

Autonomous Solar Panels Cleaning Robot

Project 1



Content



Project Planning

WBS, team, and time plan



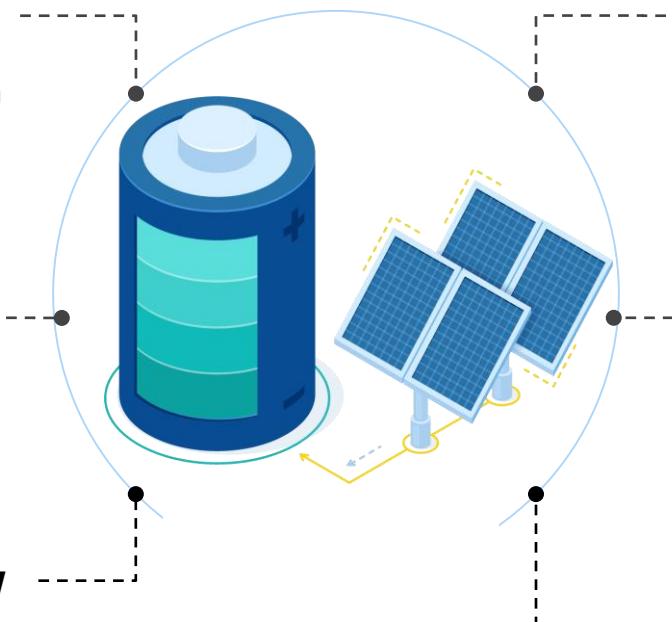
Renewable Energy

Climate change



Solar Cell Efficiency

How does PV technology work? Dust/Dirt degradation of PV panels efficiency.



Mechanical Design

Robot mechanism and complete design



Technical Design

Project circuit and software



Close-Out

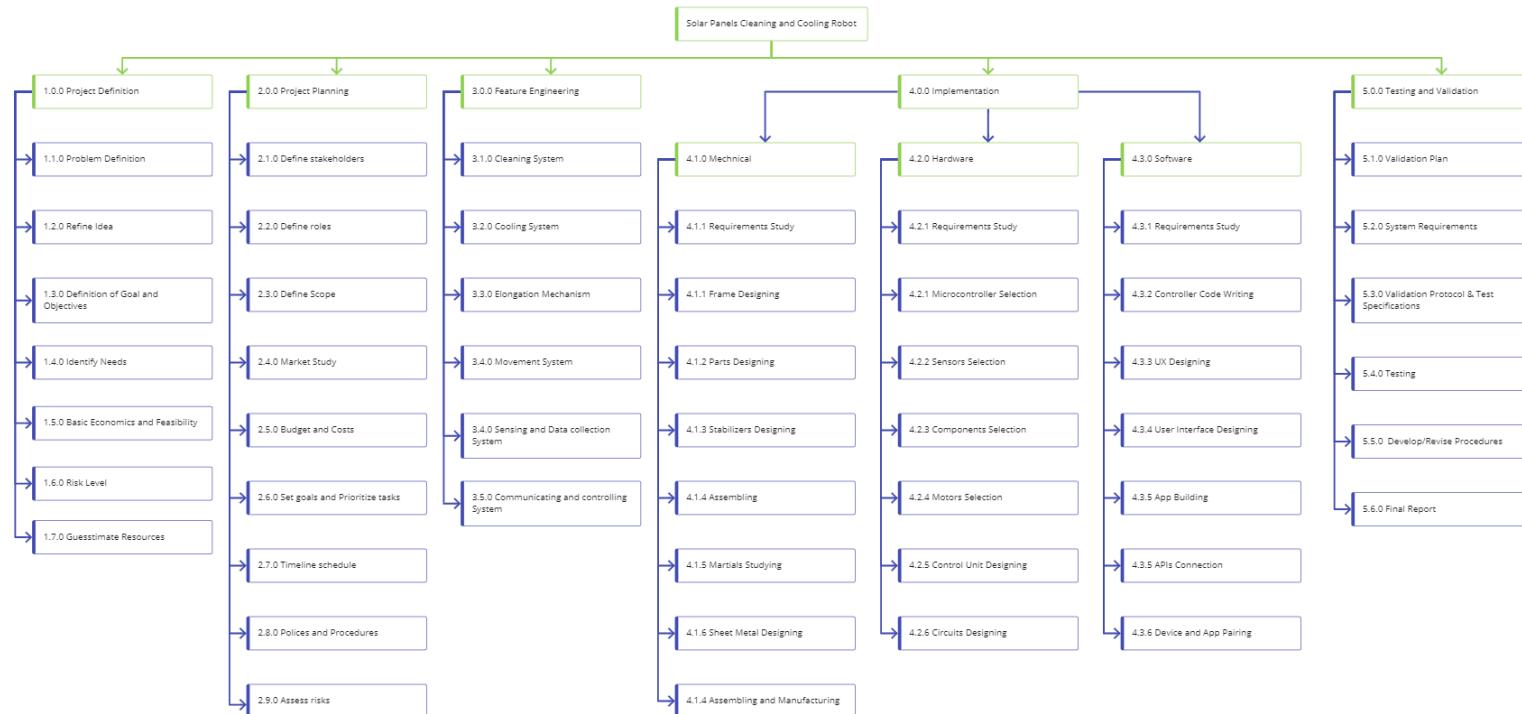
Conclusion and feature work



Basic Economy

Sector	Item/s	Cost
Components	4x Motors & Wheels	740
	Solar Panel	426
	Bluetooth	120
	Arduino Uno	250
	2x Motor Drive	130
	Brush	125
	Tools	175
	Materials	230
	12v DC Motor	234
	Wires	150
	6x Battery	180
	2x Battery holder	70
	Breadboard	50
	Workspace	450
Operational	CNC Stand	550
	CNC Holder	70
	Smith	350
	Craftsman	400
	Transportation	200
	Project book & docs	500
	Risks	600
Total		6000

Work Breakdown Structure



A work-breakdown structure (WBS) is a deliverable-oriented breakdown of a project into smaller components.

