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Solar panels cleaner

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Disclaimer:

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Abstract:

The world is moving towards solar energy to generate electricity, and the Solar Energy Association notes that dirty solar panels can lose 20% of their energy production. Clean solar photovoltaic panels ensure optimal performance. So, the solution is solar panel cleaning robot.

We designed a robot to automatically clean the surfaces of solar panels, as it is able to operate the pump and brush as well as move on multiple panels with a certain angle of inclination. It has sensors like ultrasonic sensors, two from the front, one on the right, and one on the left to ensure that it does not fall, if the robot goes towards the left or right edges, it will adjust itself. When it reaches the end of the board it will stop using ultrasonic sensor and plank on the end of the panel. The alternative available in the market is similar to the irrigation system, it sprays water on the panels, our robot is better in terms of cost and water-saving and cleans better using the brush, so it gives better performance.

The basic aim of this robot is to clean solar panels using brush and pump water. This project is a system consists of Ultrasonic sensors to detect the distance to prevent the robot from falling or changing the path, this robot will turn on through two ways, first: schedule time using RTC module that can move automatically every day at 10:00 Am. Second: Wi-fi using ESP8266 through switch (ON-OFF). The power of robot using 3 Lithium battery (each on 3.7 volt) in series to give 11.1 volt to turn on the motors. We used solar cells to charge these batteries using BMS module and Boost convert module to ensure get 12 volt.

1. Introduction

1.1 Statement of the problem:

The world is moving towards solar energy to generate electricity, and the Solar Energy Association notes that dirty solar panels can lose 20% of their energy production. Cleaning solar cells by spraying water takes a lot of water and this is not enough to remove dust, a brush must be used. When using the brush, it requires a lot of time and effort on the person under the scorching sun, and it needs several workers to clean it.

1.2 Objectives:

Solar panel cleaner aims to save time and effort for people. Our robot cleans automatically using less water, we control it through the pump and using the brush Instead of cleaning it manually using a squeegee and a mop, this requires a lot of effort on human energy. And using solar cells to charge the batteries to save energy.

We have also reduced the effort on the person so that he does not climb on the roof of the building by making the robot work automatically every day at 10:00 am using RTC module, or he can operate it while he is at home via Wi-Fi.

2. Constraints Standards/ Codes and Earlier course work

2.1 Constraints:

While working, we have faced a series of problems and challenges that we have fortunately overcome.

One is the movement of the car to the right or left at an angle of 90 while using the MPU because it gives wrong and inaccurate values. To solve this, we used function delay() to fix the directions.

Another challenge we had faced, is the stability of the car on the inclined surface and to solve this problem we have two options:

The first is the increase in the weight of the car, but it has a negative effect on the glass of the solar cells, which can break due to their small thickness.

The second is to choose the type of wheels with strong torque is an option we have adopted.

But there are factories that design solar cells at six degrees, and our robot can clean them.



Figure 1: The United Company in Nablus.

Another one is the Wi-Fi is unstable when connected to RX0, TX0. to solve this problem, we connect it to RX2, TX2

2.2 Standards/ Codes:

The following list contains the hardware components that have been used in our project

Ultrasonic:

Ultrasonic devices are used to detect objects and measure distances. by emitting ultrasonic sound waves.



Figure 2: Ultrasonic sensor.

DC motor:

12V 60RPM 25mm High Torque DC Gear Motor Kit With 65mm Plastic Wheel Without Encoder



Figure 3: DC motor.

RTC DS1307:

RTC means Real Time Clock. RTC modules are simply TIME and DATE



Figure 4: RTC DS1307.

Wi-Fi ESP8266 Module:

The ESP8266 Wi-Fi Module is a self-contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your Wi-Fi network. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor.

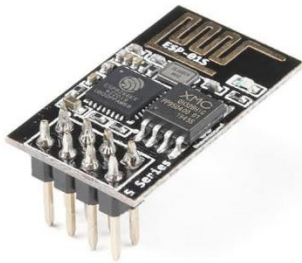


Figure 5: Wi-Fi ESP8266 Module.

Pump water:

Mini Submersible Water Pump DC 3-6V 120L/H, we can control the amount of water pump by enable pin in H-bridge driver.



Figure 6: water pump.

DC Motor:

Plastic DC Gear Motor Without Wheel For brush



Figure 7: DC motor.

Brush:



Figure 8: Brush.

