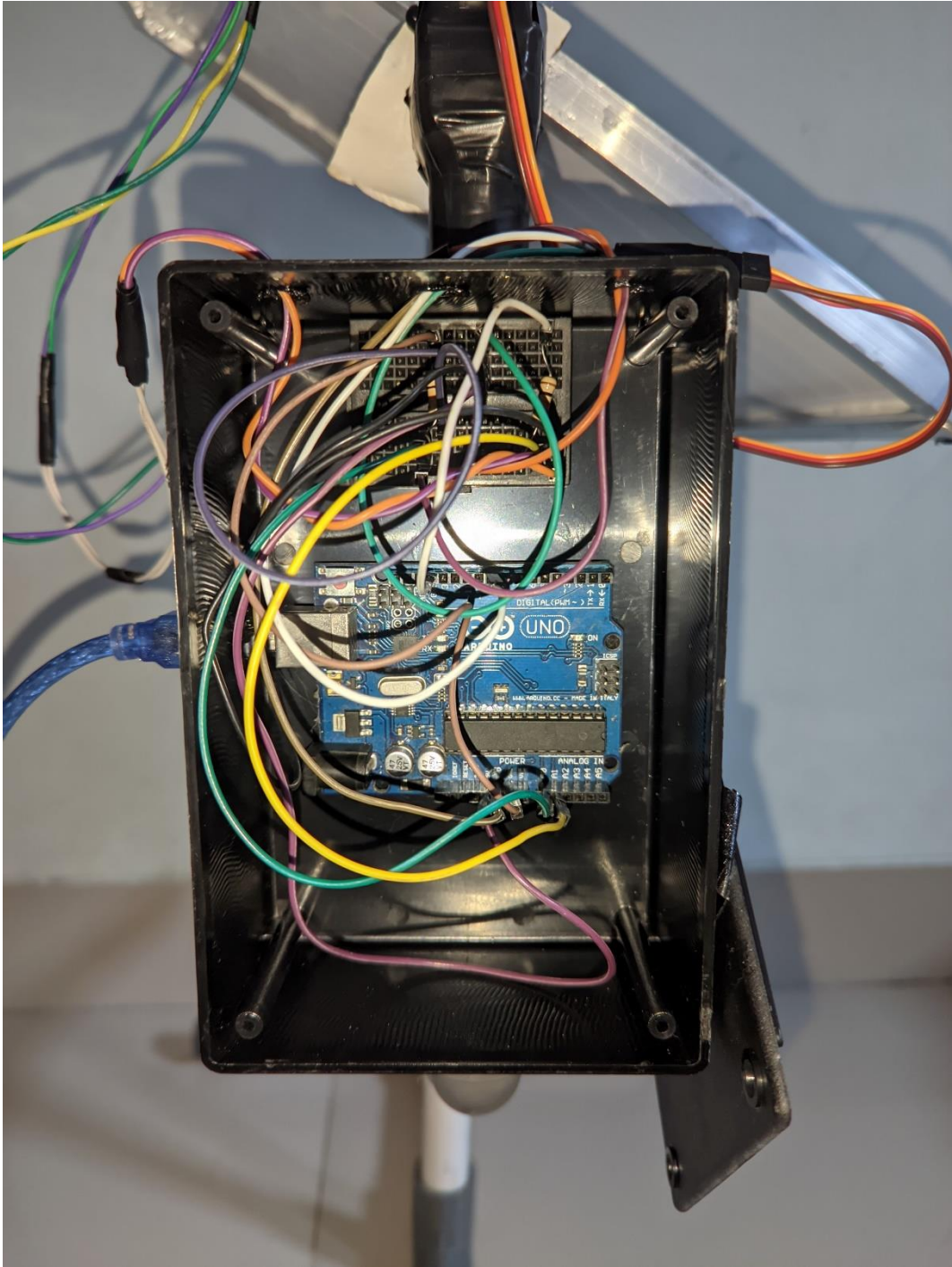


LAMPIRAN

Lampiran 1. Single-axis Solar Tracker



Lampiran 2. Rangkaian Elektronika



Lampiran 3. Data *Output* Kendali PI

Waktu	Nilai LDR 1	Nilai LDR 2	<i>Output</i>
10:09:28 AM	13.92	7.06	93.00
10:09:28 AM	13.92	7.06	93.02
10:09:28 PM	13.92	7.25	93.05
10:09:28 PM	13.92	7.25	93.25
10:09:28 PM	13.92	7.25	94.21
10:09:28 PM	13.92	7.06	93.72
10:09:28 PM	13.92	7.06	94.71
10:09:28 PM	13.92	7.06	95.18
10:09:28 PM	11.37	5.88	95.10
10:09:28 PM	11.56	6.66	94.92
10:09:28 PM	12.15	6.08	96.41
10:09:28 PM	11.76	6.86	95.73
10:09:28 PM	12.15	6.27	96.64
10:09:28 PM	14.11	7.45	97.62
10:09:28 PM	12.54	6.86	97.53
10:09:29 AM	12.74	7.06	97.93
10:09:29 AM	12.94	7.64	98.34
10:09:29 AM	13.33	7.84	98.74
10:09:29 AM	13.52	10.39	97.99
10:09:29 AM	13.72	8.43	99.41
10:09:29 AM	14.11	8.43	99.83
10:09:29 AM	13.92	8.82	100.22
10:09:29 AM	14.31	8.62	100.64
10:09:29 AM	14.9	8.43	101.66
10:09:29 AM	14.11	8.62	101.56
10:09:29 AM	14.11	8.62	101.56
10:09:29 AM	15.09	10.39	102.63
10:09:29 AM	15.88	11.76	102.98
11:09:29 PM	15.68	12.15	102.74
12:09:29 AM	13.92	11.17	102.41
10:09:30 AM	10.19	10.58	100.11
10:09:30 AM	10.19	10.58	100.11
10:09:30 AM	13.33	12.74	100.11
10:09:30 AM	10.98	13.92	98.94
10:09:30 AM	12.15	12.94	99.94
10:09:30 AM	12.94	13.13	99.94
10:09:30 AM	13.52	13.13	99.94
10:09:30 AM	13.92	12.74	100.53
