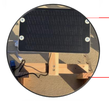
SOLAR TRACKING LITTERMINATOR

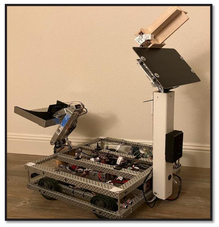
Real-World-Problem

Trash pollution destroys our environment.



Solar panels are more inefficient in the winter than during summer.

Engineering Goal



The engineering goal was to build an autonomous trash-collecting robot powered by the energy harvested from a high-efficiency sun-tracking solar panel.

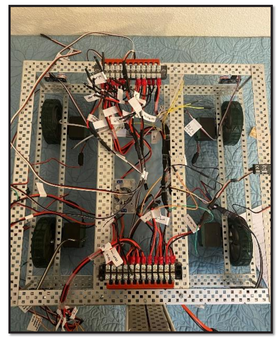
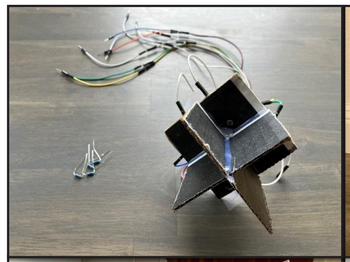
Arduino Code Sample

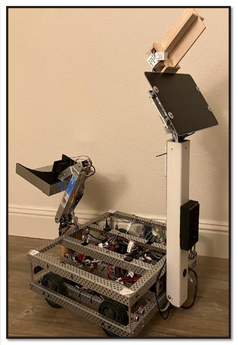
```
855  void calibrate_ldrs() {
856    if (calibrate_diag) {
857      ldr1 = analogRead(A0);
858      ldr2 = analogRead(A1);
859      ldr3 = analogRead(A2);
860      ldr4 = analogRead(A3);
861      light_avg = (ldr1+ldr2+ldr3+ldr4)/4;
862      ldr1_balance = light_avg - ldr1;
863      ldr2_balance = light_avg - ldr2;
864      ldr3_balance = light_avg - ldr3;
865      ldr4_balance = light_avg - ldr4;
866      Serial.println("============CALIBRATING============");
867      Serial.println("|      | LDR1 | LDR2 | LDR3 | LDR4 | ");
868      Serial.println("| Pure | " + (String)ldr1 + " | " + (String)ldr2 + "
869      Serial.println("| Avg  | " + (String)light_avg + " | " + (String)lig
870      Serial.println("|------|------|------|------|------| ");
871      Serial.println("| Bal  | " + (String)ldr1_balance + " | " + (String)
872      Serial.println("|------|------|------|------|------| ");
873      delay(5000);
874    }
875  }
```

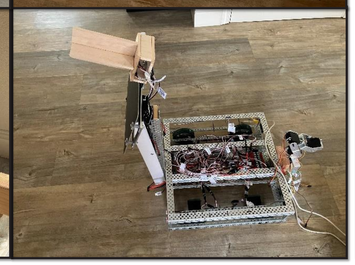
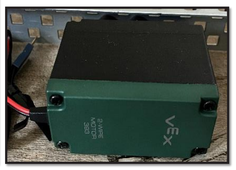
Time	mWh		Volts		Amperes		Watts	
	Litterminator	Roof	Litterminator	Roof	Litterminator	Roof	Litterminator	Roof
9:00	75	65	4.6190	4.1410	0.2034	0.1764	0.9130	0.7540
9:15	594	424	4.8910	4.1960	0.9116	0.6609	4.1480	3.8750
9:30	1598	1187	4.8790	4.0620	0.8352	0.7545	4.0880	3.0090
9:45	2698	2103	4.8990	4.9830	0.8902	0.7776	4.3520	3.8740
10:00	3589	2909	4.9210	4.9820	0.9430	0.7773	4.6600	3.8680
10:15	4791	3957	4.8790	4.9770	0.8977	0.7773	4.2090	3.8680
10:30	5951	4974	4.9180	4.9710	0.9381	0.7772	4.5260	3.8560
10:45	7095	5927	4.9240	4.9690	0.9435	0.7771	4.6430	3.8610
11:00	8154	6790	4.9330	4.9740	0.9466	0.7773	4.6300	3.8670
11:15	9410	7845	4.9460	4.9760	0.9932	0.7772	4.7970	3.8660
11:30	10562	8485	4.9550	4.9660	0.9921	0.7775	4.9120	3.8660
11:45	11886	9497	4.9560	4.9780	0.9818	0.7764	4.7990	3.8660
12:00	13016	10439	4.9580	4.9810	0.9798	0.7762	4.8550	3.8670
12:15	14295	11468	4.9580	4.9850	0.9771	0.7758	4.7940	3.8650
12:30	15406	12357	4.9600	4.9810	0.9762	0.7759	4.8350	3.8630
12:45	16621	13324	4.9590	4.9780	0.9715	0.7758	4.7620	3.8630
13:00	17964	14459	4.9670	4.9770	0.9367	0.7757	4.5340	3.8610
13:15	19009	15349	4.9660	4.9760	0.9270	0.7756	4.5000	3.8590
13:30	20067	16201	4.9630	4.9770	0.9501	0.7755	4.6990	3.8580
13:45	21336	17218	4.9670	4.1610	0.9209	0.7278	4.5300	3.0550
14:00	22144	17742	4.9730	4.1130	0.8940	0.6728	3.2450	2.7830
14:15	23302	18455	4.9710	4.0860	0.9193	0.6299	4.5400	2.5580
14:30	24384	19020	4.9710	4.0540	0.9029	0.5780	4.5630	2.3440
14:45	25396	19429	4.6010	4.0000	0.1460	0.4833	4.6060	2.0500
15:00	26255	19890	4.9530	3.9700	0.9204	0.4664	4.6100	1.8520