H-bridge driver:

is an electronic circuit that switches the polarity of a voltage applied to a load. These circuits are often used in robotics and other applications to allow DC motors to run forwards or backwards.



Figure 9: H-bridge driver.

Arduino Mega:

The Arduino Mega 2560 is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Mega 2560 board is compatible with most shields designed for the Uno and the former boards Duemilanove or Diecimila.



Figure 10: Arduino Mega.

Full Size Breadboard:
connect the wires on it

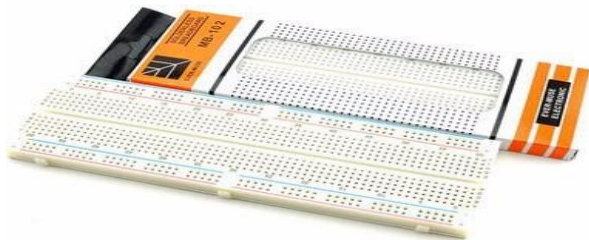


Figure 11: Full size breadboard.

Wires:
Using Male-Female and Male-Male:



Figure 12: Male-male wires.



Figure 13: Male-female wires.

Solar panel:

Solar cells are semi-conductor devices which use sunlight to produce electricity. They are manufactured and processed in a similar fashion as computer memory chips. Solar cells are primarily made up of silicon which absorbs the photons emitted by sun's rays.

12V 5.2W Solar Panel 165x210mm



Figure 14: Solar panel.

BMS:

state of health of a multicell battery string. For large, high voltage battery packs, such. A battery management system (BMS) closely monitors and manages the state of charge and.

4S 4A-5A Lithium Battery Charger Protection Board BMS



Figure 15: BMS.

Boost converter module:

XL6009 Adjustable Step-Up Boost Converter Module 3-32V To 5-35V 4A



Figure 16: Boost converter module.

Lithium Batteries:

Each one 3.7 volt.



Figure 17: Lithium batteries.

2.3 Earlier course work:

Working on our project depends on some courses we learned within the Computer Engineering program such as:

1. Microcontroller:

The microcontroller provides basic information about understanding the PIC Microcontroller and how to program hardware components, also the lab of this course provides how-to download code on the PIC Microcontroller equipment and how to understand every pin and feature there. so, it is one of the most important materials that helped us understand how to deal with the Arduino parts in the project, through our knowledge of how to deal with the microcontroller, as the laboratory of this material contributed mainly to help us start working on the project.

2. Electronic circuits:

This course has mainly contributed to helping us deal with electrical circuits and related connections.as a result of this course that provides basic information about how to deal with many different circuits and how to wire their circuits.

3. Literature Review

We searched for ideas for graduation projects and I liked this idea when we looked at the importance of solar cells today and in the future and the progress of the world to use them widely.

We found that this idea is applied outside Palestine, and no one has implemented it in Palestine, and it was not repeated as an idea for a graduation project.

We developed it by adding schedule time using RTC module also Wi-fi using ESP8266 and solar cell to charge the batteries.

4. Methodology

This is a report on a project in which a solar panel cleaner was implemented to gain the most energy by using an auto-cleaning system that rinses the panel from dust.

So, this project includes 2 parts:

4.1 The cleaning robot

This will work on a definite time each day to ensure the cleanness of the solar panel.

To implement this part, we have used 5 ultrasonic sensors, RTC, Wi-Fi, Arduino Mega.

4.1.1 Design the shape



Figure 18: Design the car.

The design contains two wooden pieces, one above the other, and between them there are most of the wires and pieces.

Used component:

1. 4 DC- motor + 4 Wheels
2. 5 ultrasonic sensors
3. RTC module: Used to know what is the time (the hours, minutes and seconds also could be used for the date)
4. Wi-Fi – esp8266 using mobile application to control the robot using switch ON-OFF

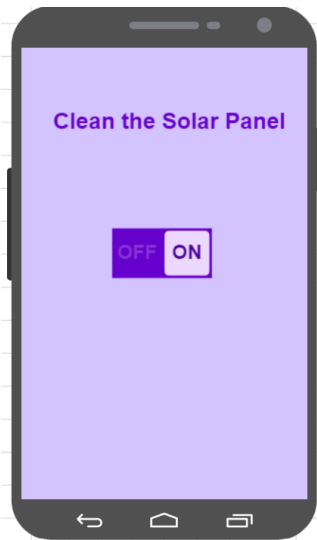


Figure 19: Mobile application.

