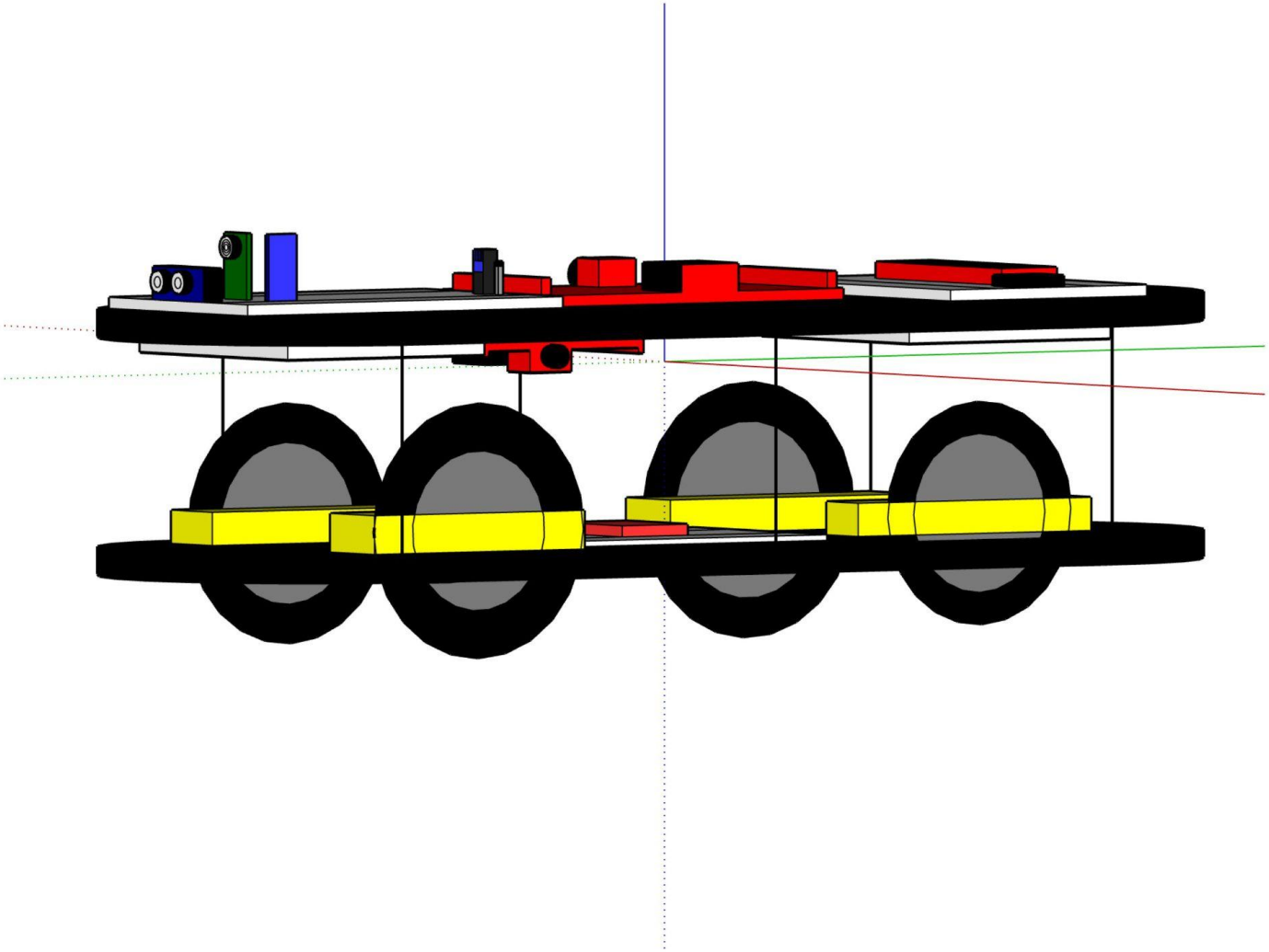