Time Plan



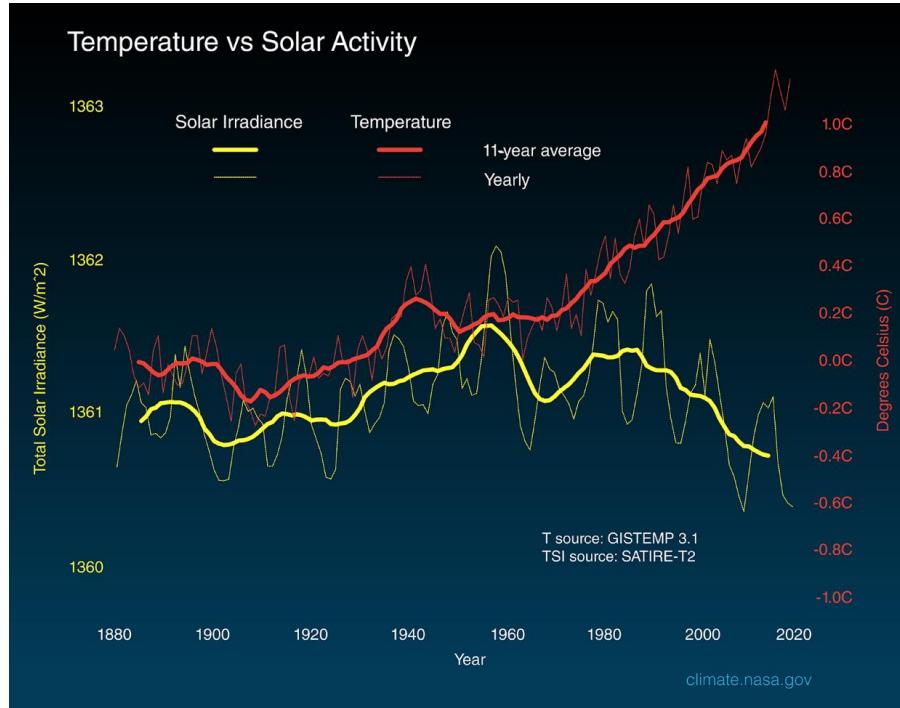
Project time management involves **analyzing and developing a schedule and timeline for project completion**.

Renewable Energy



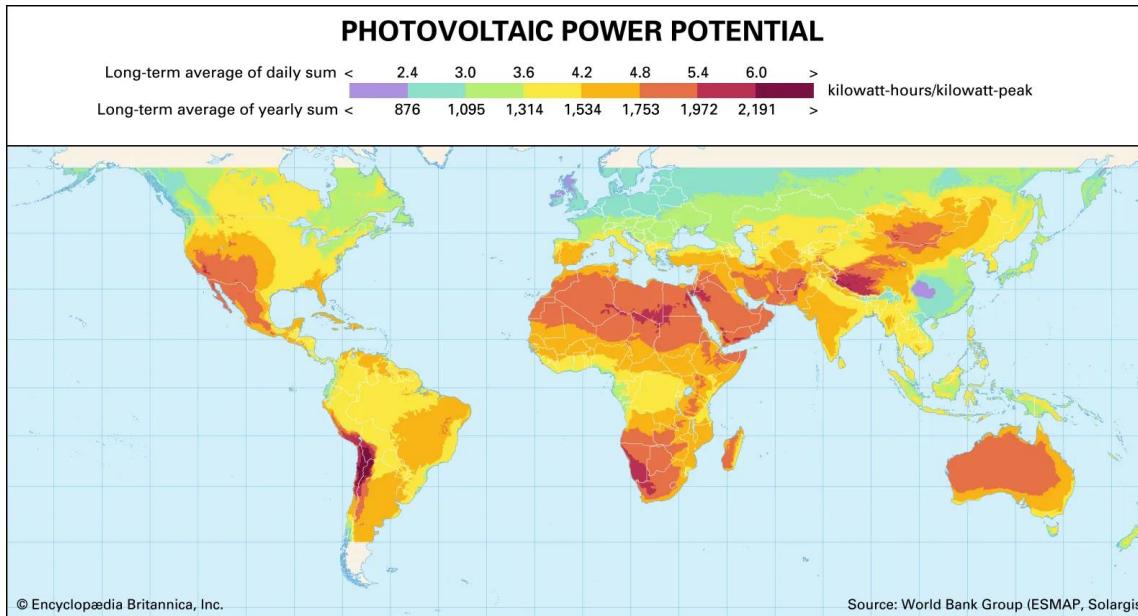
Renewable energy is energy from sources that are naturally replenishing but flow-limited.
The major types of renewable energy sources are: Solar, Wind, Biomass, Hydropower and Geothermal.