10:09:30 AM	17.05	13.13	101.79
10:09:30 AM	14.5	15.29	100.29

Lampiran 4. Data *Output* Kendali PID

Waktu	LDR 1	LDR 2	<i>Output</i>
10:30:28 AM	7.84	10.58	90.66
10:30:28 AM	8.04	11.17	88.01
10:30:28 AM	8.04	10.98	88.15
10:30:28 AM	6.66	9.02	87.77
10:30:28 AM	6.27	9.6	86.72
10:30:28 AM	5.88	10	85.48
10:30:28 AM	6.08	11.17	84.05
10:30:28 AM	5.68	11.96	82.41
10:30:28 AM	9.02	10.78	84.74
10:30:28 AM	9.41	10.98	84.54
10:30:28 AM	9.41	10.98	84.54
10:30:28 AM	10.98	12.15	87.16
10:30:28 AM	13.92	10.98	89.07
10:30:28 AM	14.7	11.17	90.13
10:30:28 AM	15.29	12.15	90.69
10:30:29 AM	15.68	12.74	90.56
10:30:29 AM	16.27	13.52	90.94
10:30:29 AM	16.66	13.33	92.00
10:30:29 AM	16.86	15.09	91.19
10:30:29 AM	16.66	12.15	93.44
10:30:29 AM	17.05	11.17	94.88
10:30:29 AM	17.25	14.31	93.75
10:30:29 AM	17.64	15.09	94.13
10:30:29 AM	17.84	15.88	93.81
10:30:29 AM	18.03	16.66	94.00
10:30:29 AM	18.03	17.05	93.50
10:30:29 AM	18.23	17.05	94.19
10:30:29 AM	18.23	16.86	94.38
10:30:29 AM	18.42	16.27	95.24
10:30:29 AM	18.42	17.05	94.93
10:30:30 AM	18.42	16.46	95.12
10:30:30 AM	19.21	16.27	96.00
10:30:30 AM	18.42	17.44	94.99
10:30:30 AM	18.82	17.64	95.69
10:30:30 AM	18.42	18.62	95.74
10:30:30 AM	18.42	18.62	95.74
10:30:30 AM	18.82	18.03	95.74
10:30:30 AM	19.01	18.03	95.74
10:30:30 AM	18.82	17.84	95.74
10:30:30 AM	19.01	18.03	95.74