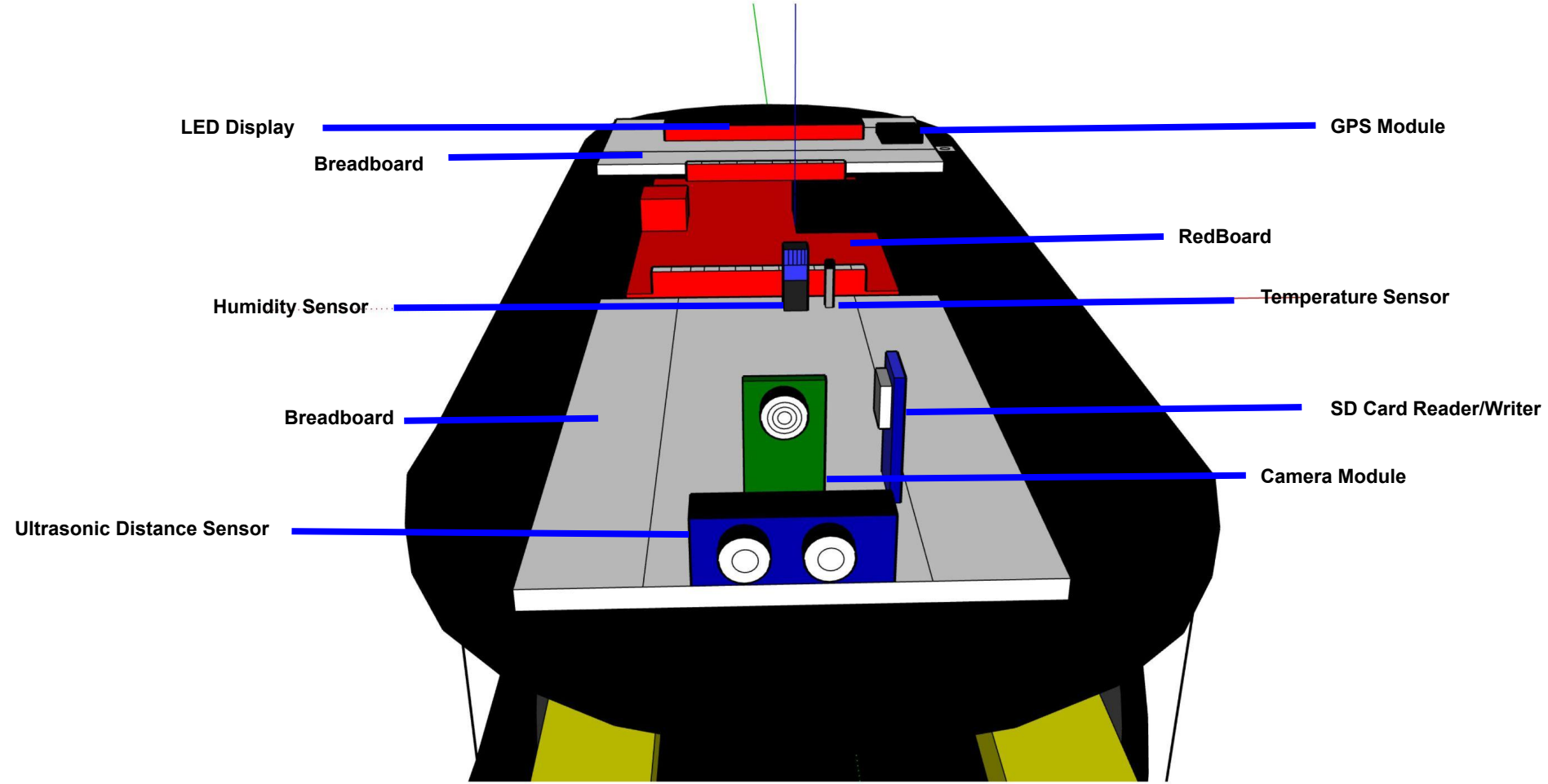
