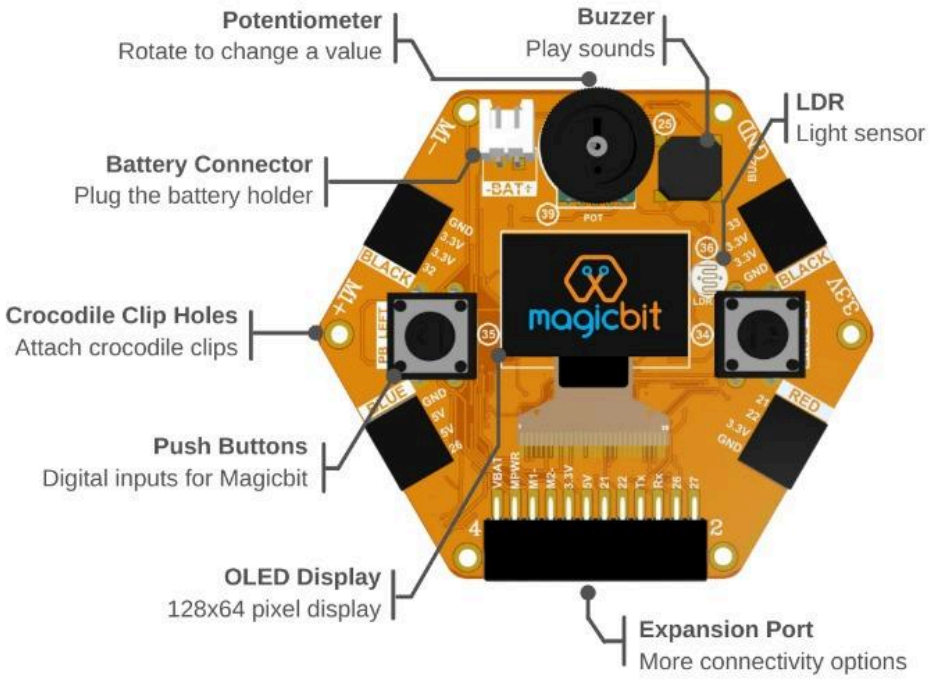
Level 3 : Advanced Robotics and Automation

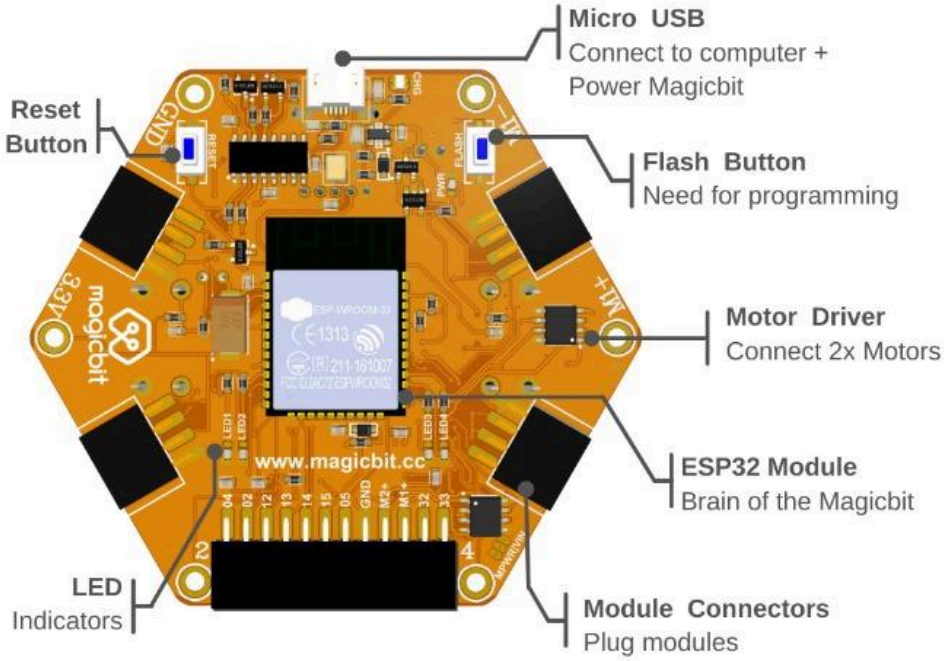
- **Learning Outcomes :-**
    - Programming in Arduino
    - Magicbit Core associated mini robotic and automated projects
    - Creative hands-on projects using simple craft materials
- **Component Kit :-** Kit 02
- **Lessons Outline**

Lesson Number	Lesson Name
01	Automated Fan System
02	Lights Automation System
03	Obstacle avoiding robot car
04	Smart Door Opener
05	Smart Home Device
06	Path Finder Robot (Line follower)
07	Automated Plant Watering System
08	Interactive Pet Toy
09	Garage Parking Assistant
10	Remote Controlled Vehicle
11	Smart Recycling Bin
12	Automated Room Curtains

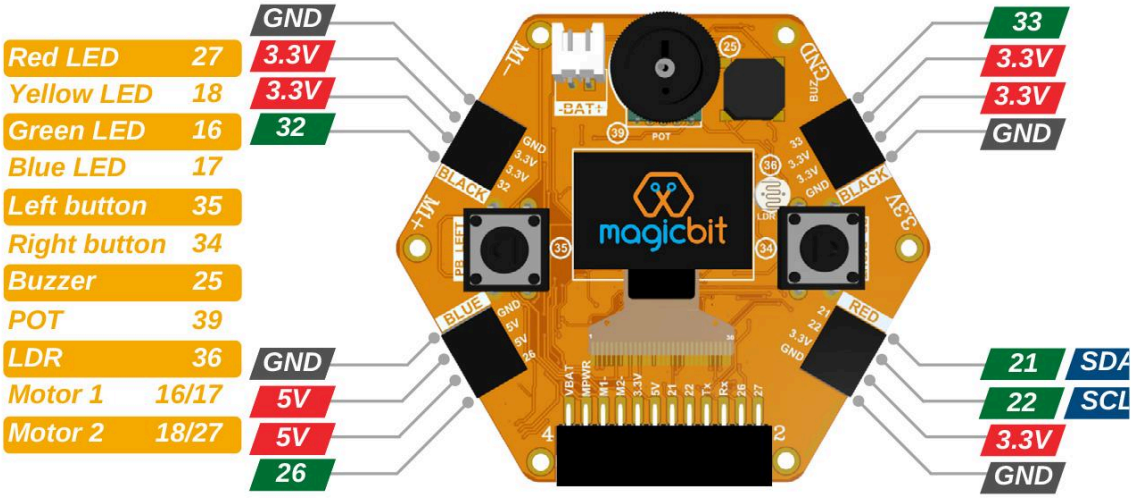
- **Time Duration :-** 1 - 1.5 hrs per lesson

Magicbit Layout

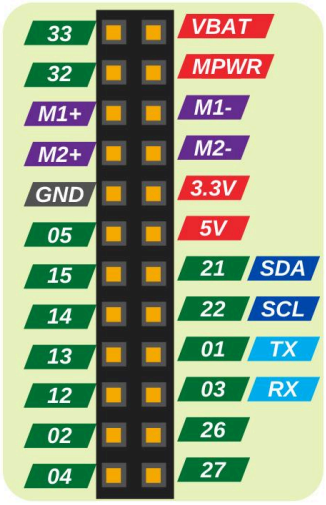




Magicbit Pinout

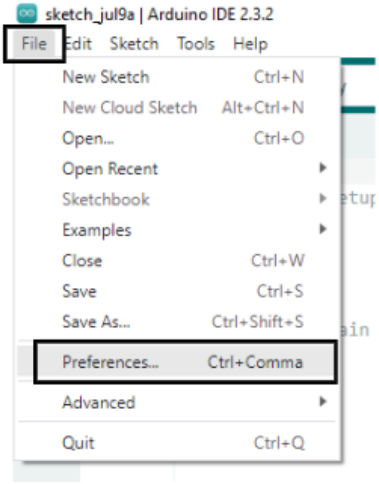


- All pins support PWM except pin 5
- 1,3,5,16,17,18,21,22 pins doesn't support analog in function
- When WiFi is enabled, Analog in working only for pin 32 to 39.
- Max input voltage for any pin is 3.3V / battery connector is 4.2V
- 2,4,5,12,15 are strapping pins.