Climate change



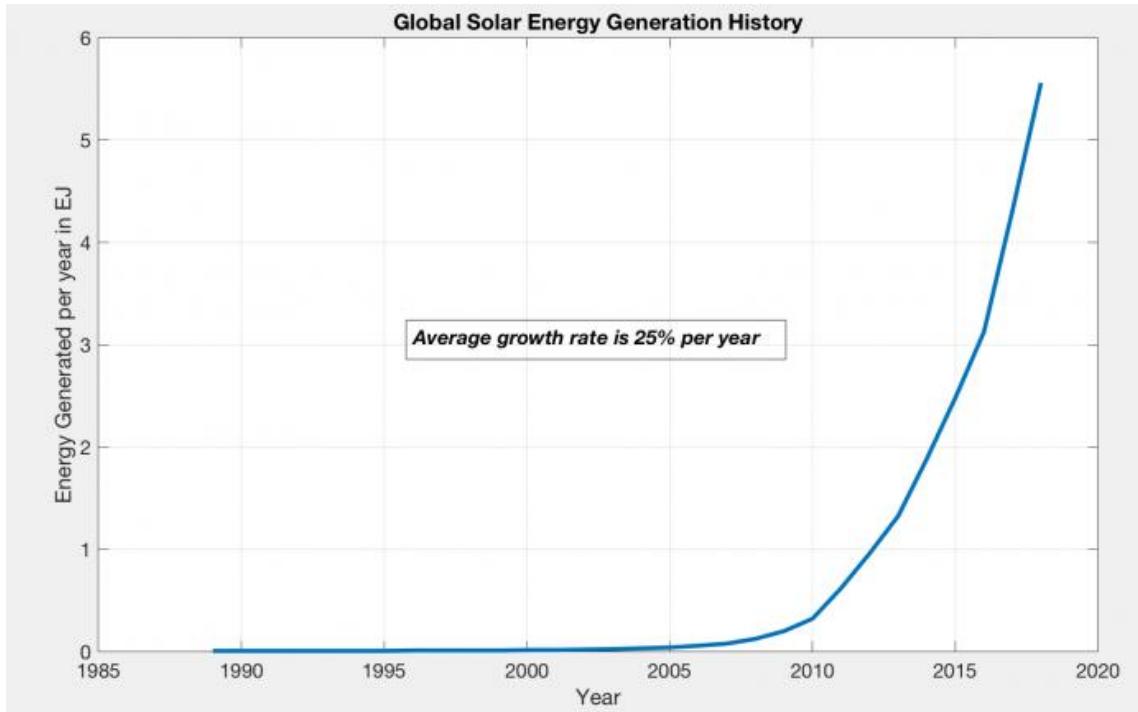
Source: Nasa.

Solar Energy



Source: World Bank Group.

Solar Energy



Source: BP Statistical Review of World Energy 2019 | 68th edition

How does PV technology work?

01

Photons

Photons strike and ionize semiconductor material on the solar panel.

02

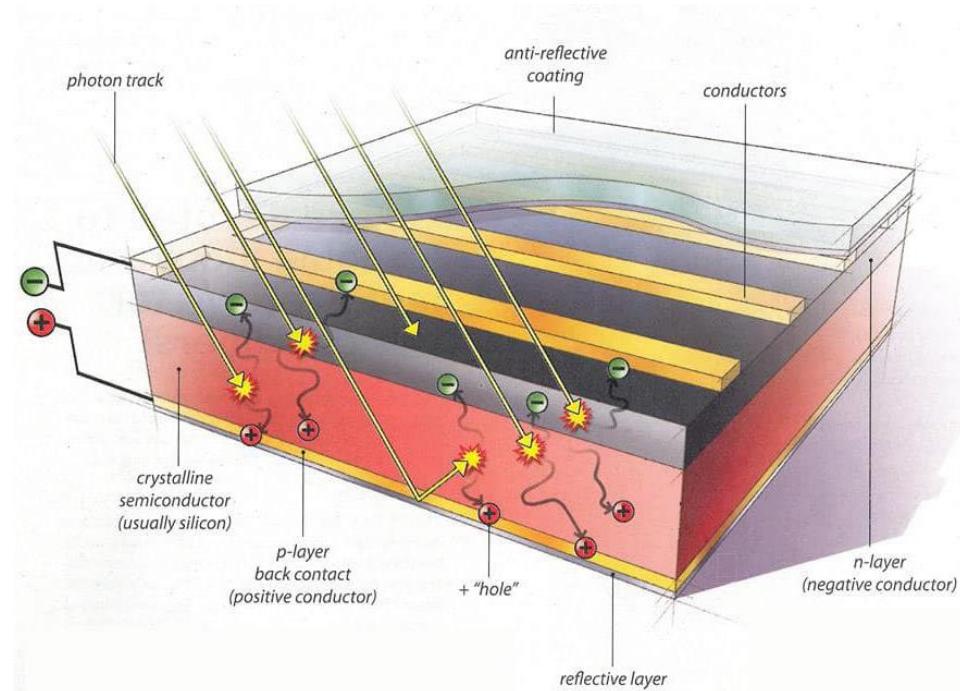
Electrons

causing outer electrons to break free of their atomic bonds.

03

Semiconductor

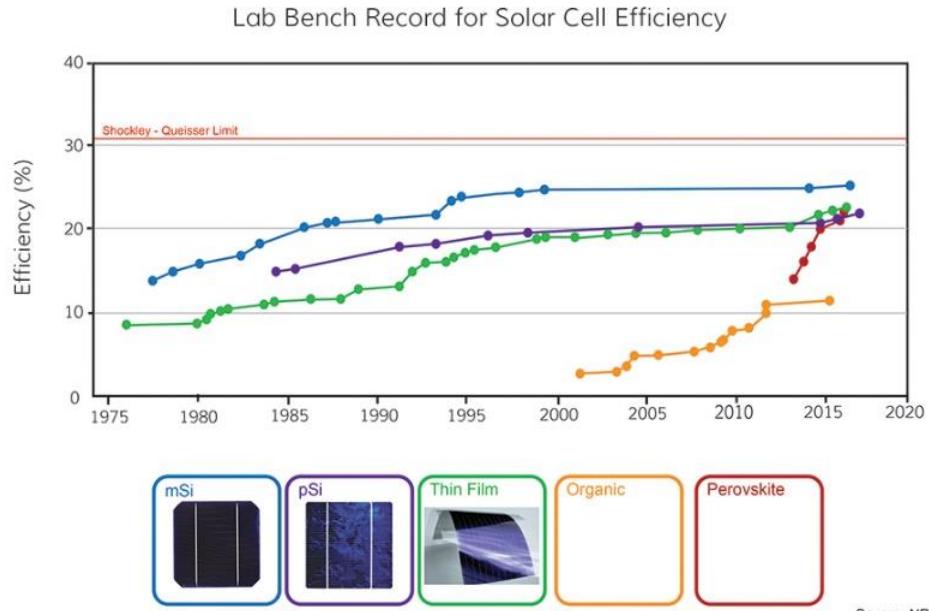
Due to the semiconductor structure, the electrons are forced in one direction creating a flow of electrical current.



