

Solar Panel Cleaner

A Sustainable Solution for Solar
Energy Maintenance

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Introduction

- This project focuses on developing an automated solar panel cleaning system that operates via Bluetooth control, improving *efficiency* and performance of solar panel.

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Problem Statement

- Dust and dirt accumulation on solar panels reduce their efficiency. Manual cleaning is time-consuming and inefficient. An automated cleaning system enhances energy output.




Before cleaning

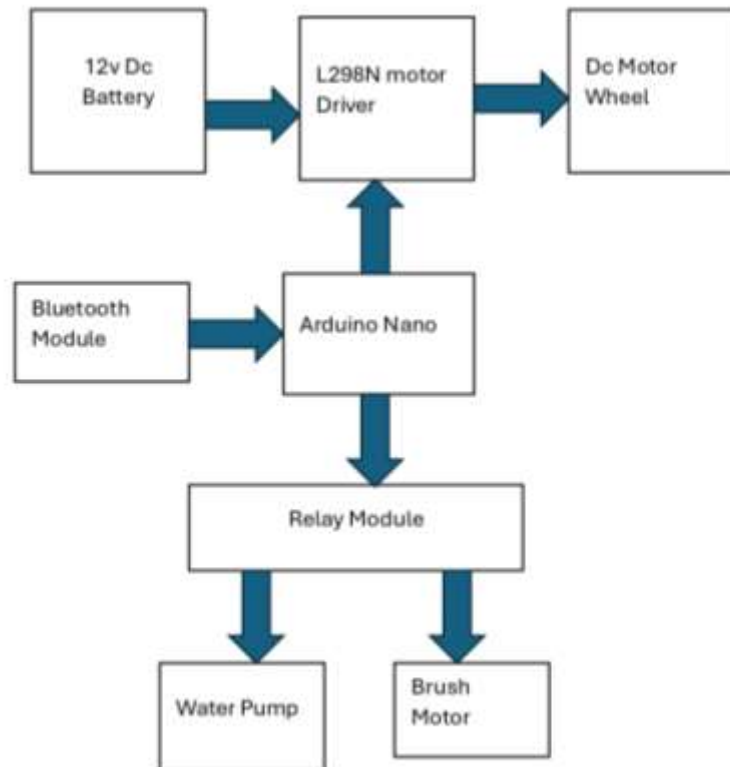


After cleaning

Time Line

- 
- **January** → Brainstorming / Idea selection
 - **Febraury** → Circuit design & Installation
 - **March** → Final Assembly & Efficiency Measurement