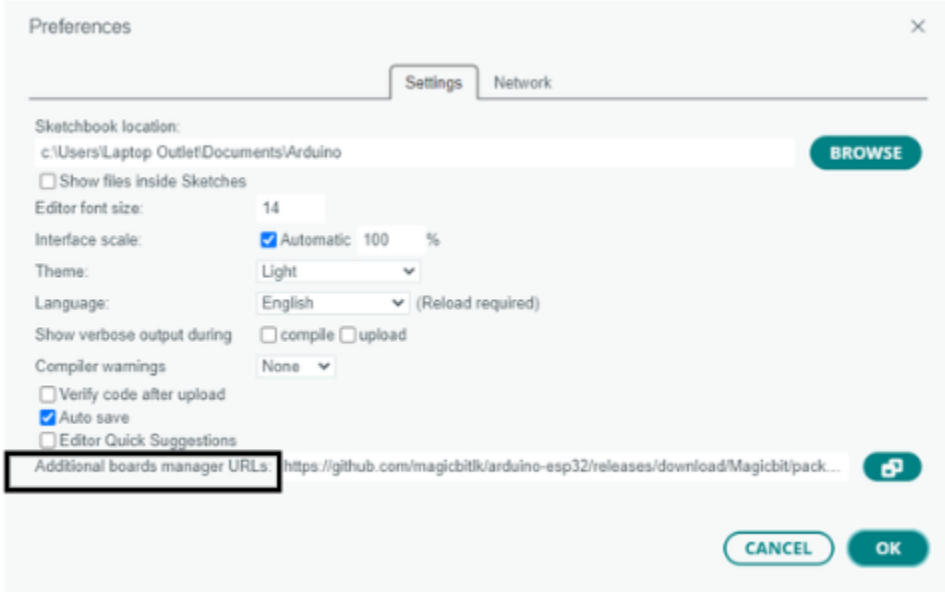


Setting Up Magicbit With Arduino

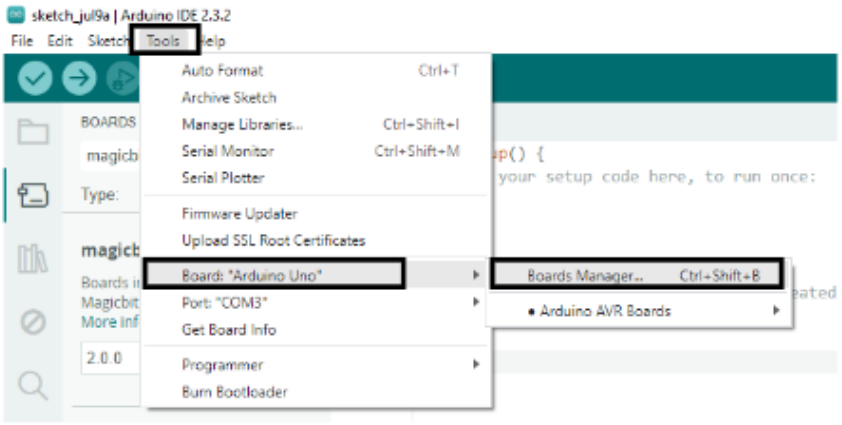
- Download the Arduino Software and install it on the computer
    - https://www.arduino.cc/en/software
- Add the Magicbit to the Arduino IDE
    - Open the **Preferences** window
        - File -> Preferences



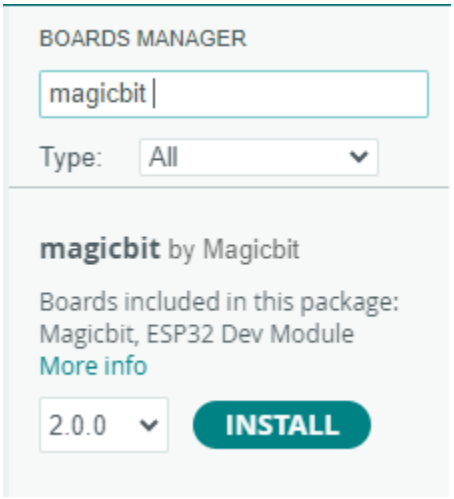
    - Insert the below release link at the **“Additional Board Manager”**
        - Release Link - **https://github.com/magicbitlk/arduino-esp32/releases/download/Magicbit/package_magicbit_index.json**



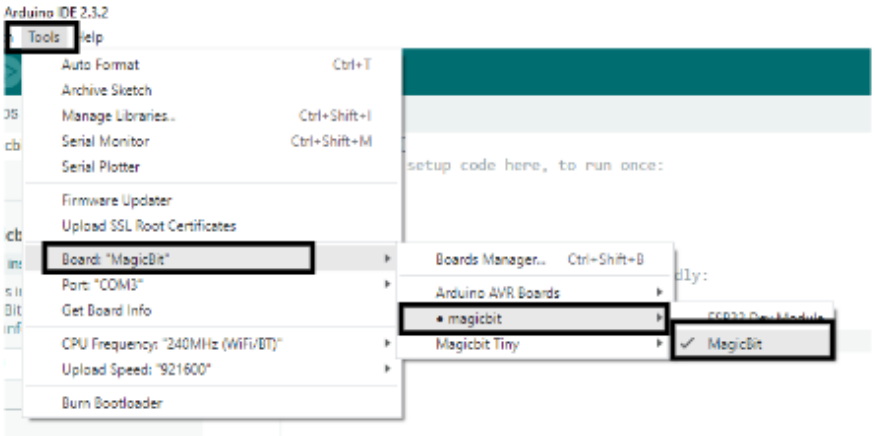
- Open the **Boards Manager** from the **Tools** Menu.
    - Tools -> Boards -> Boards Manager



- Search for **“Magicbit”** and click on **“Install”**.

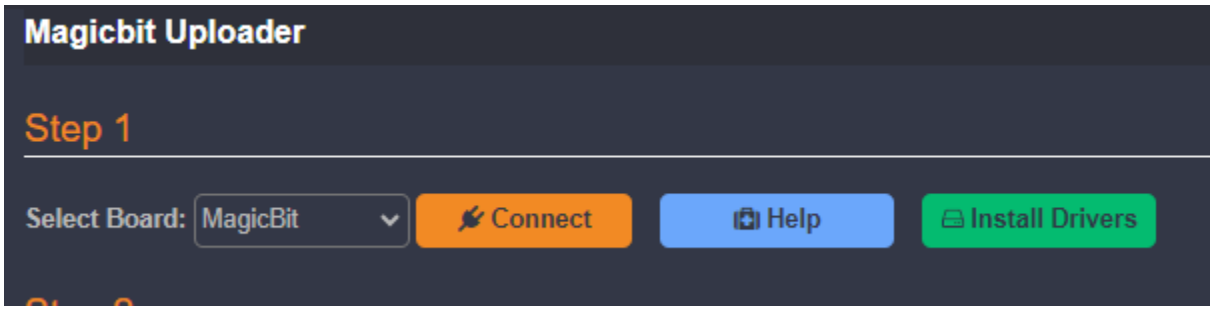


- Select the board and port
    - Connect the Magicbit to the computer via USB cable
    - Select the **Board**
        - Tools -> Boards -> Magicbit -> Magicbit



- Select the **Port**
  - Tools -> Port -> COM**X**

  - **If the port doesn't allow selection / not visible.**
    - **Install the Drivers - https://magicbit.cc/uploader/**