Lampiran 5. Program Kendali PID

```
1. #include <Servo.h>
2.
3. Servo motor;
4. unsigned long currentTime, previousTime;
5. double elapsedTime;
6. float Kp, Ki, Kd, SV, PID, Pv;
7. float PV;
8. float ldr1;
9. float ldr2;
10. int error, previousError;
11. float integral;
12. float MV, MV_1;
13.
14. void setup() {
15.   pinMode(9, OUTPUT);
16.   pinMode(A0, INPUT);
17.   pinMode(A1, INPUT);
18.   Serial.begin(9600);
19.
20.   //Tuning
21.   SV = 0;
22.   Kp = 0.5;
23.   Ki = 0.003;
24.   Kd = 0.1; // Tambahkan nilai untuk konstanta derivative
25. }
26.
27. void loop() {
28.   ldr1 = analogRead(A0) * 0.0049 * 40;
29.   ldr2 = analogRead(A1) * 0.0049 * 40;
30.
31.   MV_1 = 90;
32.   currentTime = millis();
33.   elapsedTime = (double)(currentTime - previousTime);
34.   PV = ldr2 - ldr1;
35.   error = SV - PV;
36.
37.   // Tambahkan kontrol untuk batasan integral
38.   if (Pi > 35) {
39.     error = (-1);
40.   } else if (Pi < (-35)) {
41.     error = 1;
42.   }
43.
```



```
44. integral = integral + error * elapsedTime;
45.
46. // Hitung nilai derivative
47. float derivative = (error - previousError) / elapsedTime;
48.
49. PID = (Kp * error) + (Ki * integral) + (Kd * derivative);
50.
51. motor.attach(9);
52. solar_on();
53.
54. previousTime = currentTime;
55. previousError = error; // Simpan nilai error sebelumnya
56. Serial.print("Ldr 1 : ");
57. Serial.print(ldr1);
58. Serial.print(" - Ldr 2 : ");
59. Serial.print(ldr2);
60. Serial.print(" - Output : ");
61. Serial.print(MV);
62. Serial.print(" - Error : ");
63. Serial.println(error);
64.}
65.
66.void solar_on() {
67.  MV = PID + MV_1;
68.  if (MV >= 125) {
69.    MV = 125;
70.  } else if (MV <= 55) {
71.    MV = 55;
72.  } else {
73.    MV = MV;
74.  }
75.  motor.write(MV);
76.}
77.
```

Lampiran 6. Program Kendali PI

```
1. #include<Servo.h>
2.
3. Servo motor;
4. unsigned long currentTime, previousTime;
5. double elapsedTime;
6. float Kp, Ki, SV, Pi;
7. float PV;
8. float ldr1;
9. float ldr2;
10. int error;
11. float integral;
12. float MV, MV_1;
13.
14. void setup () {
15.   pinMode(9,OUTPUT);
16.   pinMode(A0,INPUT);
17.   pinMode(A1,INPUT);
18.   Serial.begin(9600);
19.
20.   //Tuning
21.   SV = 0;
22.   Kp = 0.5;
23.   Ki = 0.003;
24. }
25.
26. void loop () {
27.   ldr1 = analogRead(A0)*0.0049*40;
28.   ldr2 = analogRead(A1)*0.0049*40;
29.
30.   MV_1 = 90;
31.   currentTime = millis();
32.   elapsedTime = (double)(currentTime - previousTime);
33.   PV = ldr2 - ldr1;
34.   error = SV-PV;
35.   if (Pi > 35){
36.     error = (-1);
37.   }else if(Pi < (-35)){
38.     error = 1;
39.   }
40.   integral = integral + error * elapsedTime;
41.   Pi = (Kp*error)+(Ki*integral);
42.
43.   motor.attach(9);
```

```
44.     solar_on();
45.     previousTime = currentTime;
46.     Serial.print("Ldr 1 : ");
47.     Serial.print(ldr1);
48.     Serial.print(" - Ldr 2 : ");
49.     Serial.print(ldr2);
50.     Serial.print(" - Output : ");
51.     Serial.print(MV);
52.     Serial.print(" - Error : ");
53.     Serial.println(error);
54. }
55. void solar_on(){
56.     MV = Pi+MV_1;
57.     if(MV>=125){
58.         MV = 125;
59.     }else if(MV<=55){
60.         MV = 55;
61.     }else{
62.         MV = MV;
63.     }
64.     motor.write(MV);
65. }
66.
```

Lampiran 7. Foto Proses Pengambilan Data Daya 1



Lampiran 8. Foto Proses Pengambilan Data Daya 2