Source: seia.org/initiatives/photovoltaics

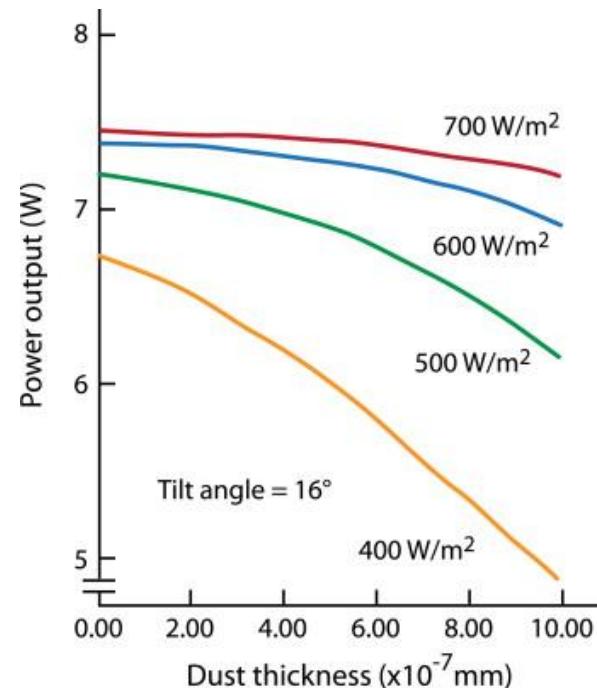
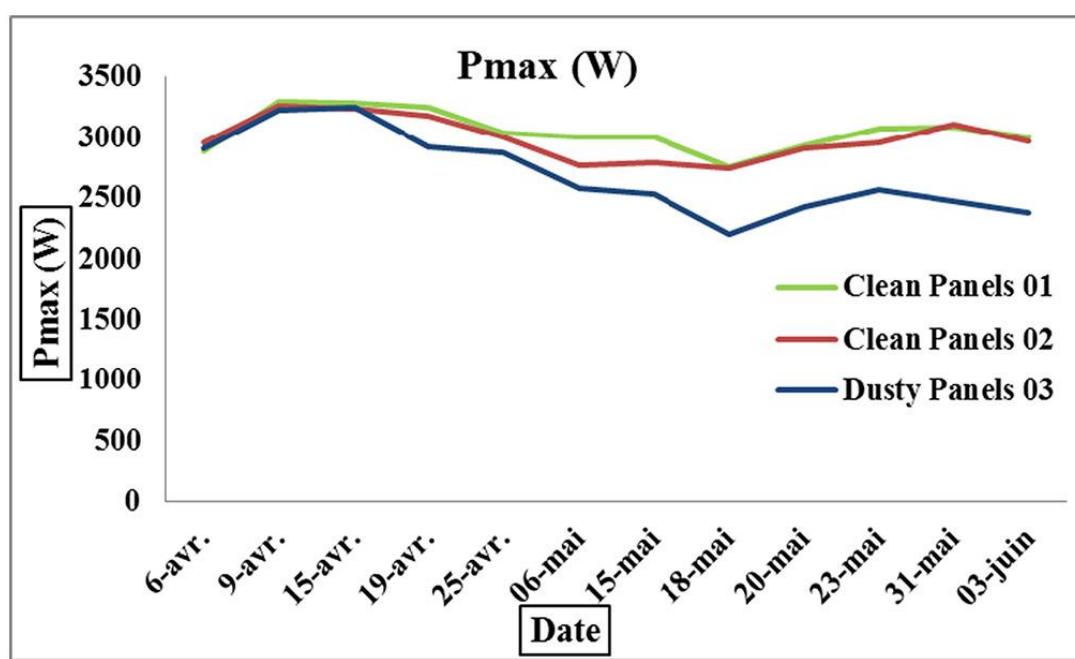
Solar Cell Efficiency

$$\text{efficiency} = \frac{\text{panel power (in kW)}}{\text{panel length} \times \text{panel width (in m)}} \times 100\%$$



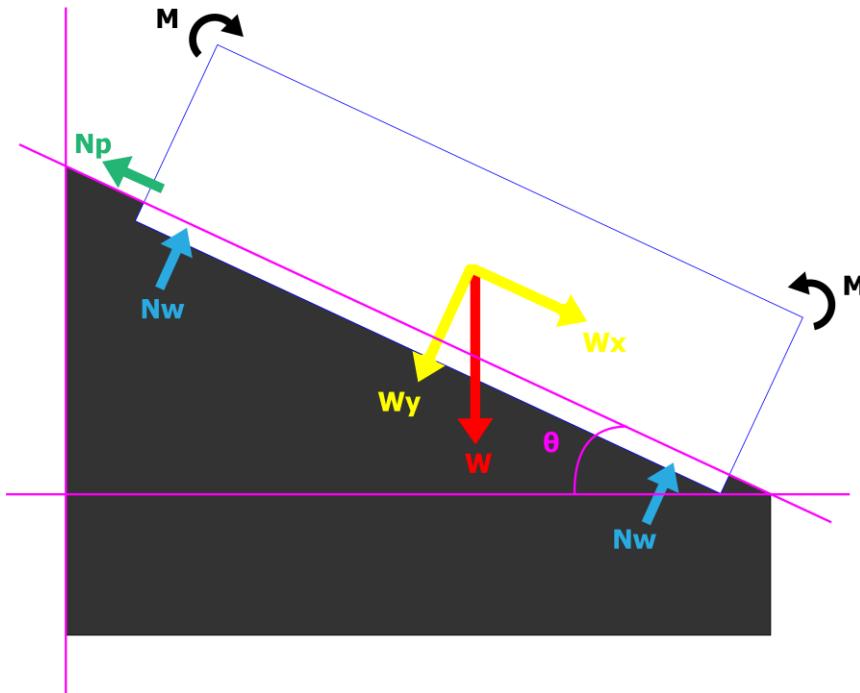
Source: The National Renewable Energy Laboratory (NREL)