Lesson 01 - Automated Fan System

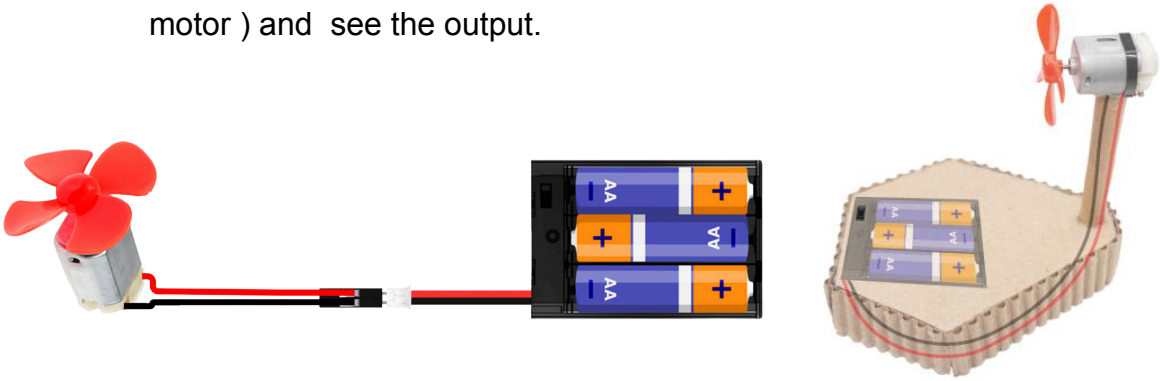
- Activity
    - Automated fan system based on the proximity sensor readings
- Learning Outcomes
    - Arduino Programming
    - Practical application of the concepts
    - Motor Controlling
    - Sensor readings
- Materials Required
    - Magicbit Core
    - USB cable
    - Computer with Arduino IDE
    - Cardboard
    - Proximity Sensor module
    - Fan blade connected DC motor
    - M-F jumper wires
- Steps for the Activity

Expected Output - https://youtu.be/z_0DrhbDgds

- **Step 01**(Optional) - Make a simple structure using cardboard which looks like a table fan stand.

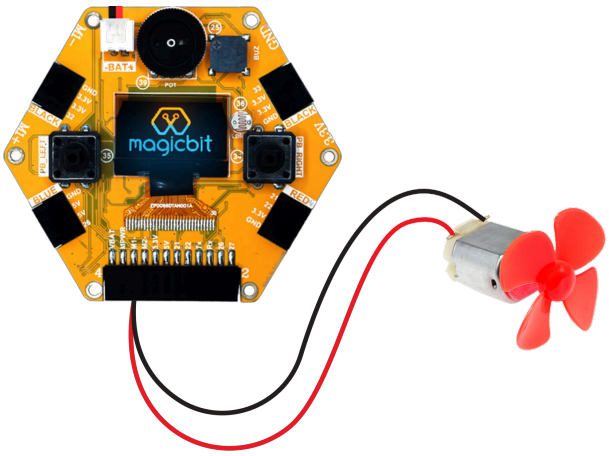
- **Step 02 -** Fix the fan blade connected DC motor to the structure as follows.

- **Step 03 -** Connect the DC motor cables to the Battery (Just to power the motor) and see the output.

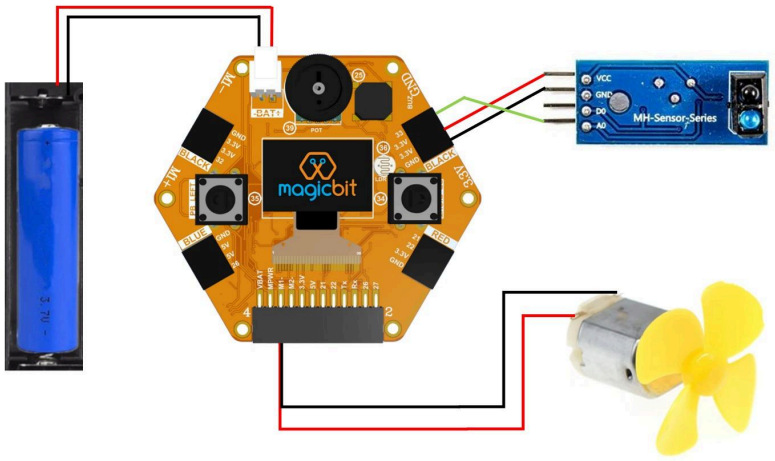


- **Step 04 -** Fix the Proximity sensor module to the above structure as follows.

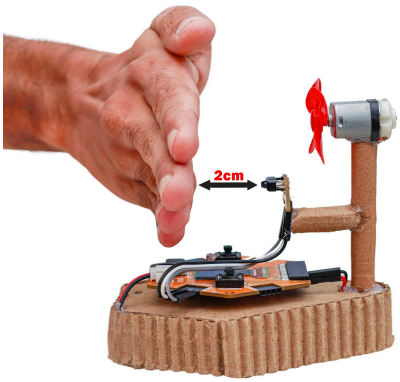
- **Step 05 -** Instead of just powering the motor, connect the DC motor cables to the M1 - and M1+ pins or M2- and M2+ pins in the Magicbit.



- **Step 06** - Connect the Proximity IR sensor to the Pin 32 or Pin 33 in the Magicbit using M-F jumper cables.



- **Step 07 -** Open the Arduino IDE and make the below program to control the Fan (DC motor) according to the motion detected by the proximity sensors.
  - Arduino Code - https://drive.google.com/file/d/1P1s0AqB7Ajjl7EIKN0JhCA1opt-Uou0y/view?usp=sharing
  - Upload the program and power the set up from the batteries and test the output while moving the hand towards the proximity sensor.



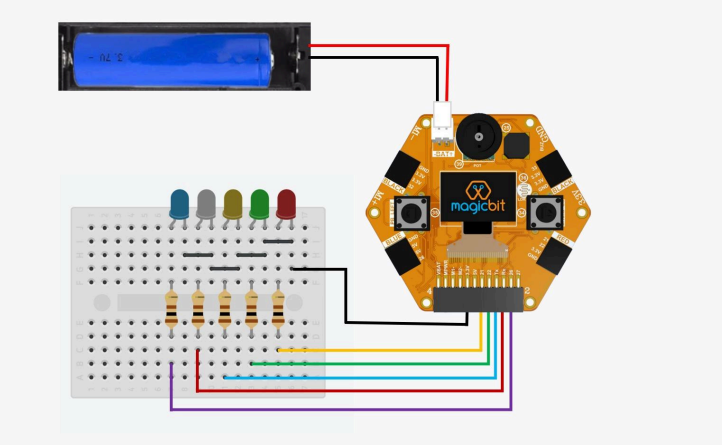
- **Step 08 -** Update the program to control the speed of the motor using the potentiometer in the Magicbit.
  - Arduino Code - https://drive.google.com/file/d/1oOG4kk1tbBMvKJuA4uav56uEGxjorMLg/view?usp=sharing

Lesson 02 - Automated Lights System

- Activity
    - Automated lights system based on the environmental light intensity as well as when a motion is detected.
- Learning Outcomes
    - Arduino Programming
    - Practical applications of the concept
- Materials Required
    - Magicbit Core
    - USB cable
    - Computer with Arduino IDE
    - LEDs
    - Resistors (100 ohm)
    - M-M jumper wires
    - Motion (PIR) sensor module
    - Breadboard
- Steps for the Activity

Expected Output - https://youtu.be/dmNpufNRJ9c

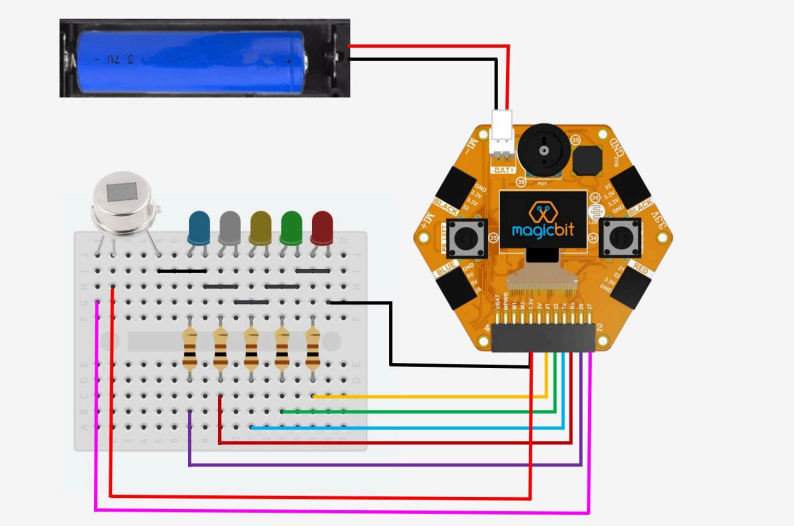
- **Step 01 -** Make a simple circuit with few LEDs and resistors (can use on-board LEDs)