BLOCK DIAGRAM



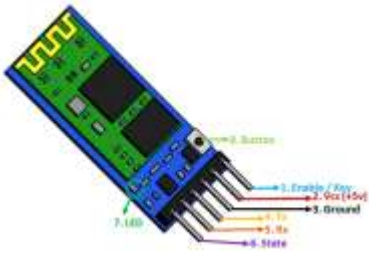
IMPORTANT COMPONENT



Arduino Nano



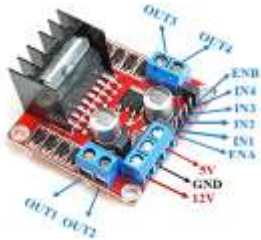
Water Pump



HC-05 - Bluetooth Module



Li-ion Battery



L298N Motor Driver Module



Relay Module

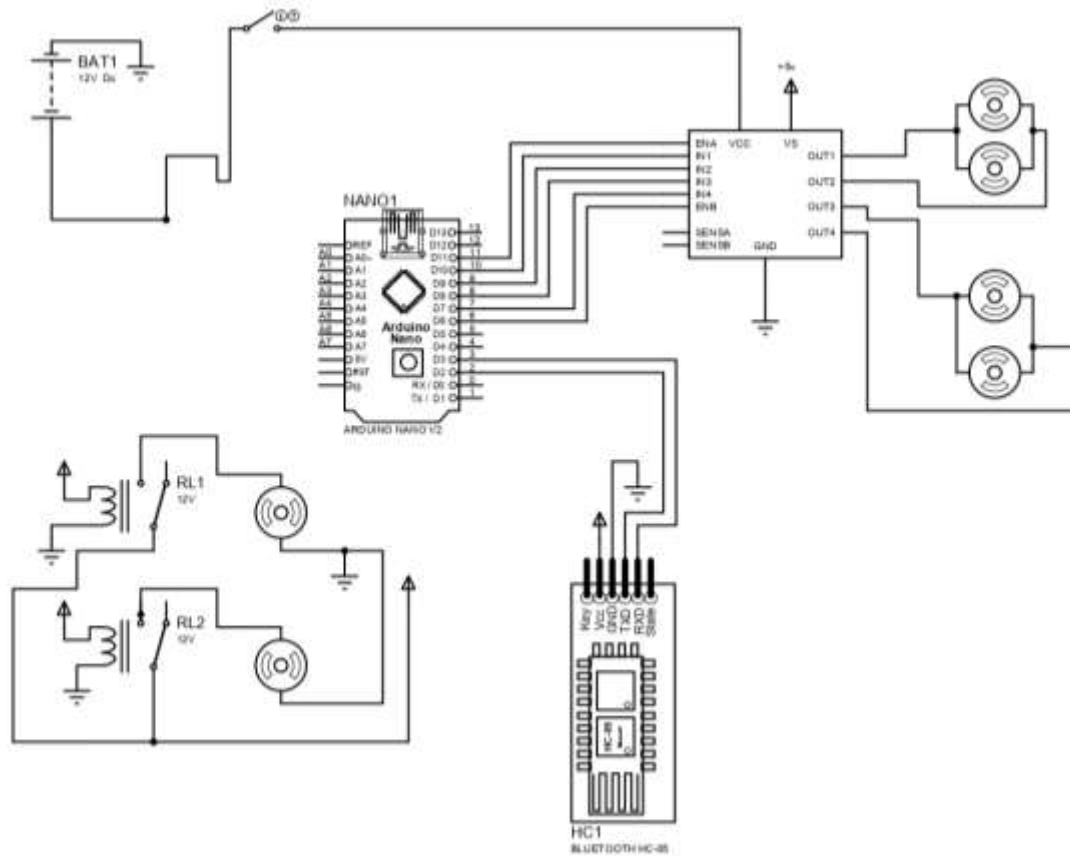


Dc Motor

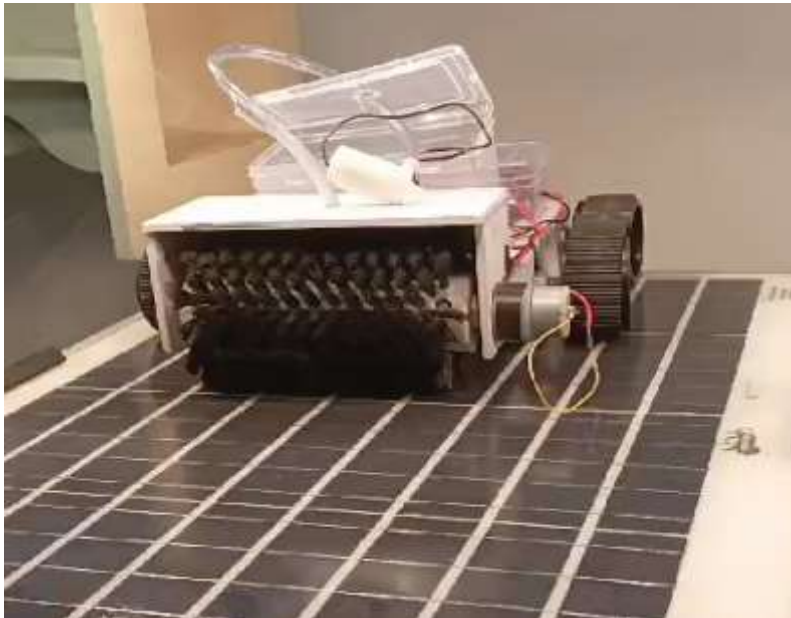
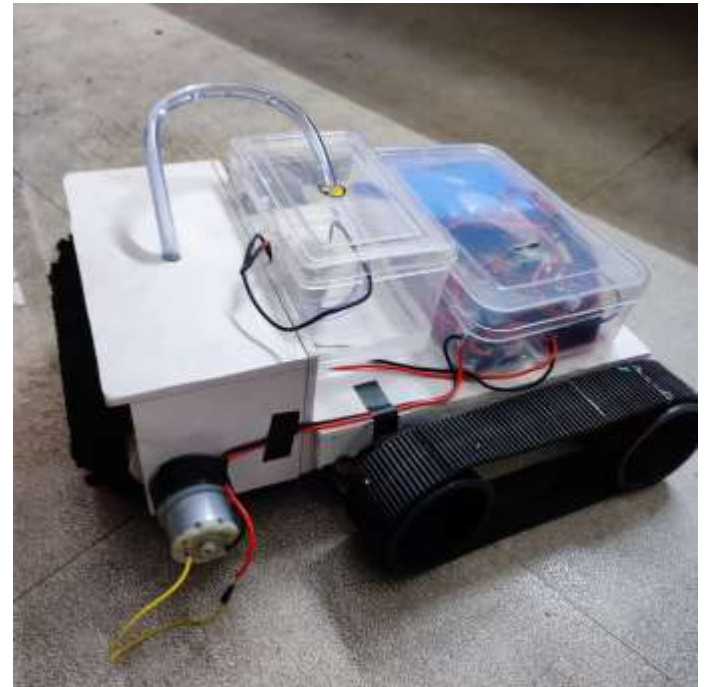