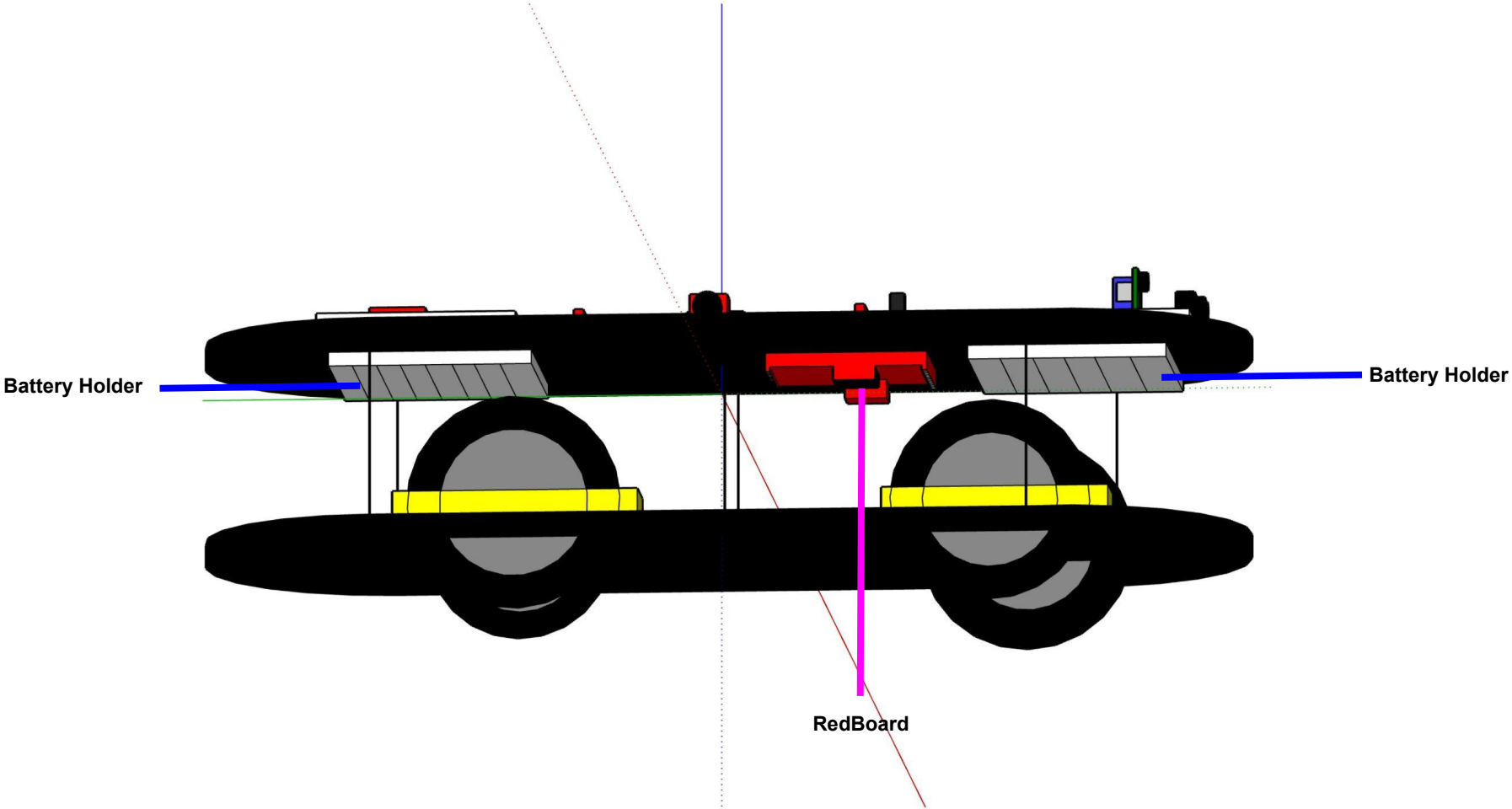