- **Step 02 -** Make the program to control the LEDs (ON and OFF) according to the light level measured by the LDR

- Arduino Code - https://drive.google.com/file/d/1yQmkfNYkxoWu85upwSvDlwxavjdB7y98/view?usp=sharing
- Upload the code and connect the LEDs (circuit with Magicbit) and power using batteries

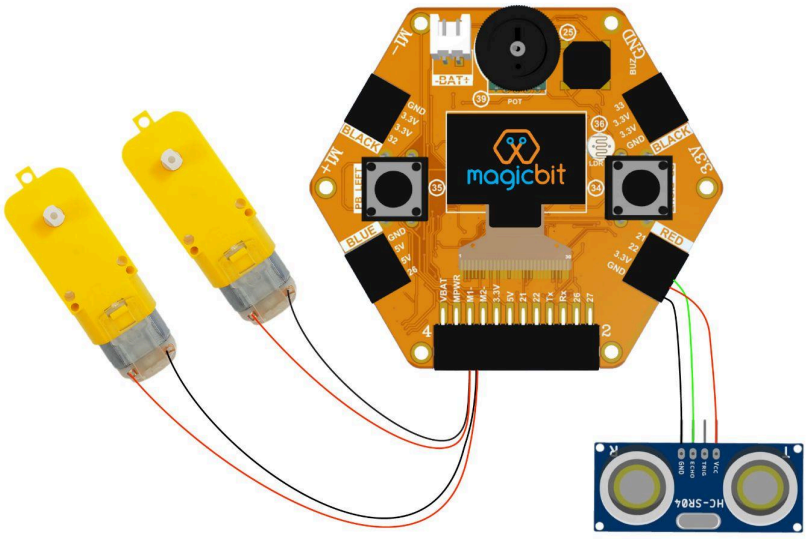
- **Step 03 -** Update the program to create different patterns according to different Light Levels.
  - Arduino Code - https://drive.google.com/file/d/1-K32SjoF4sIZQ8cEQKrvaA6sksANMqtZ/view?usp=sharing
- **Step 04 -** Update the program to control the LEDs when a motion is detected while low light intensity in the environment
  - Update the Circuit with PIR sensor
    - Connect the PIR sensor to the pin 32 or 33 in the Magicbit as follows.



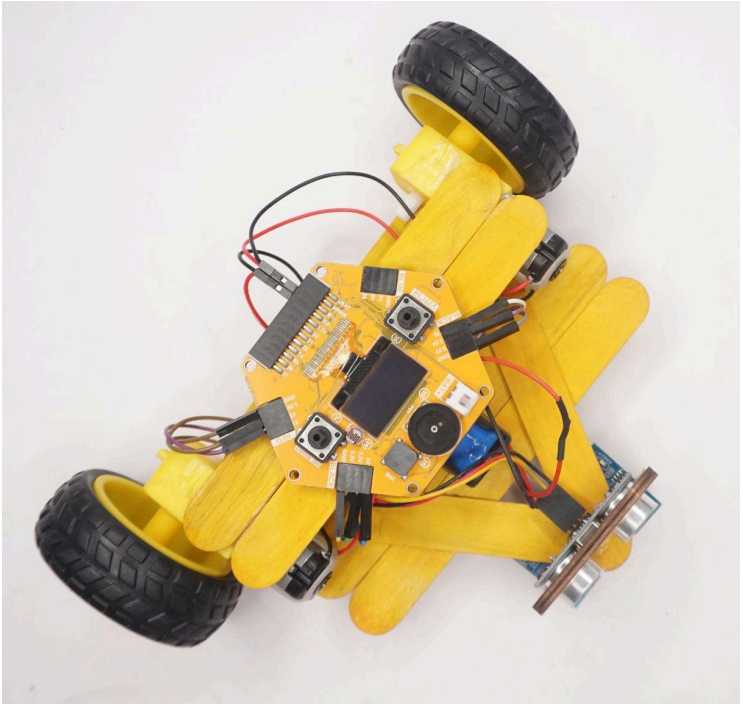
  - Arduino Code - https://drive.google.com/file/d/1Xxy3OO5awdG_84bIBfHI4JanSYZYTeph/view?usp=sharing

Lesson 03 - Obstacle Avoiding Robot

- Activity
    - Creation of a DIY robot using popsicle sticks to work as an Obstacle avoiding Robot.
- Learning Outcomes
    - Arduino Programming
    - Advanced motor controlling
    - Robotics Basics
- Materials Required
    - Magicbit Core
    - USB cable
    - Computer with Arduino IDE
    - Popsicle sticks
    - Ultrasonic sensor with cable
    - DC motors
    - Plastic yellow wheels
    - Castor wheel
    - Battery with holder
    - Hot glue gun with glue sticks.
- Steps for the Activity
    - **Step 01 -** Make the robot as guided below
        - Robot Assembly Guide - https://youtu.be/blH1afLQgMQ



- **Step 02 -** Make the program for the Obstacle Avoiding Robot using Arduino as follows.
    - Arduino Code - https://drive.google.com/file/d/1mCaXXB5GjRaSx9yq4GhevAnC5m1TOpkC/view?usp=sharing

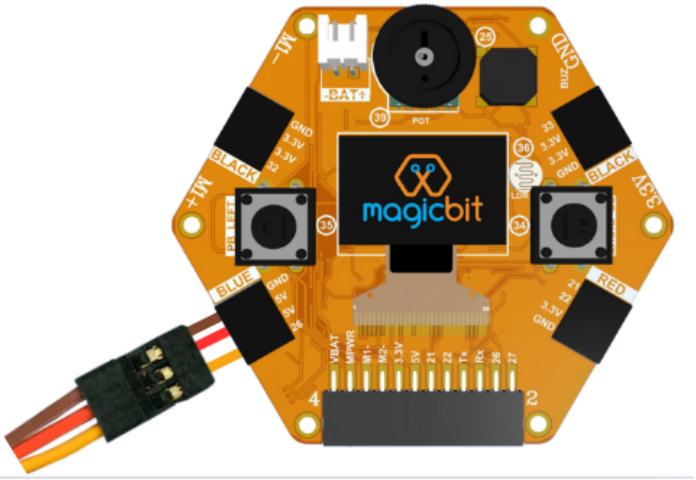


Lesson 04 - Smart Door Opener

- Activity
    - Creation of a mechanism to open the door automatically when someone is detected within the given range.
- Learning Outcomes
    - Arduino Programming - For Loops
    - Servo Motor Controlling
- Materials Required
    - Magicbit Core
    - USB cable
    - Computer with Arduino IDE
    - Cardboard
    - Ultrasonic sensor with cable
    - Servo Motor
- Steps for the Activity

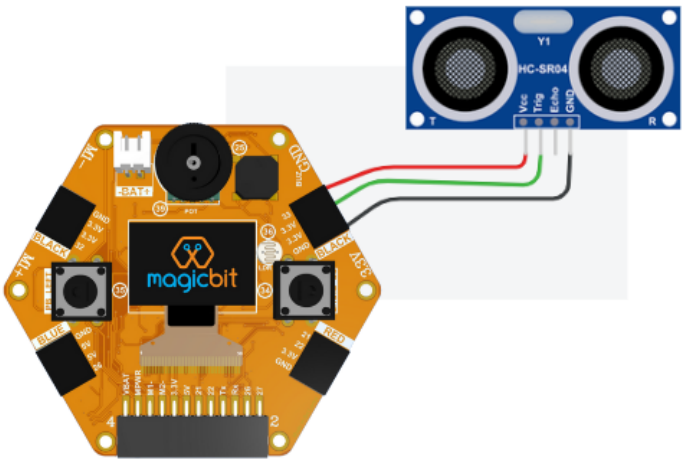
  Expected Output - https://youtu.be/d9Upvzx2qxo

    - **Step 01 -** Create a door structure using cardboard
    - **Step 02 -** Connect the servo motor to the pin 26 in Magicbit.



