Automatic Solar Panel Cleaning Device

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***Abstract*—In desert areas, sand constantly accumulates on the solar panels, which leads to a decrease in efficiency. This report is related to the solution to the same concern. We made an automatic solar panel cleaning system using Arduino, IR sensor and Servo motors. With the help of wiping arms installed on servo motors, the panel is cleaned. It requires no human intervention.**

Keywords—IR sensor, Solar panel cleaning, Arduino, Automatic cleaning.

I. Aim

In the desert area, Sand get accumulates on the panels, which decreases the efficiency. We made an automatic wiper with the help of Arduino Uno, an IR Sensor and Servo motors, which cleans the panel when it detects that sand is accumulated.

II. Theory

IR Sensor is broadly used as an object detection device, We are using this to detect sand on panels. When sand is detected, with the help of Arduino and servo motors, wipers are used to clean out that sand.

IR sensor Consists of an IR transmitter and an IR detector. When an object comes near the sensor. Transmitted IR is reflected by the object, and after reflecting, waves get detected by the IR detector.

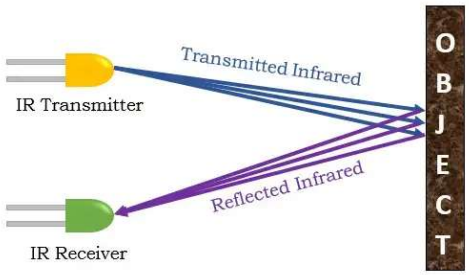

Figure 1: IR working principle

Source: https://electricalfundablog.com/infrared-sensor/

Arduino is used to processing data given by IR and trigger wipers.

III. Instrument Required

For making this prototype mainly, these components are used.

Component	Purpose
Arduino Uno	Working as intermediate
IR sensor	For detecting sand
Servo motors	For rotating wipers

Also, for this purpose, a small-sized solar panel is used. And a few jumpers and breadboards were used to make connections according to the following circuit diagram.

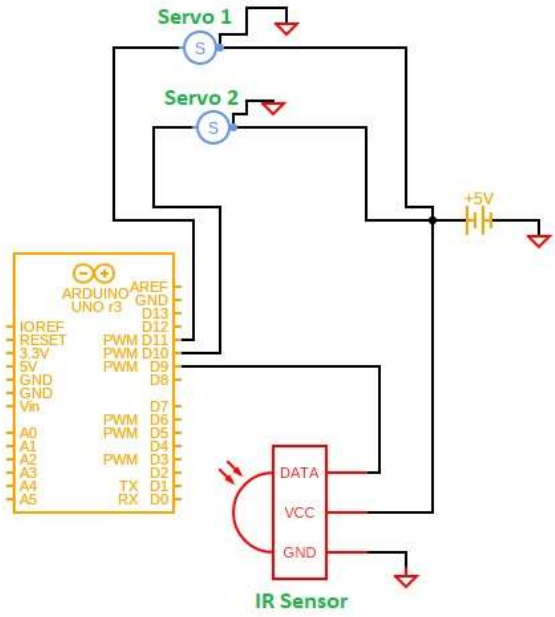

Figure 2: Circuit Diagram

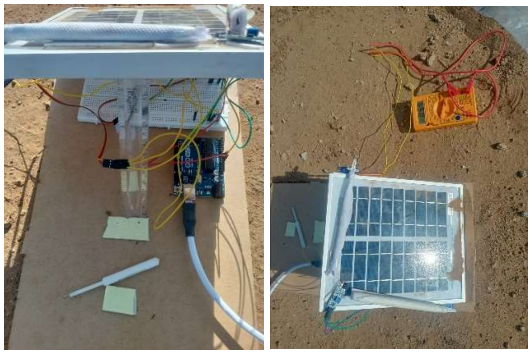

Figure 3 and 4: Hardware Implementation of Circuit

IV. Result

We measured output voltage and short circuit current by increasing the amount of sand on the solar panel at two different times. We have obtained the following data.

Table 1: Reading taken at 3 PM

Amount of sand	Output voltage(V)	Short Circuit current (A)	Power generated
Very small	11.36	0.92	10.45
Small increment	11.32	0.86	9.74
.	11.29	0.83	9.37
.	11.17	0.71	7.93
.	11.12	0.62	6.89
Almost covered with sand	10.99	0.49	5.38
Wiped	11.36	0.93	10.56

Table 2: Reading taken at 8 AM(cloudy weather)

Amount of sand	Output voltage(V)	Short Circuit current (A)	Power generated
Very small	10.81	0.6	6.49
Small increment	10.74	0.43	4.62
.	10.53	0.36	4.53
.	10.37	0.32	3.32
.	10.31	0.29	2.99
Almost covered with sand	10.20	0.26	2.65
Wiped	10.83	0.62	6.71

As the above readings clearly state, the accumulation of sand decreases the efficiency to almost half of the one with a clean surface.

Calculation: Change in efficiency

From 1st Table

((10.56-5.38)/10.56)*100=49.05%

From 2nd Table

((6.71-2.65)/6.71)*100=60.51%

With the accumulation of sand, Voltage output doesn't vary much, but short circuit current decreases significantly. Efficiency decreases by approximately 50%, even with a very thin layer of sand on the panel.

Servo motors used in the project take a maximum of 3.5 watts of power, which is still less than power generated with solar panels almost covered with sand.

V. Discussion

A. *Other Opportunities:*

1) The system can be made solar tracking to collect whole days' data with wipers and without wipers. One pair of batchmates is working on making a system for solar tracking and analysing daylong data, we also thought to implement both features together, but as they are working especially on that idea, so we left that idea.

2) During rain, the sensor will detect objects continuously and will send a signal to Arduino, but this is not required, so another improvement can be that during rain, the system turns off.

3) Wipers can be improved by using some fine material.

4) Whole system can be designed into a minimalistic package so that it can be installed easily.

5) Initially, Arduino was programmed to run wipers as soon as the signal was detected, but we realised that it was running wipers without sand. So we change the program to run wipers only when there is an obstacle for more than5 seconds.

B. *Learnings:*

1) Learned working principle of IR sensor and distance detection using IR Proximity module. Knew about limitation of the sensor.

2) Had an intuition of the outputs of Solar panels changing with the intensity of sunlight.

3) Revised Arduino programming.