Dust/Dirt degradation of PV Panels Efficiency



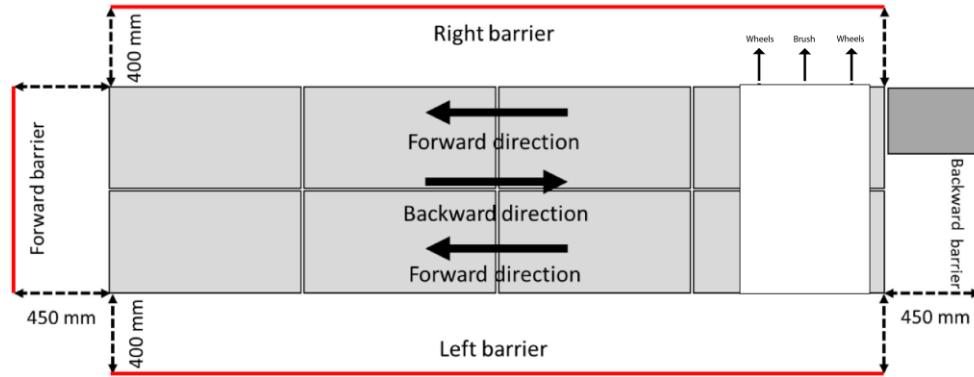
Source: [1] Lasfar, S., Mouallif, I., Latrach, A., Chergui, M., Choukir, A., Diab, A., 2021. Study of the influence of dust deposits on photovoltaic solar panels. [2] J.T. Mailuha, H. Murase, I.K. Inoti, Knowledge engineering-based studies on solar energy utilization in Kenya.

Robot Mechanism



Mechanism is a system of parts working together in a machine; a piece of machinery.

Robot Dynamics



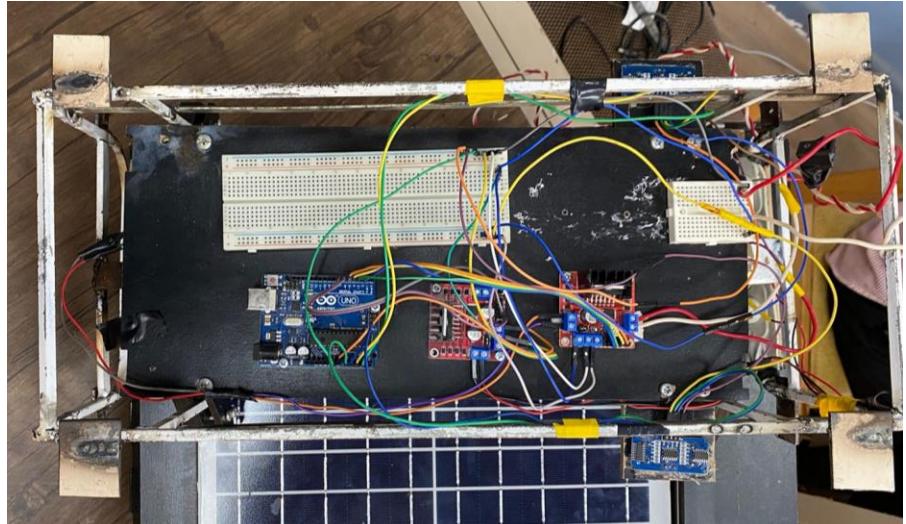
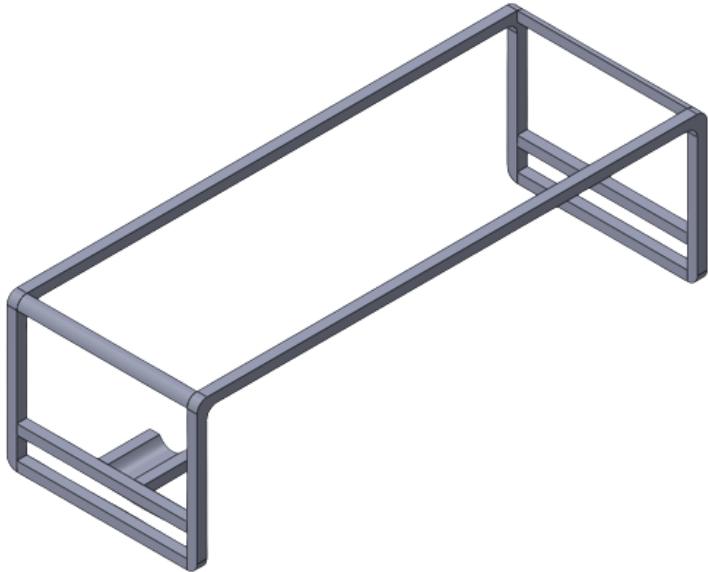
Robot dynamics is concerned with the relationship between the forces acting on a robot mechanism and the accelerations they produce.