    - **Step 03 -** Make the below program to rotate the servo motor to one direction

        - Arduino Code - https://drive.google.com/file/d/1mlE4kZAywVfX-R4Os3BjUTmxiRd6iPqC/view?usp=sharing
    - **Step 04 -** Update the above program to rotate the servo motor to the opposite direction as well as at different speeds.
        - Arduino Code - https://drive.google.com/file/d/1yzi2K2ZoXgtmdaiZn7e7RIlKH18kuUep/view?usp=sharing
    - **Step 05 -** Fix the earlier created door structure with the servo motor and ultrasonic sensor near to the structure as necessary.
    - **Step 06 -** Connect theUltrasonic sensor to the magicbit pin 32 or 33 using jumper cables.



    - **Step 07 -** Make the program to rotate the servo to different angles (opening and closing positions of the door) when an object is detected within the given range of the door which is measured by the ultrasonic sensor.
        - Arduino Code - https://drive.google.com/file/d/15f2Sy-Birr0d6g-bpONwneIGTZb30QQu/view?usp=sharing

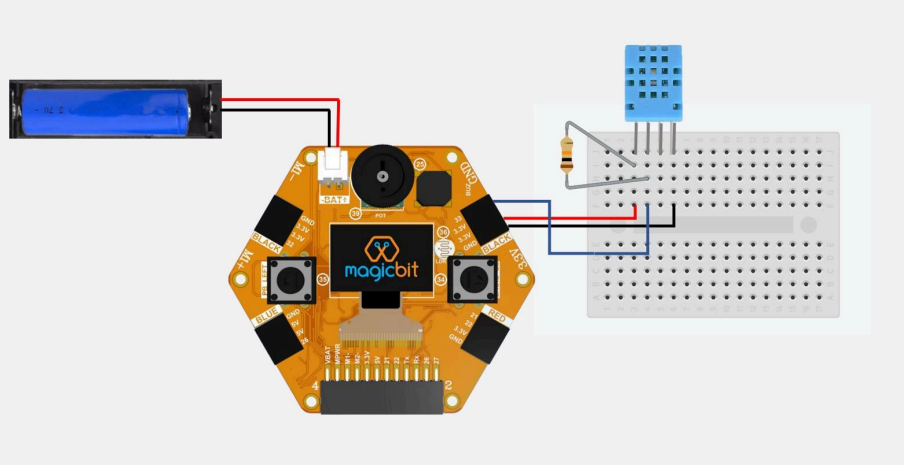
- Try - Try the same activity with PIR motion sensor instead of ultrasonic sensor.

Lesson 05 - Smart Device

- Activity
    - Creation of a mechanism to control the fan and light bulb according to the temperature within the room which is detected by the DHT11 sensor.
- Learning Outcomes
    - Arduino Programming - Serial printing
    - Sensor readings - DHT11 sensor
- Materials Required
    - Magicbit Core
    - USB cable
    - Computer with Arduino IDE
    - Cardboard
    - DHT11 sensor
    - 10K resistor
    - Fan connected DC motor
    - LED with resistor
- Steps for the Activity

Expected Output - https://youtu.be/RFtnV3Me-v8

- **Step 01** - Connect the DHT11 sensor to pin 33 in the Magicbit .Use the 10K resistor.

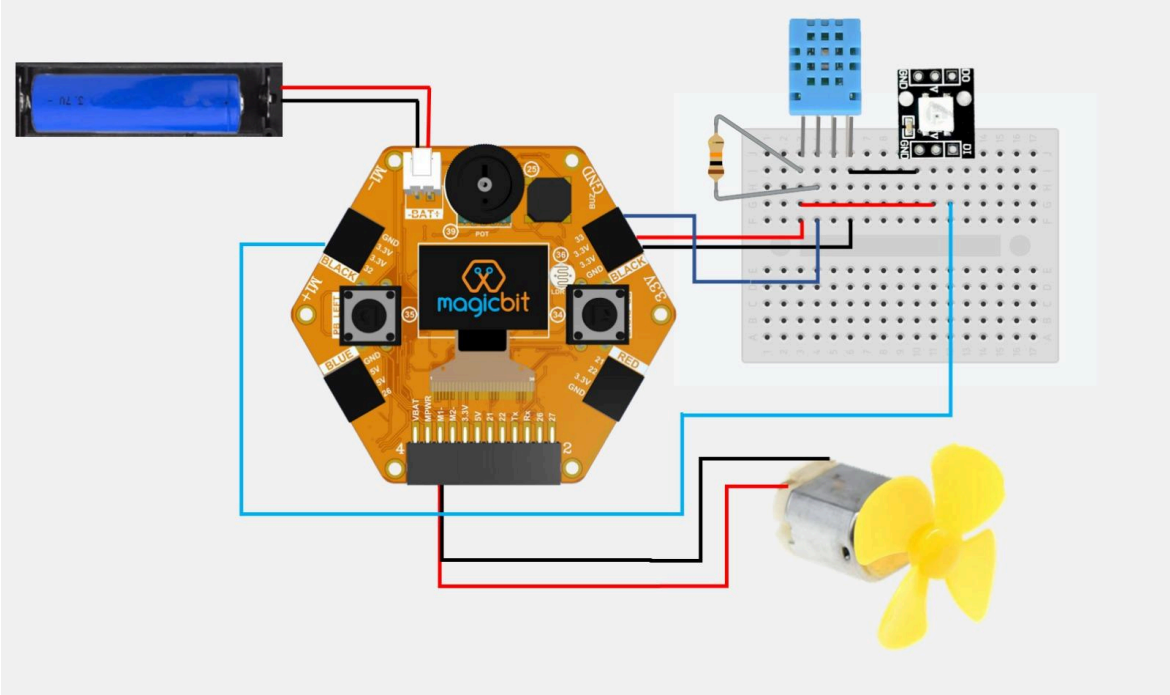


- **Step 02 -** Connect the Magicbit with Arduino IDE and make the below code to get the readings from the DHT11 sensor .
  - Arduino Code - https://drive.google.com/file/d/1eaY5UlHd--mOcVfOy7YjLsg2sMOe2do4/view?usp=sharing
- **Step 03 -** Create a simple table fan stand using cardboard.

- **Step 04 -** Fix the fan connected DC motor to the above structure

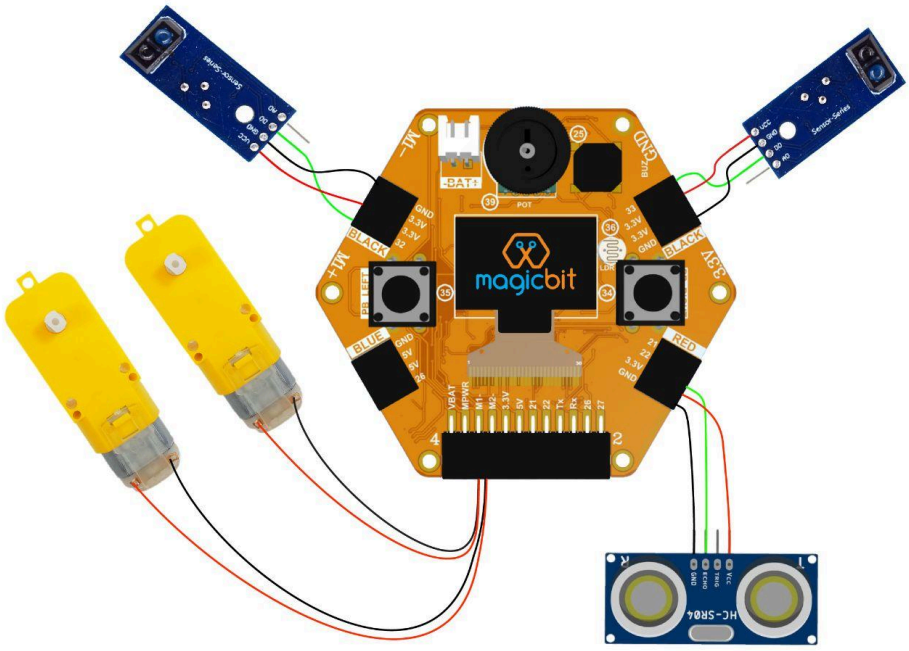
- **Step 05 -** Connect the DC motor cables to the M1and M1+ or M2- and M2+ pins in the Magicbit. Keep the DHT11 sensor connected.
- **Step 06 -** Update the earlier program to activate the fan (DC motor) according to the readings from DHT11 sensor
  - If the temperature is higher than a certain value, turn on the motor.
  - If the temperature is less than the value, turn off the motor.
  - Arduino Code - https://drive.google.com/file/d/1I5G5X26Qiiw3W1DV6nsWmdrbLdCjPapR/view?usp=sharing
- **Step 07** - Connect the RGB module to pin 32 in the Magicbit.