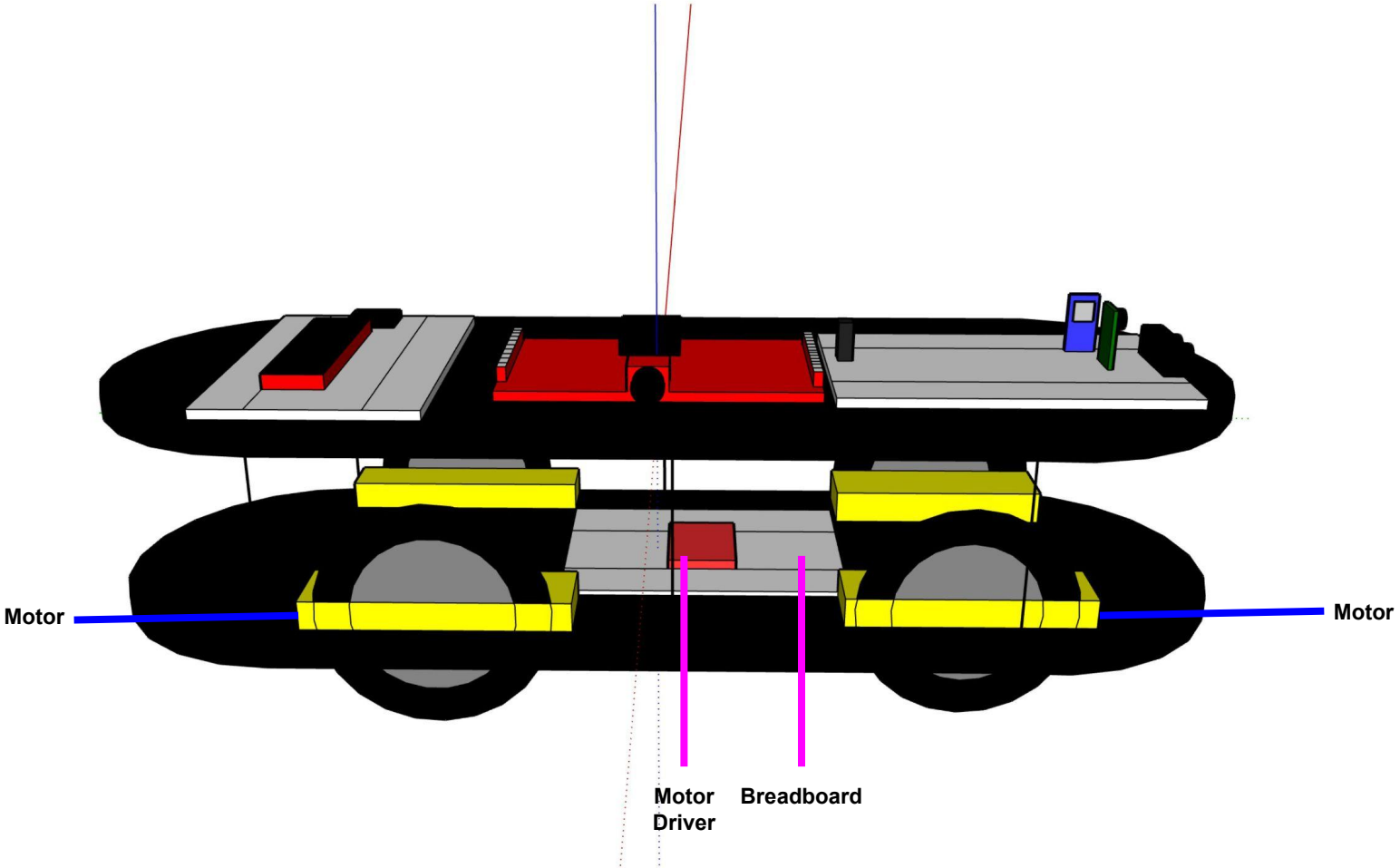