Trial Groups	Aluminum Can		Glass Bottle	
	Pick Up	Sort	Pick Up	Sort
Trial 1	Success	Success	Success	Success
Trial 2	Success	Success	Fail	N/A
Trial 3	Success	Success	Success	Success
Trial 4	Success	Success	Success	Success
Trial 5	Success	Fail	Fail	N/A
Success Rate	100%	80%	60%	100%

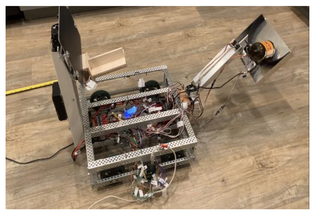
Methods

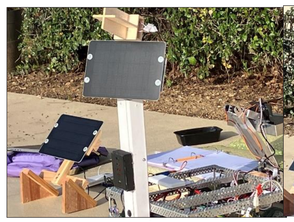


Data Collection



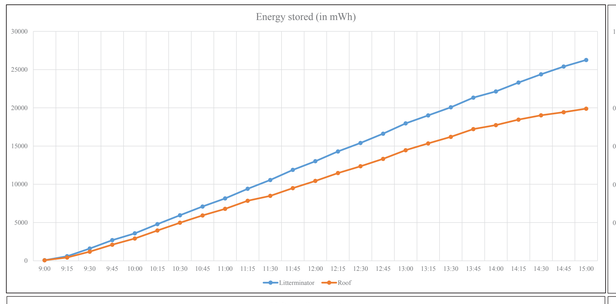
Trash Collection

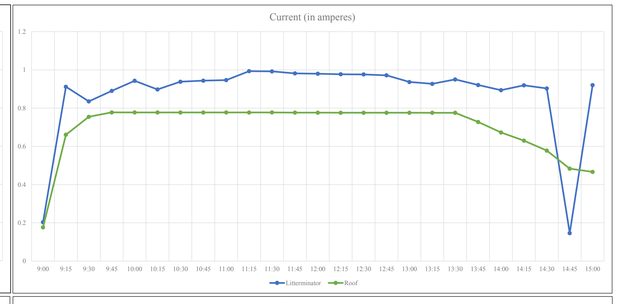


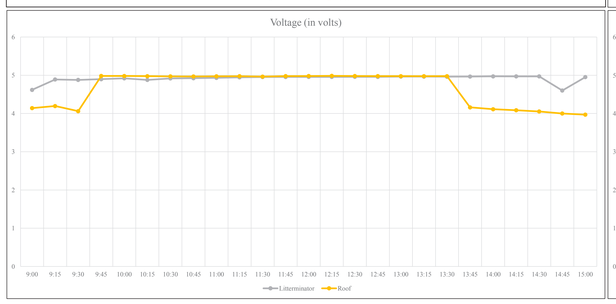
Morning

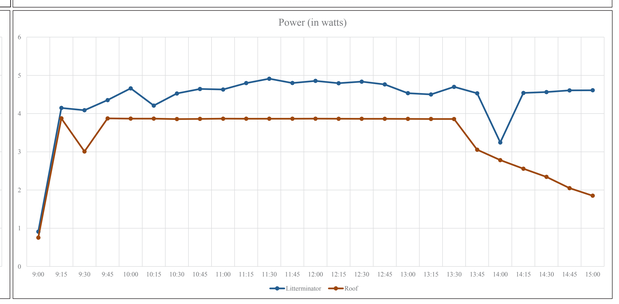
Afternoon

Evening









Further Research/Improvements

- Servo power efficient usage
- Reduce frequency of panel adjustment
- Use actuators instead of servos
- Plastic/glass detection based on audio frequency detector

- Use a Raspberry Pi for trash detection
- Utilize AI for trash and recycle sorting

- Use a 7V or 12V solar panel
- Have a robotic arm to pick up trash
- Make the whole robot face the sun
- Test the robot on uneven terrain
- Make the robot rain-resistant

Images from: Arduino IDE, Raspberry Pi, iStock

Trash Routine Code

```
693  void trash_routine() {
694    //Serial.println("Rotate count: " + (String)rotate_count);
695    //Serial.println("Back count: " + (String)bk_count);
696    Serial.println("================================");
697    if (rotate_count < 1) {
698      int turn_counter = 0;
699      //pick_up_process();
700      bool trash_detected = ((get_distance(sns_prox_fl) < max_dista
701      while ((!trash_detected) && (turn_counter < 500)) {
702        go_right(30);
703        trash_detected = ((get_distance(sns_prox_fl) < max_distance
704        if (trash_detected) all_stop();
705        turn_counter += 1;
706        delay(10);
707      }
708      all_stop();
709      if (trash_detected) {
710        //pick up and reset counters to 0
711        Serial.println("Trash detected. Starting pick up trash");
712        tone(squeakPin, 500, 500);
713        delay(510);
714        pick_up();
715      } else {
716        Serial.println("Trash NOT detected in loop count: " + (Stri
717      }
718      rotate_count += 1;
719    }
720    if (rotate_count >= 1) {
721      if (bk_count < 1) {
```

Diagnostics Code

```
1027  void diagnostic_program() {
1028    //simple diags
1029    servo_diagnostics();
1030    ldr_diagnostics();
1031    motor_diagnostics();
1032    led_diagnostics();
1033    sensor_diagnostics();
1034    induction_diagnostics();
1035    calibrate_ldrs();
1036    energy_measure();
1037
1038    //compound functional diags
1039    solar_arm_diagnostics();
1040    trash_arm_diagnostics();
1041    pick_up();
1042    is_trash_diagnostics();
1043    pick_up_process_diagnostics();
1044    trash_routine_diagnostics();
1045  }
```

All images and graphics were created by the researcher unless otherwise noted.