- **Step 08 -** Update the earlier program to indicate the temperature level in different colors of the RGB
    - High temperatures - RED
    - Middle temperatures - Green
    - Low temperatures - Blue
    - Arduino Code - https://drive.google.com/file/d/1pXOAaRJuMdeaMvH_fz7PVCCnEAbCBgos/view?usp=sharing



Lesson 06 - Path Finder Robot

- Activity
    - Creation of a DIY robot using popsicle sticks to work as a line follower / path finder Robot.
- Learning Outcomes
    - Arduino Programming - Serial printing
    - Sensor readings - IR proximity sensor
- Materials Required
    - Magicbit Core
    - USB cable
    - Computer with Arduino IDE
    - Popsicle sticks Robot
    - IR proximity sensor modules
    - Black line track
- Steps for the Activity
    - **Step 01 -** Assemble the robot (Use the same robot created in obstacle avoiding robot lesson)
        - Robot Assembly Guide - https://youtu.be/WcdRQHzG7Zg
    - **Step 02 -** Update the the robot with IR proximity / line tracking sensors

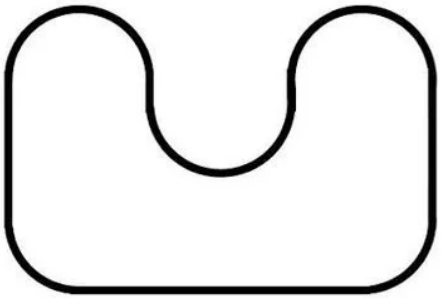


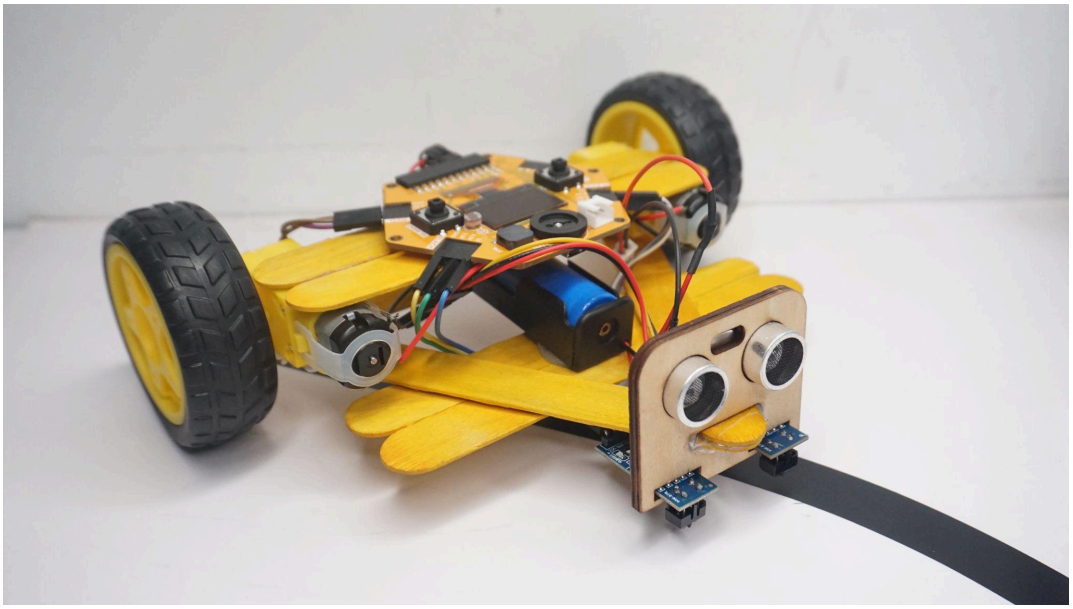
- **Step 03 -** Make the program to follow the black line

Arduino Code - https://drive.google.com/file/d/1Uz5S8qMpkzwmvYNhMuh4c0GYbKX0Sg0n/view?usp=sharing

- **Step 04 -** Make a black track / line on a white surface to test the robot
  - Printable Black Track - https://drive.google.com/file/d/1hNrdazskvo0TiJwfUG0tOLLoG9YEOq5S/view?usp=sharing

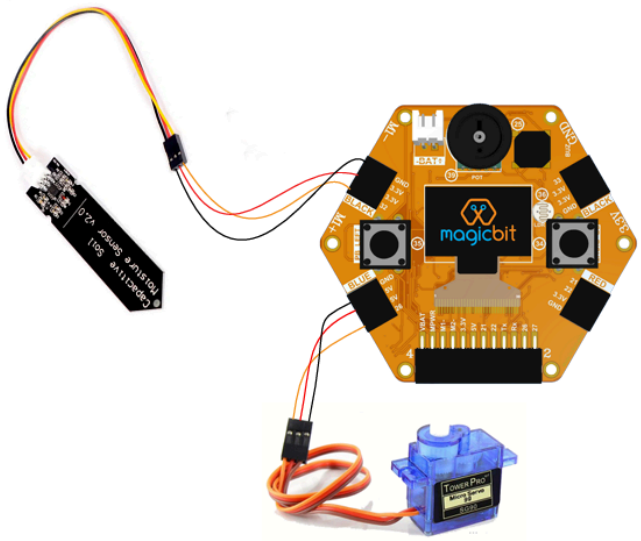
Important - This document is scaled to A2 size.





Lesson 07 - Automated Plant Watering System

- Activity
    - Creation of a DIY setup and a program to water the plants automatically depending on the plant's soil moisture level.
- Learning Outcomes
    - Arduino Programming - Serial printing
    - Sensor readings - Soil Moisture sensor
    - Servo Motor operation
- Materials Required
    - Magicbit Core
    - USB cable
    - Computer with Arduino IDE
    - 2 Popsicle sticks
    - Servo Motor
    - Soil Moisture sensor
    - Saline / Rubber Tube
    - Plant pot / soil sample
    - Mini Plastic bottle - as the water container
    - M-M jumper cables
- Steps for the Activit
    - **Step 01 -** Make the set up as guided below.
        - https://youtu.be/GRwXbWTSIO8
    - **Step 02 -** Connect the components with each other according to the below circuit diagram.