PVC Sheets

CIRCUIT DESIGN



FINAL PRODUCT

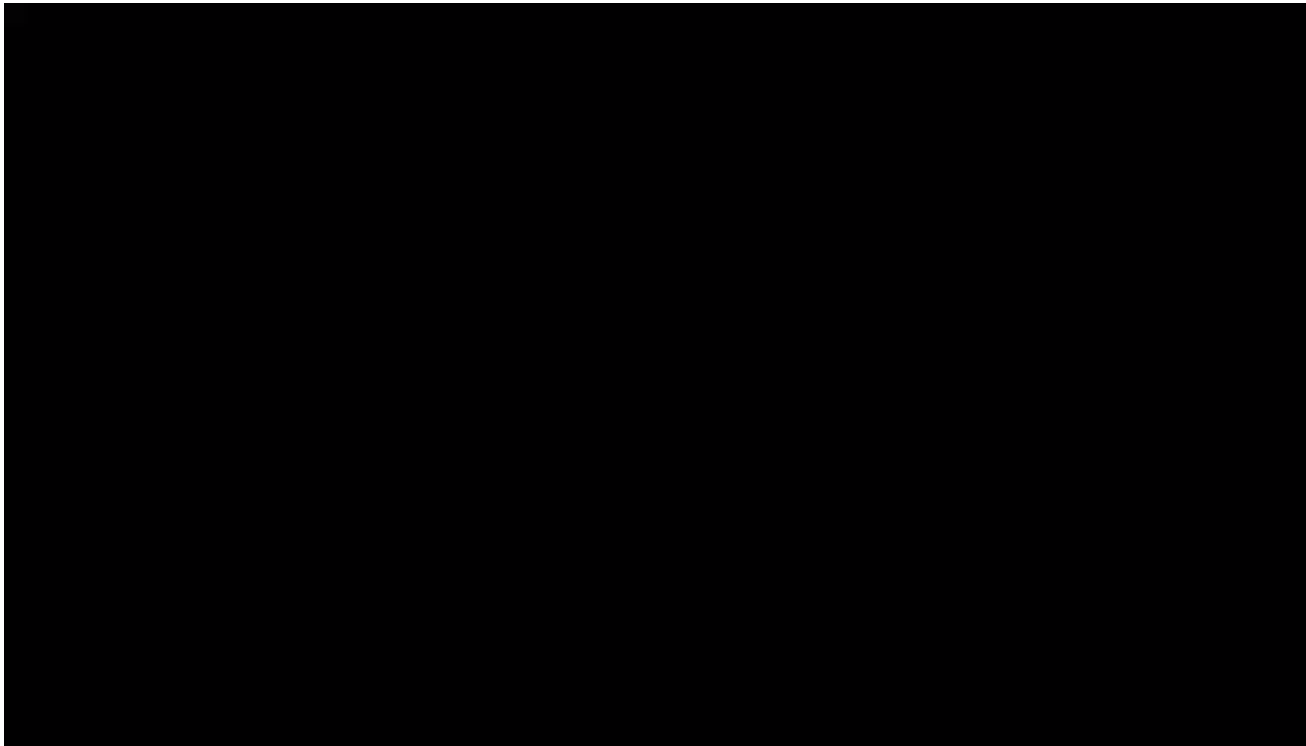


FINAL PRODUCT



WORKING OF ROVER

- The system receives cleaning commands via a Bluetooth-enabled mobile app. The microcontroller controls motors and sprayers to clean the panel efficiently.



EFFICIENCY

SOLAR PANEL EFFICIENCY

1. BEFORE CLEANING

		Temperature	Voltage	Current	Power
Radiation					
300		29.1	4.4	0.44	1.936
300		29.1	4.4	0.45	1.98
					Mean power = 1.968

2. AFTER CLEANING

		Temperature	Voltage	Current	Power
Radiation					
		29.1	4.5	0.47	2.115
300		29.1	4.5	0.48	2.16
300					Mean power = 2.1375

EFFICIENCY ANALYSIS FOR WET CLEANING

$$Power = V \cdot I$$

① Before cleaning mean power

$$\Rightarrow 1.968$$

② After cleaning mean power

$$\Rightarrow 2.1375$$

% change in power of solar panel

$$= \left| \frac{P_{\text{initial}} - P_{\text{Final}}}{P_{\text{initial}}} \right| \times 100$$

$$= \left| \frac{1.968 - 2.1375}{1.968} \right| \times 100$$
$$= 8.6128 \%$$

Cleaning Method	Efficiency Improvement	Pros	Cons
Dry Cleaning (brush, air blower)	5-30%	Saves water, easy automation	May not remove sticky dirt
Wet Cleaning (water spray, wipers)	10-40%	More thorough cleaning	Uses water, may require drainage

ADVANTAGES

- Enhances solar panel efficiency
- Reduces manual labor
- Saves water compared to traditional cleaning methods
- Remote operation via Bluetooth
- Cost-effective solution

APPLICATIONS

- Residential and commercial solar power plants
- Remote and inaccessible solar panel installations
- Large-scale solar farms
- Urban and industrial solar setups

CONCLUSION

- The Bluetooth-controlled solar panel cleaner enhances efficiency, reduces maintenance efforts, and ensures optimal energy generation. Future improvements could include IoT integration for automated scheduling.

