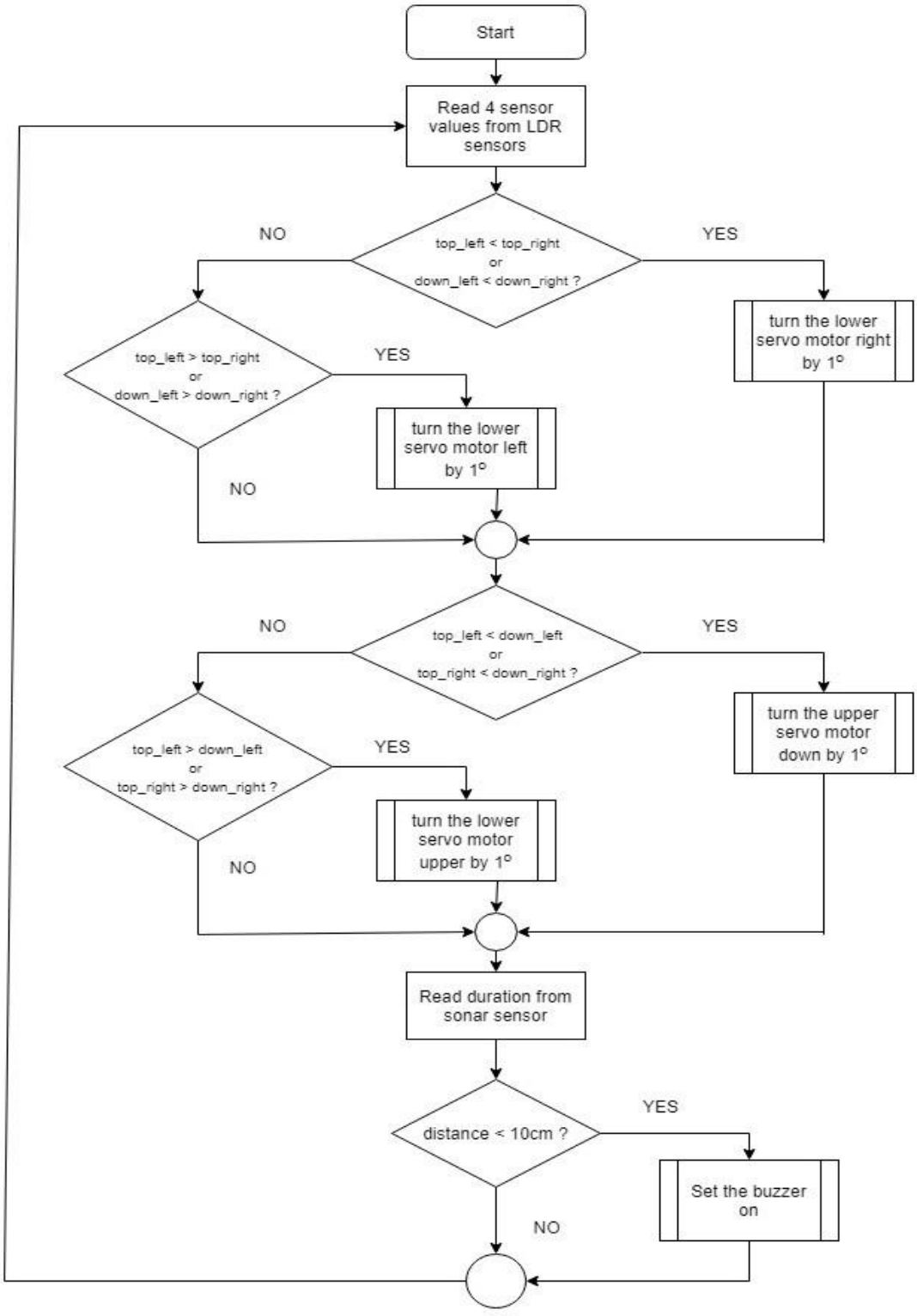

Fig. 4: Flowchart of Smart Solar Panel Control & Obstacle Detection System

Pseudocode:

Here is the pseudocode for the software design of the system:

s1, servo type global var1

s2, servo type global var2

echo:= 9

trig:= 8

buzzer:= 7

upper_servo:= 6

lower_servo:= 5

servo1:= 57

servo2:= 143

function setup()

pinMode echo to input

pinMode trig to output

pinMode buzzer to output

pinMode upper_servo to output

pinMode lower_servo to output

lower_servo attach to s1

upper_servo attach to s2

end function

function loop()

set delay to 1ms

top_left:= analogRead(A0)

top_right:= analogRead(A1)

down_left:= analogRead(A2)

down_right:= analogRead(A3)

if (top_left+100) less than top_right

servo1:=servo1+1

```
    if servo1 greater than 145
        servo1:= 145
    end if
    write servo1 to s1
end if
if (down_left+100) less than down_right
    servo1:=servo1+1
    if servo1 greater than 145
        servo1:= 145
    end if
    write servo1 to s1
end if
if top_left greater than (100+top_right)
    servo1:=servo1-1
    if servo1 less than -30
        servo1:= -30
    end if
    write servo1 to s1
end if
if down_left greater than (100+down_right)
    servo1:=servo1-1
    if servo1 less than -30
        servo1:= -30
    end if
    write servo1 to s1
end if
if (top_left+100) less than down_left
    servo2:=servo2+1
    if servo2 greater than 230
        servo2:= 230
```

```
    end if
    write servo2 to s2
end if
if (top_right+100) less than down_right
    servo2:=servo2+1
    if servo2 greater than 230
        servo1:= 230
    end if
    write servo2 to s2
end if
if top_left greater than (100+down_left)
    servo2:=servo2-1
    if servo2 less than 55
        servo2:= 55
    end if
    write servo2 to s2
end if
if top_right greater than (100+down_right)
    servo2:=servo2-1
    if servo2 less than 55
        servo2:= 55
    end if
    write servo2 to s2
end if
buzzer in LOW mode
trig in LOW mode
set delay to 2ms
trig HIGH in mode
set delay to 10 ms
trig in LOW mode
```

duration:= pulseIn(HIGH to echo)

*distance:=duration * 0.034/2*

if distance less than 10

buzzer in HIGH mode

set delay to 10ms

end if

end function

Hardware Design:

Hardware equipment that we need in order to build the project are given below:

1. Arduino UNO
2. servo motors (SG90)
3. LDR sensors
4. 100kΩ resistors
5. ultrasonic sensor
6. buzzer
7. bread board
8. Power supply
9. Connecting wire (As required)

Using these apparatuses, we have constructed this circuit diagram below:

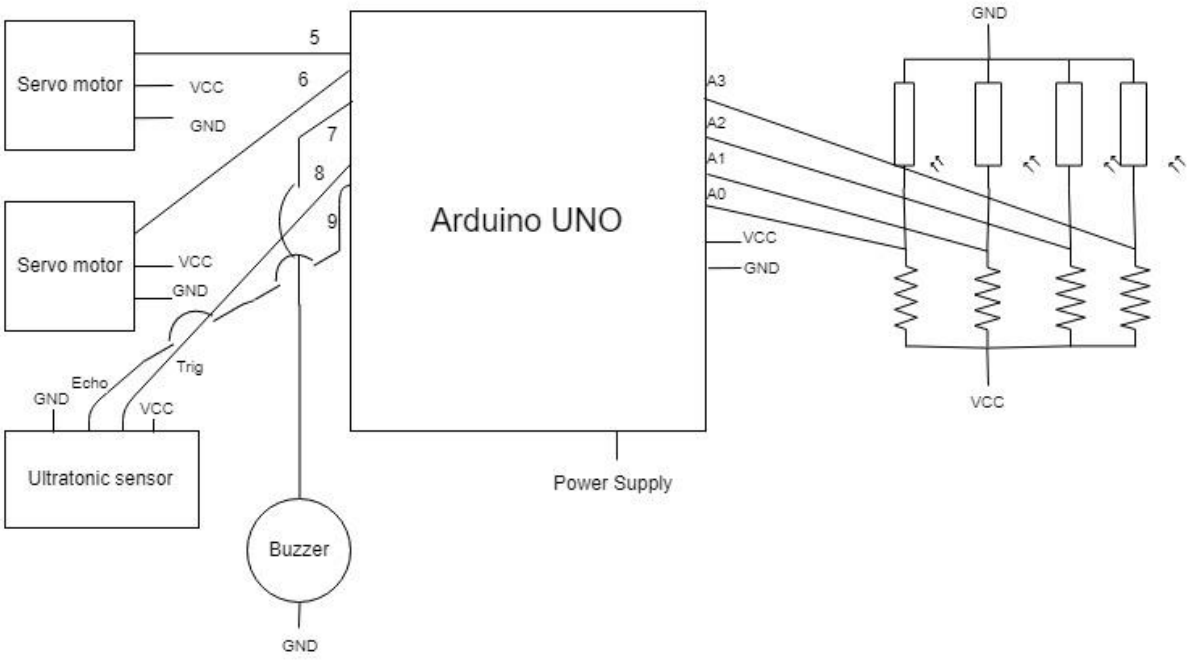

Fig. 5: Hardware Design of Smart Solar Panel Control & Obstacle Detection System

Prototype Design & Implementation:

We have designed the prototype for automatic solar panel control system. In fig. 6, rotating between left and right sides will be performed by the lower servo motor. And rotating between up and down sides will be performed by the upper servo motor. So, we can easily get a dual axis sun tracking solar panel system.

Now, from the designed figure, we have implemented a real prototype of the system where a panel considered as a solar panel can move in the above four directions. Moreover, an ultrasonic sensor was used on the surface of the panel which can detect the obstacle with distance less or equal 10cm. Fig. 7 shows our built prototype of the system.