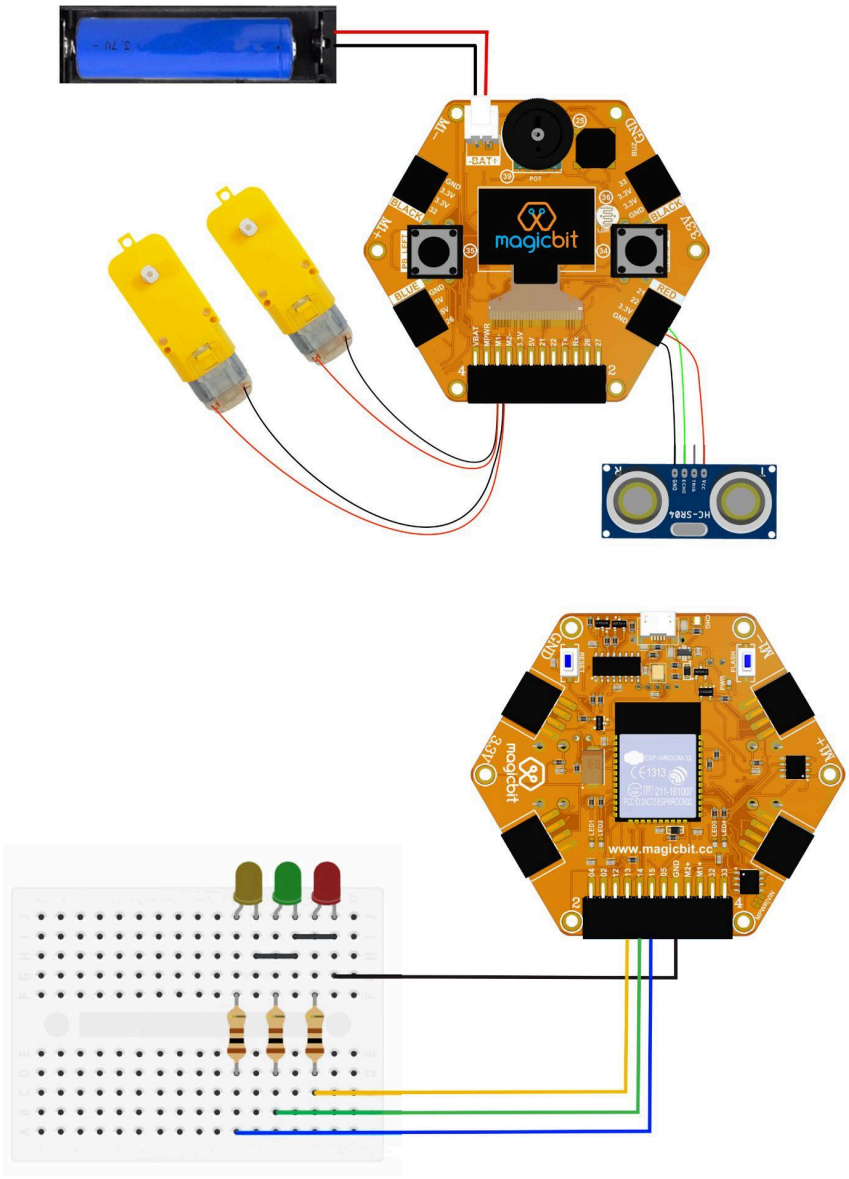
- **Step 03 -** Make the program to get the readings of the moisture level in the soil using capacitive soil moisture sensor and decide the threshold value.
    - Explain about the moisture sensors
        - Difference between resistive and capacitive soil moisture sensors
        - Method of getting the readings
    - Arduino Code - https://drive.google.com/file/d/1l5Dt6ZTt-d-aNmwRQ05X5BKEIHBvY-8x/view?usp=sharing
- **Step 04 -** Make the program to get the angles of the servo motor which it should rotate to make the water flow and stop water flow.
    - Arduino Code - https://drive.google.com/file/d/12M_3H_CE7w5UTXplclKUvmaSN-QABG7p/view?usp=sharing
- **Step 05 -** Make the final program to activate the servo according to the soil moisture level.
    - Arduino Code - https://drive.google.com/file/d/1OAIvhSgCos6m5raaf5MXJjPhFld7Tn-f/view?usp=sharing

Lesson 08 - Interactive Pet Toy

- Activity
  - Creation of a DIY robot pet using cardboard to respond when a person is detected near it.
- Learning Outcomes
  - Arduino Programming
  - Sensor readings - Ultrasonic sensor
  - LED patterns
- Materials Required
  - Magicbit Core
  - USB cable
  - Computer with Arduino IDE
  - Cardboard
  - DC gear motors x 2
  - Ultrasonic sensor x 1
  - LEDs x 3
  - 100 ohm resistors x 3
  - Mini Breadboard x 1
  - Metal ball castor wheel x 1
  - M-M jumper cables
  - M-F jumper cables
- Steps for the Activity
  - **Step 01 -** Cut out the sketch of the robot using cardboard
    - Sketch - https://drive.google.com/file/d/1BcZuAkbwThOpluGiu1VjqJTrvYJJfCTq/view?usp=sharing

      This document is arranged to A3 size.
  - **Step 02 -** Make the pet robot as in the guided video below.
    - https://youtu.be/7ZdrGHuQFWo

- **Step 03 -** Connect the components with Magicbit as in the below diagram



- **Step 04 - Make the program**
  - Move the robot forward
  - Detect the people / objects using ultrasonic sensor
  - Rotate / move in circular motion , when a person/ object is detected
  - Activate a pattern in LEDs , when a person/ object is detected

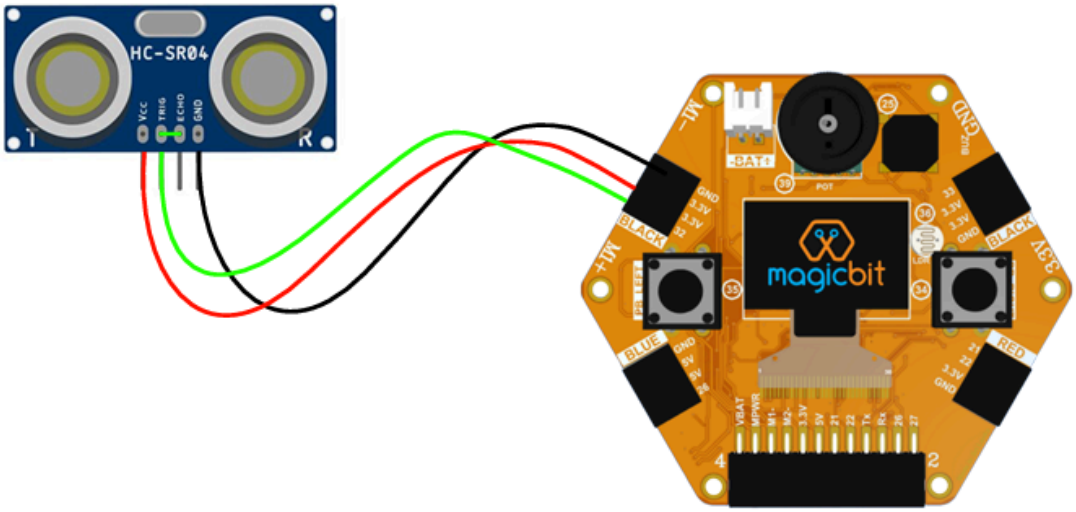
Arduino Code - https://drive.google.com/file/d/1vBExrmrkvXgIDRG_l4uW8HQbXCAZmJxZ/view?usp=sharing

Lesson 09 - Garage Parking Assistant

- Activity
    - Creation of a DIY setup and a program to measure the distance between the vehicle and the garage wall and indicate it on a display and warning alarm using a buzzer.
- Learning Outcomes
    - Arduino Programming
    - Sensor readings - Ultrasonic sensor
    - OLED display
    - Buzzer
- Materials Required
    - Magicbit Core
    - USB cable
    - Computer with Arduino IDE
    - Ultrasonic sensor
    - M-F jumper cables
- Steps for the Activity

Expected Output - https://youtu.be/_h_zFK6oVuI

- **Step 01 -** Make the arrangement of the components as follows.



- **Step 02 -** Make the program with following functions
  - Get the distance using ultrasonic sensor
  - Activate and deactivate the buzzer
  - Displaying texts in the OLED display

Arduino Code - https://drive.google.com/file/d/14vyiWiYhovsMMWg-I0rAteV8xnZn0UTj/view?usp=sharing

Lesson 10 - Remote controlled Vehicle

- Activity
    - Creation of a program to control a DIY robotic car remotely or via bluetooth.
- Learning Outcomes
    - Arduino Programming
    - Remote controlling
- Materials Required
    - Magicbit Core
    - USB cable
    - Computer with Arduino IDE
    - Popsicle sticks robot car
    - Smart Phone
- Steps for the Activity

Expected Output - https://youtu.be/rUQgRxwqF38

- **Step 01 -** Use the robot created in lesson 03 or lesson 06 (Popsicle sticks robot)
    - Assembly guide - https://youtu.be/WcdRQHzG7Zg
- **Step 02 -** Make the program having below functions
    - Receive serial commands via serial monitor
    - Move forward , backward, left , right and stop

Arduino Code - https://drive.google.com/file/d/1cy5GEEtqd7NKu30FvYErelynAGF9Q0cN/view?usp=sharing

- Upload the code and open the serial monitor and send the given commands and observe the output
- Keep the robot connected via USB to the computer

- **Step 03 -** Update the program to control the robot via mobile app connected via bluetooth

Arduino Code - **https://drive.google.com/file/d/1b7izzmkcpLgcdAr-r4sN6fiVY00D3PhI/view?usp=sharing**