CODE

BLUETOOTH_CAR.ino

```
1  #include <SoftwareSerial.h>
2  #include <Servo.h>
3
4  // Define motor driver pins
5  #define IN1 5
6  #define IN2 6
7  #define IN3 9
8  #define IN4 10
9
10 // Define brush and water pump pins
11 #define BRUSH_MOTOR 7
12 #define WATER_PUMP 8
13
14 // Bluetooth module RX & TX pins
15 SoftwareSerial Bluetooth(2, 3);
16
17 void setup() {
18     pinMode(IN1, OUTPUT);
19     pinMode(IN2, OUTPUT);
20     pinMode(IN3, OUTPUT);
21     pinMode(IN4, OUTPUT);
22     pinMode(BRUSH_MOTOR, OUTPUT);
23     pinMode(WATER_PUMP, OUTPUT);
24
25     Bluetooth.begin(9600);
26     Serial.begin(9600);
27 }
28
29 void loop() {
30     if (Bluetooth.available()) {
```

```
27     }
28
29     void loop() {
30         if (Bluetooth.available()) {
31             char command = Bluetooth.read();
32             Serial.println(command);
33
34             switch (command) {
35                 case 'F': // Move Forward
36                     moveForward();
37                     break;
38
39                 case 'B': // Move Backward
40                     moveBackward();
41                     break;
42
43                 case 'L': // Turn Left
44                     turnLeft();
45                     break;
46
47                 case 'R': // Turn Right
48                     turnRight();
49                     break;
50
51                 case 'S': // Stop
52                     stopMotors();
53                     break;
54
55                 case 'W': // Activate Water Pump
56                     digitalWrite(WATER_PUMP, HIGH);
57                     break;
58
59                 case 'w': // Deactivate Water Pump
60                     digitalWrite(WATER_PUMP, LOW);
61                     break;
62             }
63         }
64     }
65 }
```

CODE

```
BLUETOOTH_CAR.ino
--
54
55     case 'W': // Activate Water Pump
56         digitalWrite(WATER_PUMP, HIGH);
57         break;
58
59     case 'w': // Deactivate Water Pump
60         digitalWrite(WATER_PUMP, LOW);
61         break;
62
63     case 'M': // Activate Brush Motor
64         digitalWrite(BRUSH_MOTOR, HIGH);
65         break;
66
67     case 'm': // Deactivate Brush Motor
68         digitalWrite(BRUSH_MOTOR, LOW);
69         break;
70
71     default:
72         stopMotors();
73         break;
74 }
75 }
76 }
77
78 void moveForward() {
79     digitalWrite(IN1, HIGH);
80     digitalWrite(IN2, LOW);
81     digitalWrite(IN3, HIGH);
82     digitalWrite(IN4, LOW);
83 }
84
85 void moveBackward() {
86     digitalWrite(IN1, LOW);
```

```
80     digitalWrite(IN2, LOW);
81     digitalWrite(IN3, HIGH);
82     digitalWrite(IN4, LOW);
83 }
84
85 void moveBackward() {
86     digitalWrite(IN1, LOW);
87     digitalWrite(IN2, HIGH);
88     digitalWrite(IN3, LOW);
89     digitalWrite(IN4, HIGH);
90 }
91
92 void turnLeft() {
93     digitalWrite(IN1, LOW);
94     digitalWrite(IN2, HIGH);
95     digitalWrite(IN3, HIGH);
96     digitalWrite(IN4, LOW);
97 }
98
99 void turnRight() {
100     digitalWrite(IN1, HIGH);
101     digitalWrite(IN2, LOW);
102     digitalWrite(IN3, LOW);
103     digitalWrite(IN4, HIGH);
104 }
105
106 void stopMotors() {
107     digitalWrite(IN1, LOW);
108     digitalWrite(IN2, LOW);
109     digitalWrite(IN3, LOW);
110     digitalWrite(IN4, LOW);
111 }
112
```

CODE

- <https://github.com/Adityaraikasyap/SOLAR-PANNEL-CLEANER-ROVER>
- https://drive.google.com/drive/u/0/folders/1Tr15nN_ph6pI2-XOvi5rFi-KKgHrUbUt