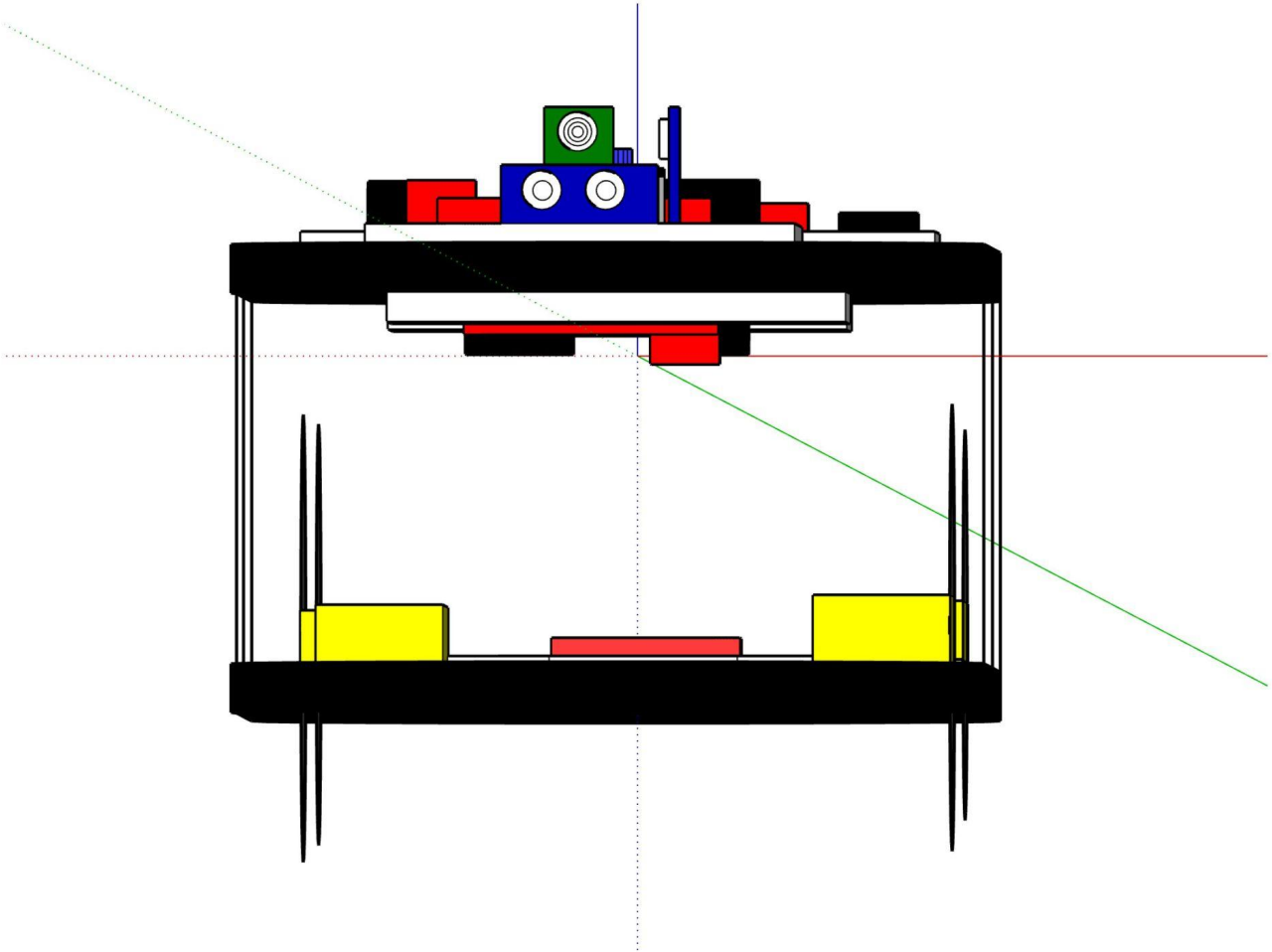