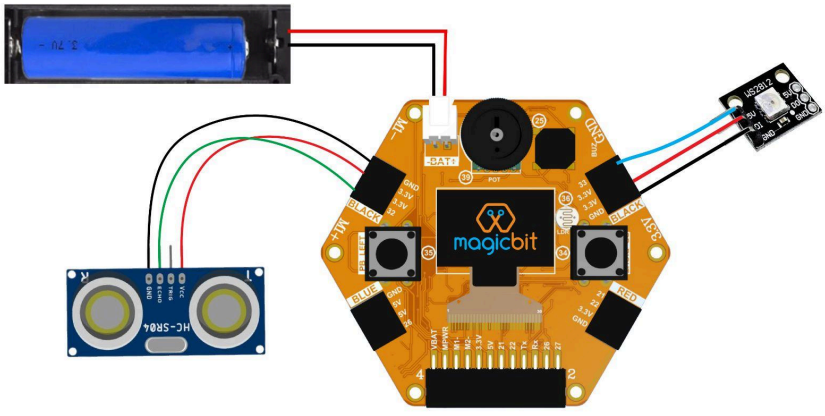
- Upload the code to the robot (Magicbit)
- Power the robot using batteries
- Download any bluetooth remote controlling app to the mobile phone
  - Eg - Arduino Bluetooth Control
- Turn On the bluetooth in the smartphone
- Search for the device which you gave for the robot in the above code and pair with it.
  - In the above code it is "`MagicbitRobot`".
- Open the previously downloaded mobile app and connect with the same device name as above.
- Select the option "Use as a gamepad or car controller" if available.
- Now control the car accordingly.

Lesson 11 - Smart Recycling Bin

- Activity
    - Creation of a program to detect the garbage level inside a dustbin and indicate it via Color LEDs (RGB)
- Learning Outcomes
    - Arduino Programming
    - Neopixels controlling
- Materials Required
    - Magicbit Core
    - USB cable
    - Computer with Arduino IDE
    - Styrofoam cup
    - Ultrasonic sensor
    - Neopixel LED
    - Battery with holder
    - M-F jumper cables
    - Piece of carboard
- Steps for the Activity

Expected Output - https://youtu.be/G7I3vBCc0rM

- **Step 01**
    - Make the dustbin using a styrofoam cup and a lid for that using the piece of cardboard.
    - Attach the other components and connect them as in the diagram below.



- **Step 02 -** Make the code with following functions
  - Measure the distance using ultrasonic sensor
  - Switch the colors in neopixel LED according to different distance ranges

  Arduino Code - https://drive.google.com/file/d/1O3l9FEJLVsxCBg4aQpRU5oSGGVp-JYt6/view?usp=sharing

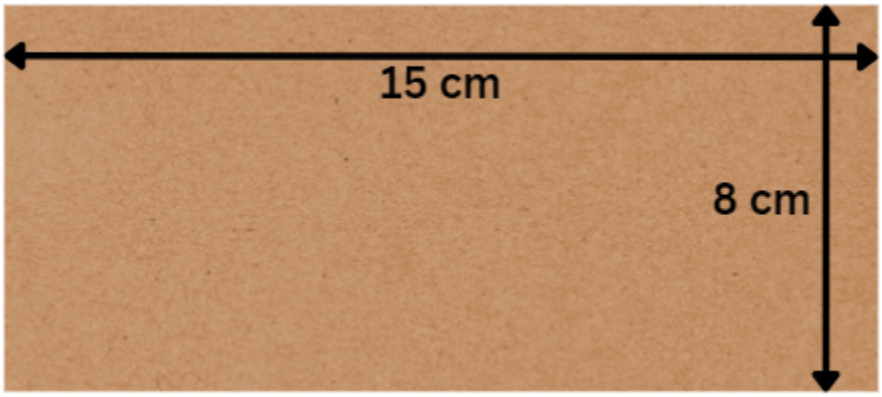
- **Step 03 -** Update the above program to display the measured distance on the Magicbit Display .
  - Arduino Code - https://drive.google.com/file/d/1N7s2TAjCly8Bv_28Pk0mQj6l3vvCsCsY/view?usp=sharing

Lesson 12 - Automated Room curtains

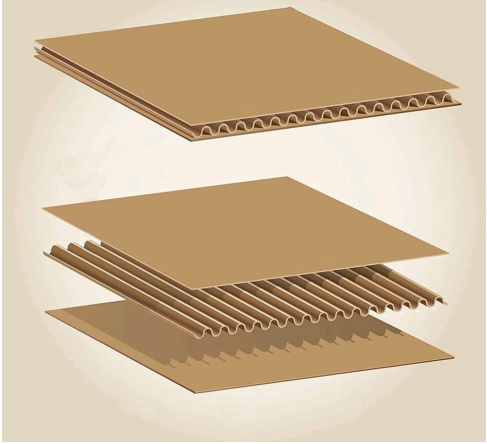
- Activity
    - Creation of a program to fold and unfold the room curtains according to the light level in the room.
- Learning Outcomes
    - Arduino Programming - switch case
    - Sensor readings - LDR
    - DC motor controlling
- Materials Required
    - Magicbit Core
    - USB cable
    - Computer with Arduino IDE
    - Yellow gear Motor
    - Plastic pen tubes
    - Cardboard
    - Hot glue gun with sticks / Double tape
- Steps for the Activity

Expected Output - https://youtu.be/FKSrVIKp7dg

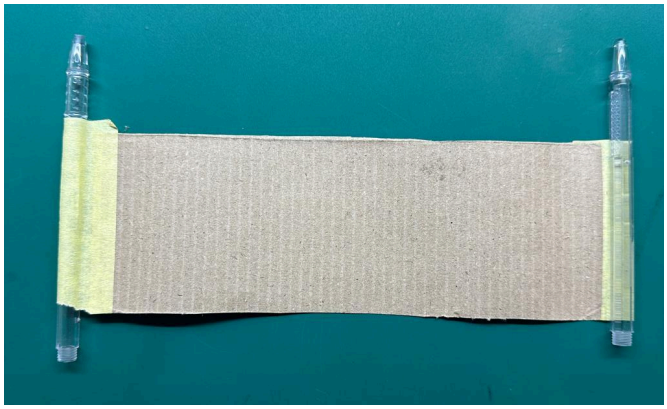
- **Step 01 -** Make the set up as below (Example set-up of a curtain)
    - Take a piece of cardboard with the size 8 x 15 cm (Hereyou can use a piece of cloth or tissues)



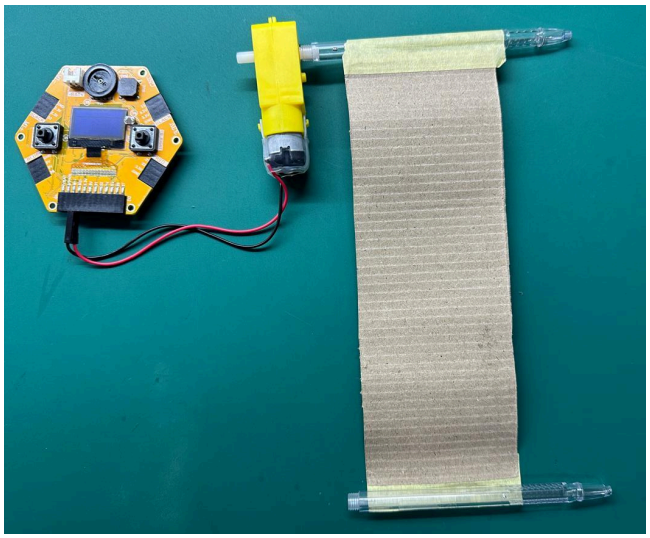
- Remove one ply of the above piece to make it more flexible.



- Attach the both ends to the pen rods using hot glue or double tape



- Fix one pen rod to the DC gear motor shaft and connect the motor to the magicbit M1 or M2 pins.



- **Step 02 -** Make the code with following functions
  - Get the readings from LDR in the Magicbit
  - Rotate the motor to forward, backward and stop directions.
  - Control the motor's rotation according to the LDR readings.

Arduino Code - https://drive.google.com/file/d/1VPMYxVzVI4tp4-_o-6VGsR76UVTx20-q/view?usp=sharing