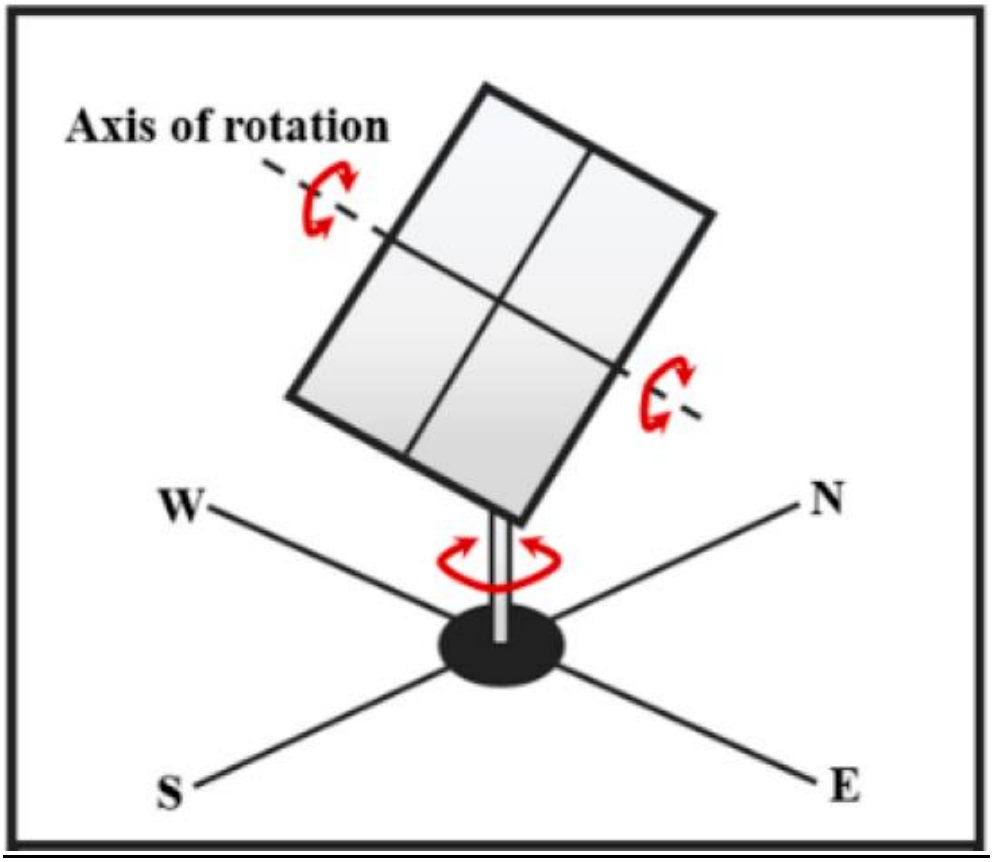

Fig. 6: Prototype Design of Automatic Solar Panel Control System (without obstacle detection)

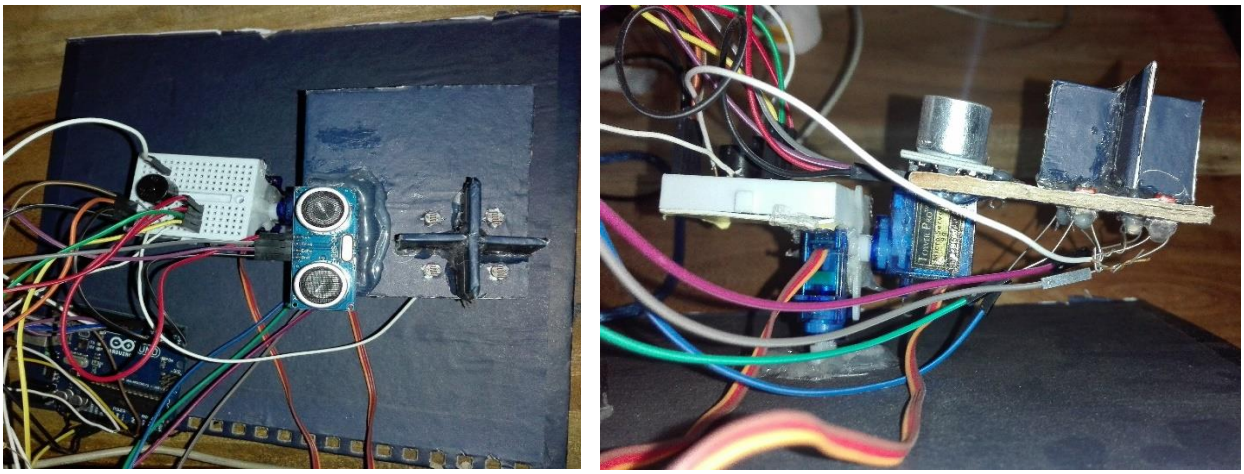

Fig. 7: Built prototype of Smart Solar Panel Control & Obstacle Detection System(upper & side view)

System Testing:

We have tested the design system with torch as source of light. The testing results we have found are:

1. In case of fig: 8, the source of light was straight perpendicular to the surface of the project that's why the panel remained unchanged.
2. In case of fig: 9, the source of light was in an angle with surface in a clockwise direction of the panel's normal position, that's why the panel turned in that direction and exactly in same angle as source of light.
3. In case of fig: 10, the source of light was in an angle with surface in a counter clockwise direction of the panel's normal position, that's why the panel turned in the counter clockwise direction and exactly in same angle as source of light.
4. In case of fig: 11, an object with distance less than 10cm from the surface was detected by ultrasonic sensor. That's why the buzzer was found alarming.