LED Display
Breadboard
GPS Module
RedBoard
Humidity Sensor
Temperature Sensor
Breadboard
SD Card Reader/Writer
Camera Module
Ultrasonic Distance Sensor

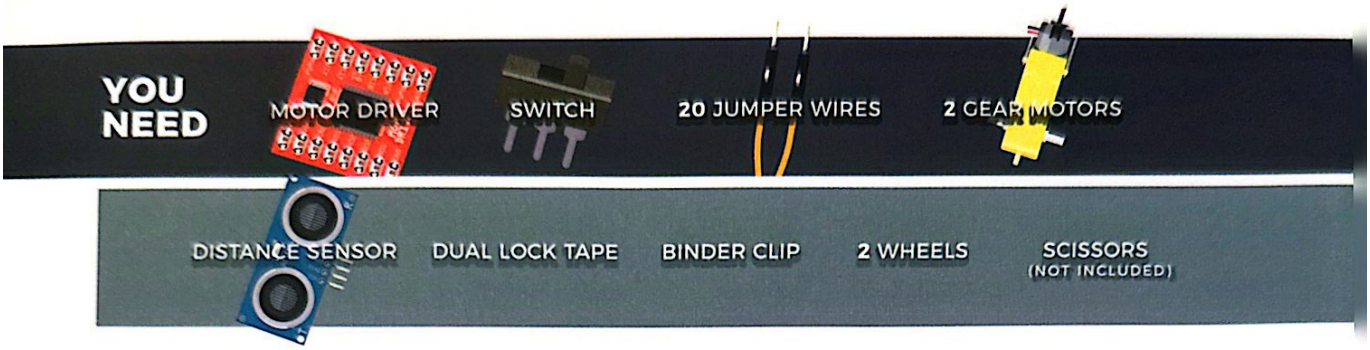

Battery Holder
Battery Holder
RedBoard


Motor
Motor
Motor Driver
Breadboard



Circuit 5C: Autonomous Robot

Free the robots! In this circuit, you'll unplug your robot and program it to navigate the world on its own. When the robot senses an object using the distance sensor, it will back up and change course.



NEW CONCEPTS

AUTONOMOUS VEHICLES: The robot that you will build uses a simple sensor to avoid obstacles. This kind of system is used in Mars rovers, autonomous cars and the bots built for all kinds of robotics competitions. Understanding this example code will set you on the path to building bigger and better autonomous vehicles!

Keep in mind that the ultrasonic distance sensor needs a clear path to avoid unwanted interruptions in your robot's movements. Keep the distance sensor clear of any wires from your circuit.

HEADS UP!

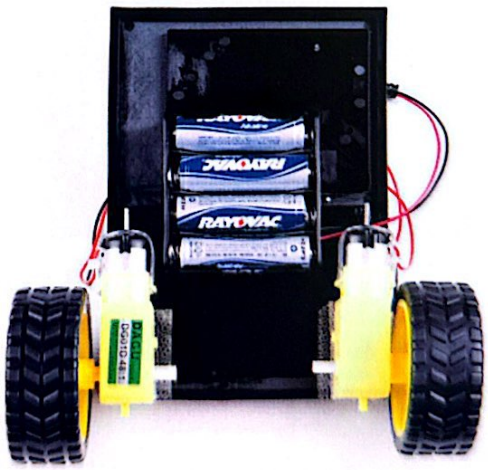
Make sure your switch is in the **OFF** position. As soon as the code is finished uploading, your robot will begin driving. Make sure it cannot drive off a table or other high surface and injure itself.

ASSEMBLY

BATTERY HOLDER ATTACHMENT: If you did not attach the battery pack in Project 4, cut two pieces of Dual Lock, about 1 inch x 1 inch (2.5cm x 2.5cm) each. Remove the adhesive backing, and attach one piece to the back of the battery holder.

Adhere the second piece to the bottom of the baseplate, directly in the middle.