Robot Brush



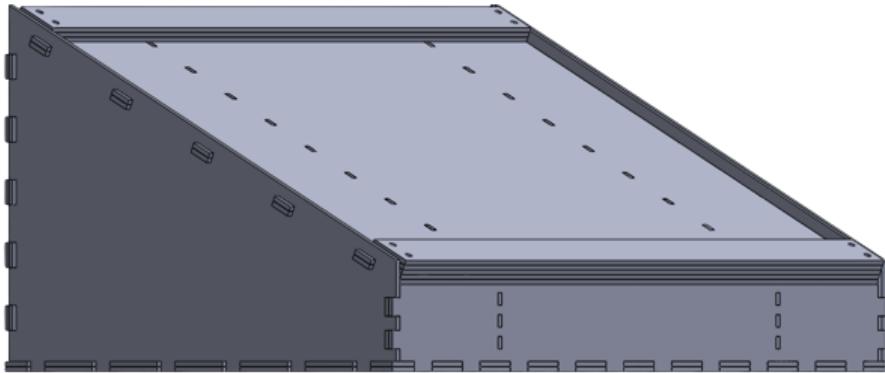
For the robot to be able to do dry cleaning for the panels the use of rotary brush is necessary.

Robot Frame



Robot frame is the basic element of the robot, it holds the components together, provide the mechanical stability, and distributes the loads.

Robot Structure



Structures are any system that resists vertical or horizontal loads.

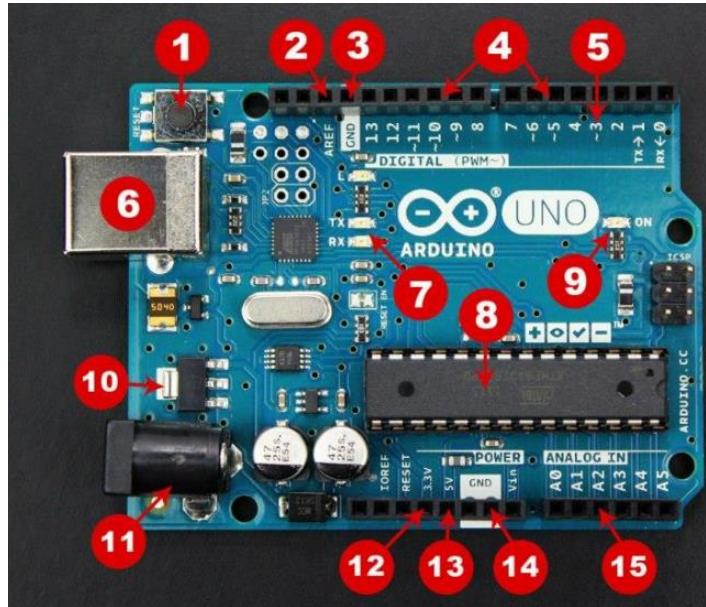
Robot Complete Design

Element	Material	Purpose
Robot Frame	Steel	Strength and bear loads.
Components Connectors	Acrylic wood	Flexibility to work with and easy to customize
Robot Cover	Gladden	Reliability, quality and brightness.
System Structure	Acrylic wood	Light, strength, flexibility to customize.
Brush	Microfiber	Availability in market
Wheels	Rubber	Solid throughout, withstand extreme weather and absorbency



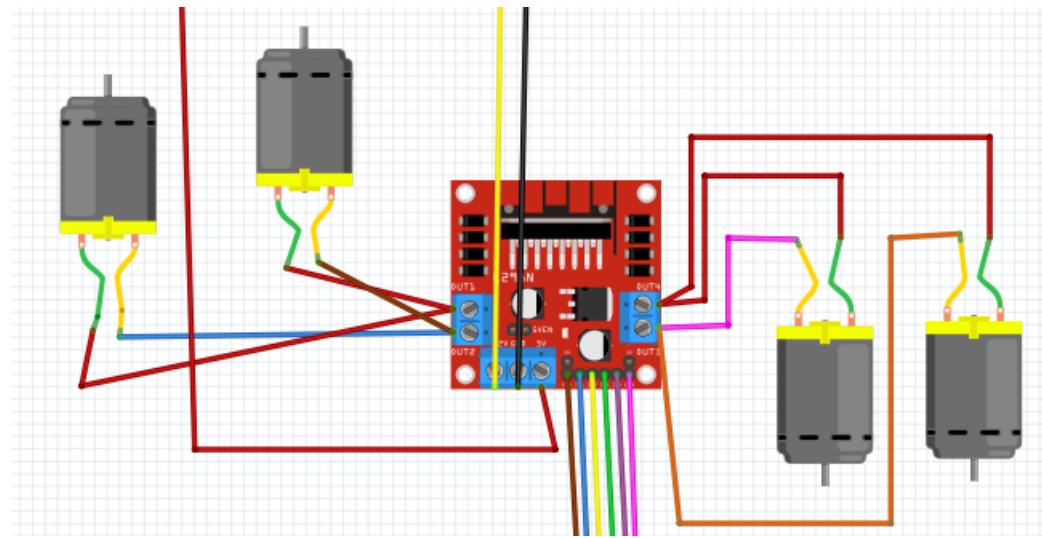
Material selection is a step in the process of designing any physical object.