5. Brush

6. water pump: to drive the water pump we need a motor controller, that works on 12v and could drive a 5v water pump

7. 2 L298N Dual Motor Controller Module:

** To control a brush, wheels and water pump using motor controller

- Connect out1 and out2 to the water pump wires, out3 and out4 to the brush motor
- Connect 12V and GND to the regulator load output + And -
- Connect IN1, IN2, IN3, IN4 to Arduino digital output pins.
- To turn the water pump on the 2 pins value should Vary, if one is high the other is low as well as the brush.

A pipe to rinse the panel with the pumped water from that water pump



Figure 20: Pipe.

4.1.2 Implementation

To determine and control robot motion we will use Arduino Mega micro-controller. And this is the map for the project

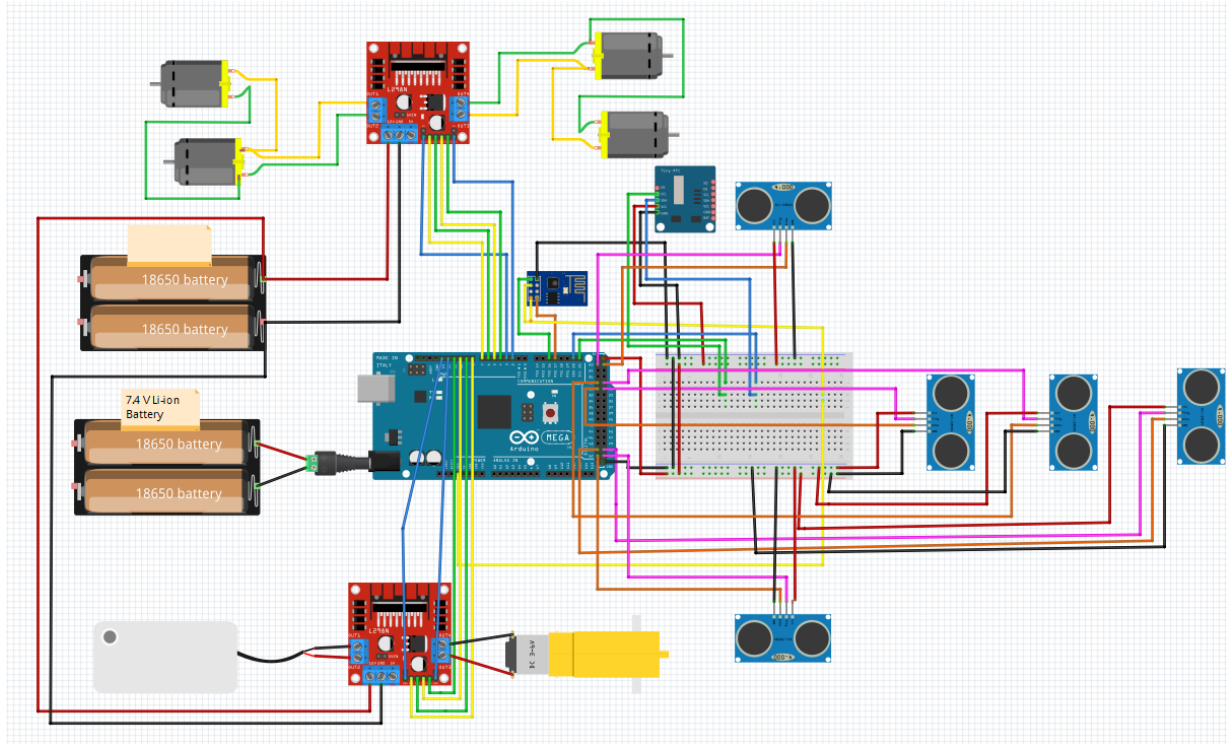


Figure 21: Cleaning robot map.