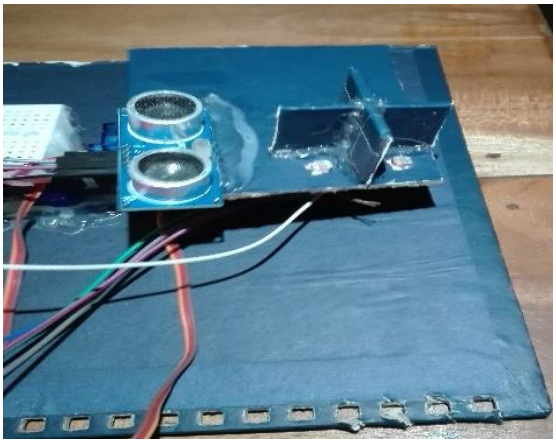

Fig. 8

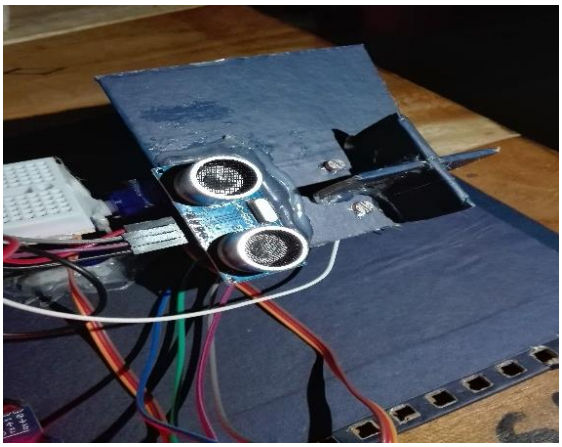

Fig. 9

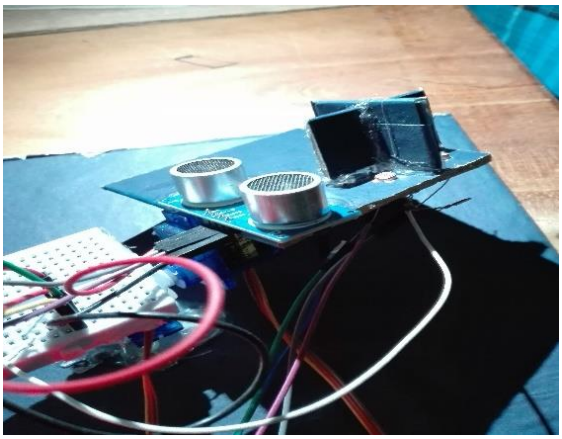

Fig. 10

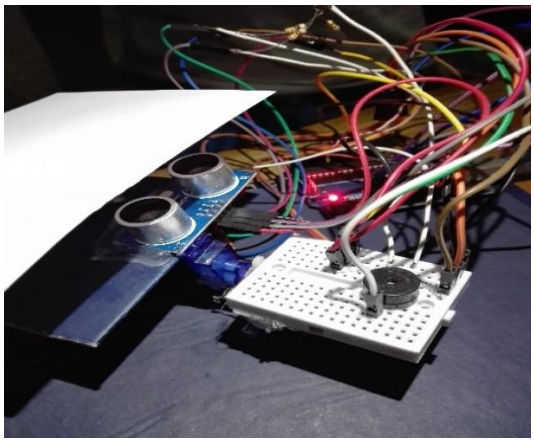

Fig. 11

Experimental Results:

We have experimented the system to gather some statistical results. After the experience, we have found the rotating speed of lower servo as 10.71^{o} per second and the upper servo was rotating faster than the lower one with the speed of 14.56^{o} per second. As the servo motors can rotate no more than 180^{o}, so if we applied source of light in a direction such that the panel would rotating continuously, the panel eventually stopped rotating after 90^{o} in both sides. The ultrasonic sensor can detect the obstacle with distance less or equal 10cm perfectly.

Discussion:

In this project, an automated control system was built in order to increase the energy production in a solar panel which automatically moves the solar panel surface. The rotating speeds of the panel in the four directions were found satisfying. But, as a servo motor can rotate no more than 180^{o}, there were found some restrictions to rotate the panel to track the source of light. Moreover, obstacle detection system was developed which detect and alarm when an obstacle appears on the panel. Here, distance was measured perfectly by the ultrasonic sensor, so the buzzer was alarming properly if an obstacle was found.

Conclusion:

The report has presented a novel and a simple control implementation of a solar panel controller and obstacle detector that employed two servo motor to follow the Sun and used a ultrasonic sensor with buzzer to detect the obstacle.

A laboratory prototype has been successfully built and tested to verify the effectiveness of the control implementation. Experiment results indicated that the developed system increased the energy gain for a partly cloudy day.

References:

1. https://www.arduino.cc/reference/