Robot Circuit - Microcontroller



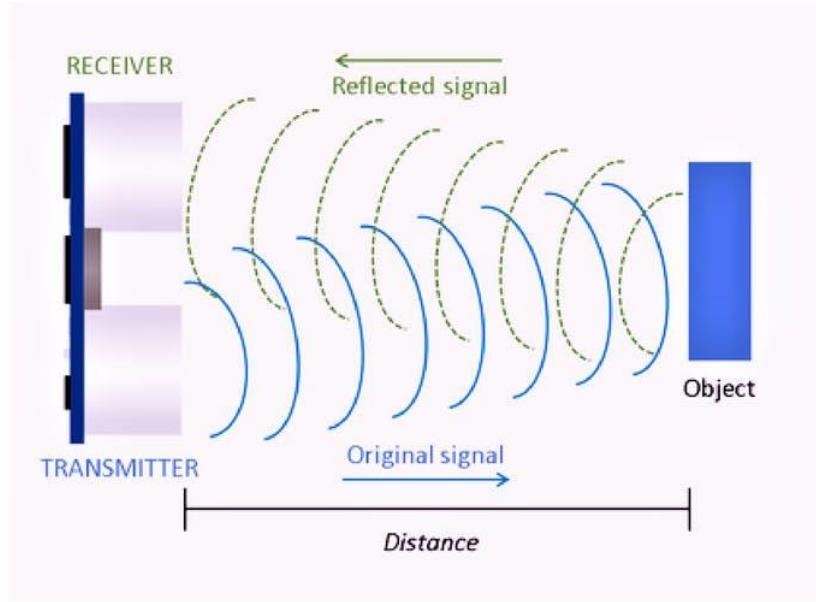
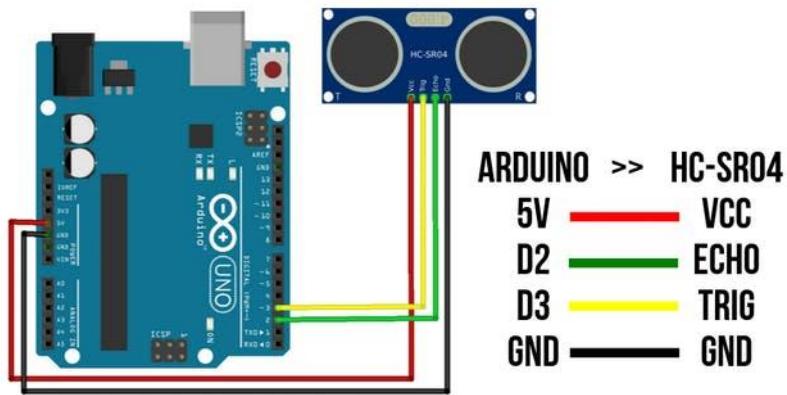
One of the most popular Arduino boards out there is the Arduino Uno. While it was not actually the first board to be released, it remains to be the most actively used and most widely documented on the market.

Robot Circuit - L298N Motor Driver



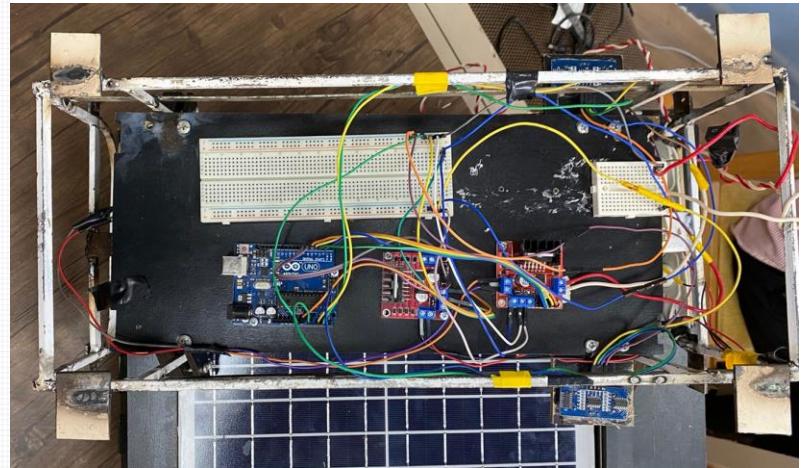
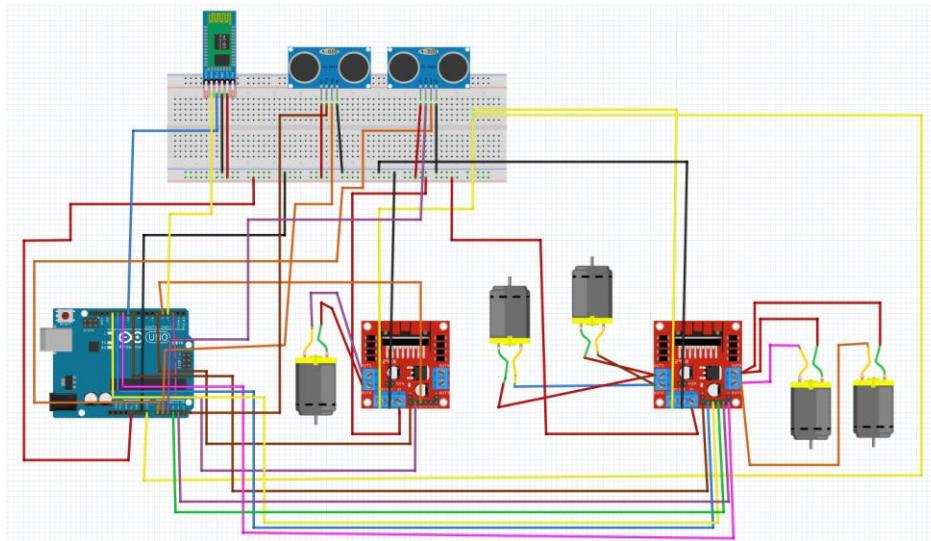
The L298N Motor Driver is a controller that uses an H-Bridge to easily control the direction and speed of up to 2 DC motors.