The libraries we used:

```
#include <SoftwareSerial.h>
#include <RemoteXY.h>
#include <Wire.h>
#include "RTCLib.h"
```

definitions on the code:

For wi-fi:

```
#define REMOTEXY_MODE__ESP8266_SOFTSERIAL_POINT
#define REMOTEXY_SERIAL_RX 10
#define REMOTEXY_SERIAL_TX 11
#define REMOTEXY_SERIAL_SPEED 15200
#define REMOTEXY_WIFI_SSID "Dana&Haneen"
#define REMOTEXY_WIFI_PASSWORD "12345678"
#define REMOTEXY_SERVER_PORT 6377
****
RemoteXY_Handler ();
if ((RemoteXY.switch_1==1)) { // if the switch on mobile is on
```

```
flag ==1;
}
```

For RTC:

```
RTC_DS1307 rtc;
DateTime robojax = rtc.now();
const int alarm[]={10,0,0}; // to turn the robot on at 10:00 am
boolean checkAlarm(DateTime timeNow){
  if (
    alarm[0]==timeNow.hour()
    &&
    alarm[1]==timeNow.minute()
    &&
    alarm[2]==timeNow.second()
  ){
    return true;
  }else{
    return false
  }
}
if(checkAlarm(robojax)) {
  flag=1; // if flag==1 turn on the robot
}
```

4.2 charging process

To implement this part, we have used:

1. solar panel: which provide 12 volt as output.
2. BMS: battery management system.
3. Boost converter module:

And this is the map:

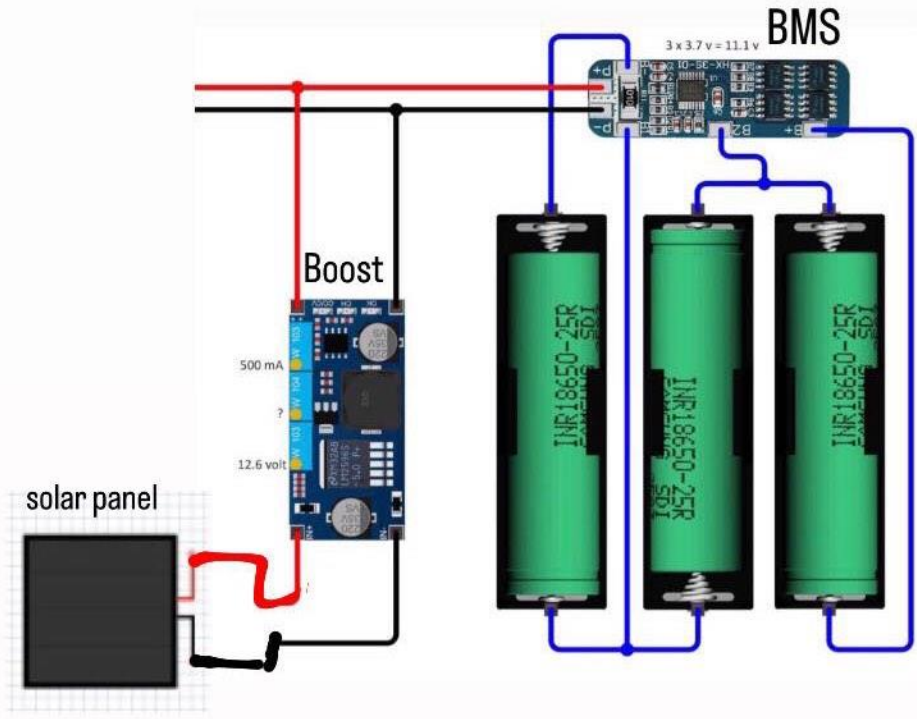


Figure 22: Charging process map.

5. Discussion:

Is the cleaning car worth it?

the solar panels are inefficient, they can't get 100% from the sun's energy falling into it, there could be methods to improve the output from the solar panel such as cleaning them with an irrigation system but the best may be the best way is using brush with water.

Let's talk about the solar cleaner, it is a self-driving car that contains a brush and a pump to clean the cells very well.

The world is moving towards solar energy to generate electricity, and the Solar Energy Association notes that dirty solar panels can lose 20% of their energy production. Clean solar photovoltaic panels ensure optimal performance.

so, in order to know when panels get the maximum energy, we have to know what affect the solar panel?

irradiance: the power in watts falling on a surface at any instant in time,

insolation: the power falling on a surface over time,

temperature: solar panels most efficient at 77 degrees F,

Cleaning: Should keep the solar panels always clean to have good performance.

For temperature, irradiance, insulations we can't do anything.

For cleaning we solve it by using our robot to save the panels always clean.

6. Conclusions and Future work:

At the end of the project, we were able to build a prototype of a cleaning car that that will help to clean the solar cells from the dust, so the solar panel will generate the best possible output.

For a future work we can improve our project by sending notifications when the robot stops. Also, check if the solar panels are completely clean by adding a camera (image processing). Due to insufficient accuracy of the Delay() function and MPU, we can use the Shaft Encoder (Rotary encoder).

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