Press the battery holder to the baseplate

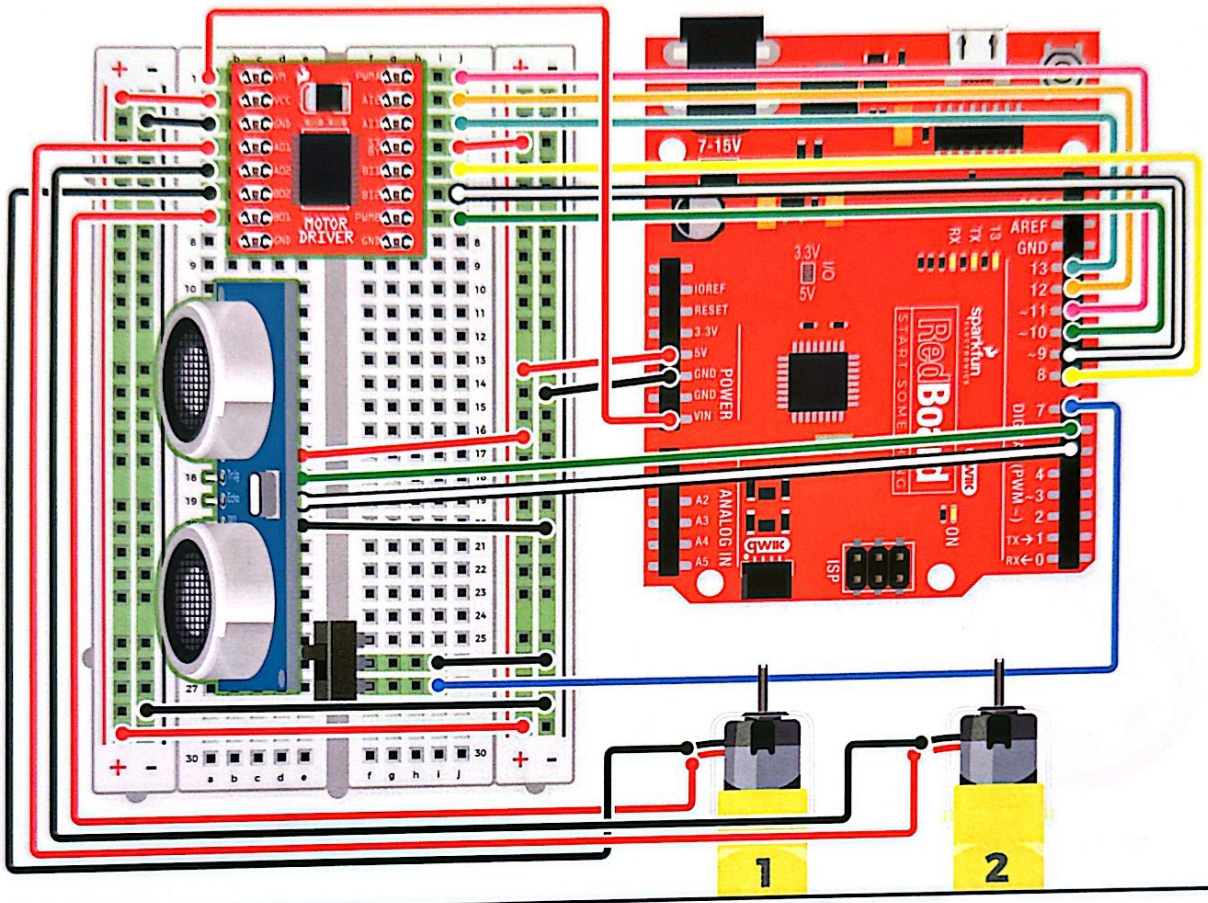


so that the two pieces of Dual Lock snap together. Insert the batteries into the holder if you have not done so already. Remember that batteries are polarized and can only go in one way.

Clip the binder clip back on, and you are ready to roll!

HOOKUP GUIDE

READY TO START HOOKING EVERYTHING UP? Check out the circuit diagram and hookup table below to see how everything is connected.