Robot Circuit - Ultrasonic Sensor HC-SR04



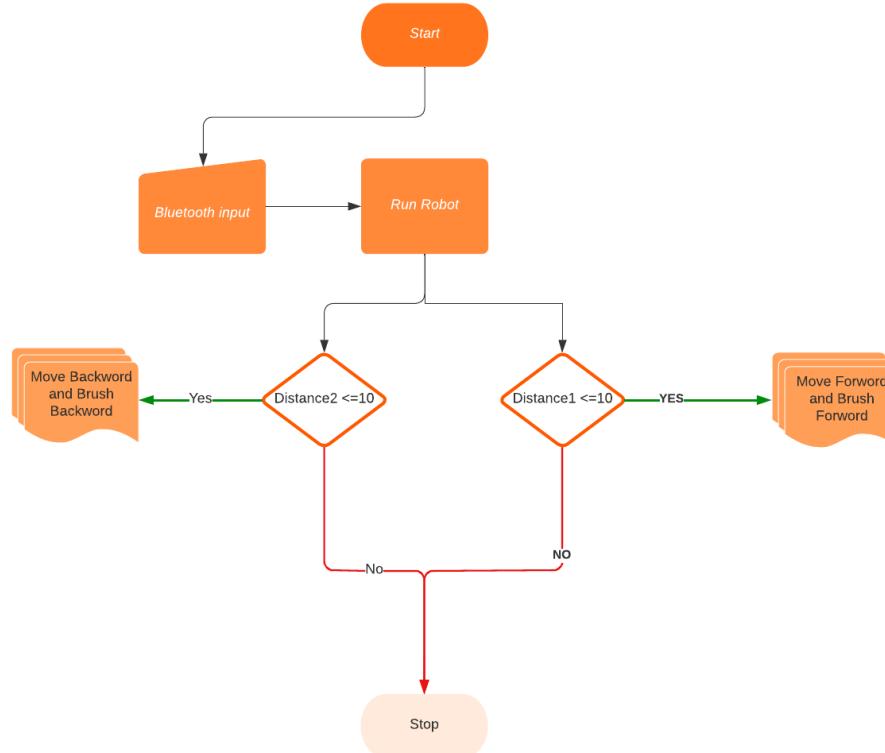
Electrical circuit is an interconnection of electrical components or a model of such an interconnection, consisting of electrical elements.

Robot Circuit



Electrical circuit is an interconnection of electrical components or a model of such an interconnection, consisting of electrical elements.

Robot Flowchart



Robot Code



Project code available [on project book](#).

Robot App



```
when BluetoothList .BeforePicking
do set BluetoothList .Elements to BluetoothClient1 . AddressesAndNames

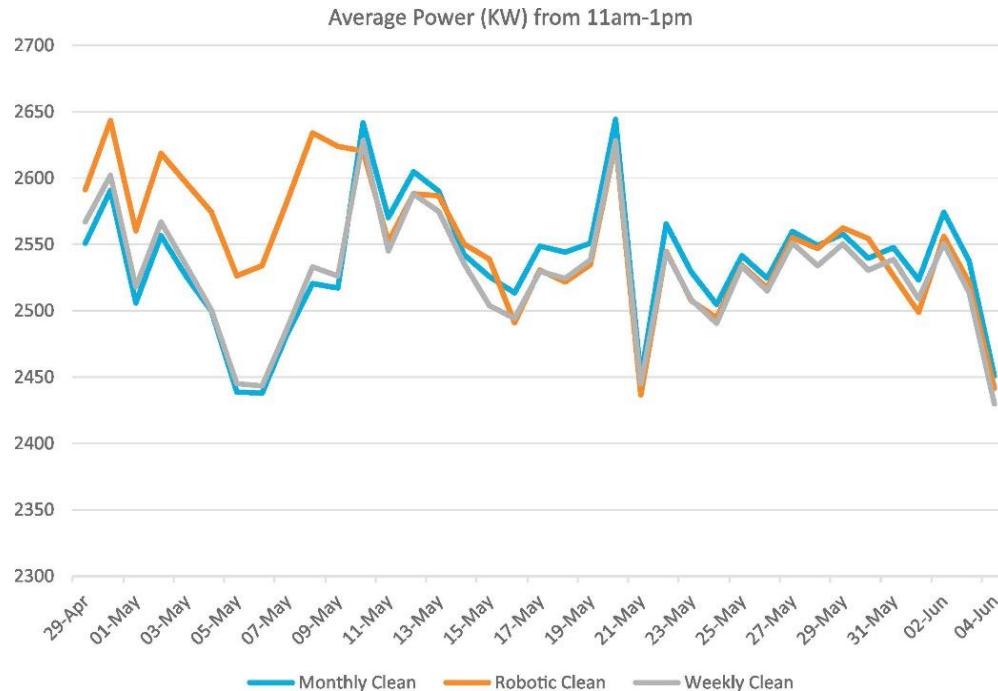
when BluetoothList .AfterPicking
do if call BluetoothClient1 .Connect
    address BluetoothList .Selection
then set BluetoothList .Elements to BluetoothClient1 . AddressesAndNames

when Clock1 .Timer
do if BluetoothClient1 .IsConnected
    then set Connected .Text to "Connected"
        set Connected .Text to 
    if not BluetoothClient1 .IsConnected
        then set Connected .Text to "Not Connected"
        set Connected .Text to 

when ON .Click
do call BluetoothClient1 .Send1ByteNumber
    number 49
set Robot_Status .Text to call BluetoothClient1 .ReceiveText
    numberOfBytes call BluetoothClient1 .BytesAvailableToReceive
```

APK (Android Package Kit) is the file format for applications used on the Android operating system. APK files are compiled with Android Studio, which is integrated development environment (IDE) for building Android software.

Project Close-Out



Source: Brian Parrott, Pablo Carrasco Zanini, Ali Shehri, Konstantinos Kotsovlos, Issam Gereige on 'robotic dry-cleaning of solar panels using a silicone rubber brush', Thuwal, Saudi Arabia at 2017.

Future Work

- 1 Embedded cooling system.
- 2 Embedded wet cleaning system.
- 3 System for cleaning robot brush.
- 4 Data collecting module for solar panel efficiency monitoring analyzing.
- 5 User Interface for data tracking.
- 6 Machine learning model for predicting solar panels performance and recommending best solutions to ensure best performance.

Thank You