JUMPER WIRES

- 5V to 5V
- GND to GND (-)
- VIN to A1
- D8 to J5
- D9 to J6
- D10 to J7
- D11 to J1
- D12 to J2
- D6 to E18
- D5 to E19
- D13 to J3
- D7 to I27
- 5V (+) to 5V (+)
- GND (-) to GND (-)
- A2 to 5V (+)
- A3 to GND (-)
- J4 to 5V (+)
- I26 to GND (-)
- E17 to 5V (+)
- E20 to GND (-)

MOTOR 1 (RIGHT)

- A4(RED +)
- A5(BLACK -)

MOTOR 2 (LEFT)

- A7(RED +)
- A6(BLACK -)

MOTOR DRIVER

- C1-C8 to G1-G8 *(VM on C1, PWMA on G1)*

SWITCH

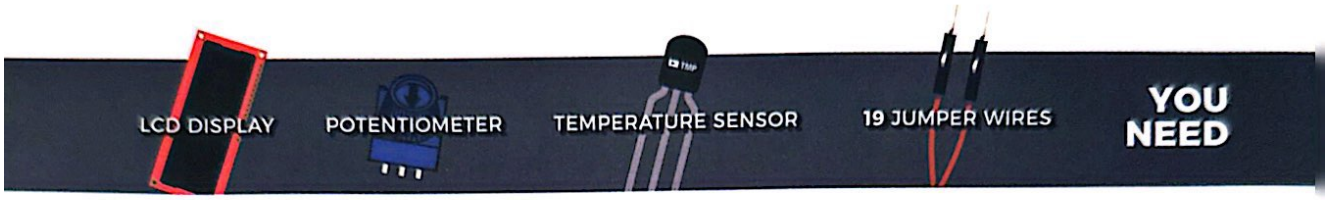
- F25 + F26 + F27

DISTANCE SENSOR

- A17(VCC) + A18(TRIG) + A19(ECHO) + A20(GND)

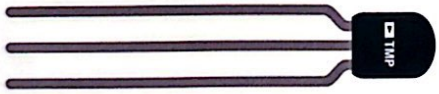
Circuit 4B: Temperature Sensor

Want to create a DIY environmental monitor or weather station? You can use a small, low-cost sensor like the TMP36 to make devices that track and respond to temperature. In this activity you will also use the LCD screen to display sensor readings, a common use for LCDs in electronics projects.



NEW COMPONENTS

TMP36 TEMPERATURE SENSOR: This temperature sensor has three legs. One connects to 5V, one to ground, and the voltage output from the third leg varies proportionally to changes in temperature. By doing some simple math with this voltage, we can measure temperature in degrees Celsius or Fahrenheit.



NEW CONCEPTS

ALGORITHMS: An algorithm is a process used in order to achieve a desired result. Often, the information needed to create an algorithm lives in the part's datasheet. This sketch uses a few formulas to turn a voltage value into a temperature value, making them all part of the larger temperature-retrieving algorithm. The first formula takes the voltage read on analog pin 0 and multiplies it to get a voltage value from 0V–5V:

```
voltage = analogRead(A0) * 0.004882813;
```

The number we are multiplying by comes from dividing 5V by the number of samples the analog pin can read (1024), so we get: 5 / 1024 = 0.004882813.

The second formula takes that 0–5V value and calculates degrees Celsius:

```
degreesC = (voltage - 0.5) * 100.0;
```

The reason 0.5V is subtracted from the calculated voltage is because there is a 0.5V offset, mentioned on page 8 of the TMP36 datasheet found here: **http://sfe.io/TMP36**. It's then multiplied by 100 to get a value that matches temperature.

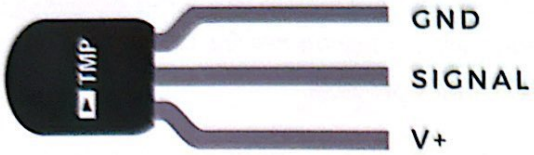
The last formula takes the Celsius temperature and converts it to a Fahrenheit temperature using the standard conversion formula:

```
degreesF = degreesC * (9.0/5.0) + 32.0;
```

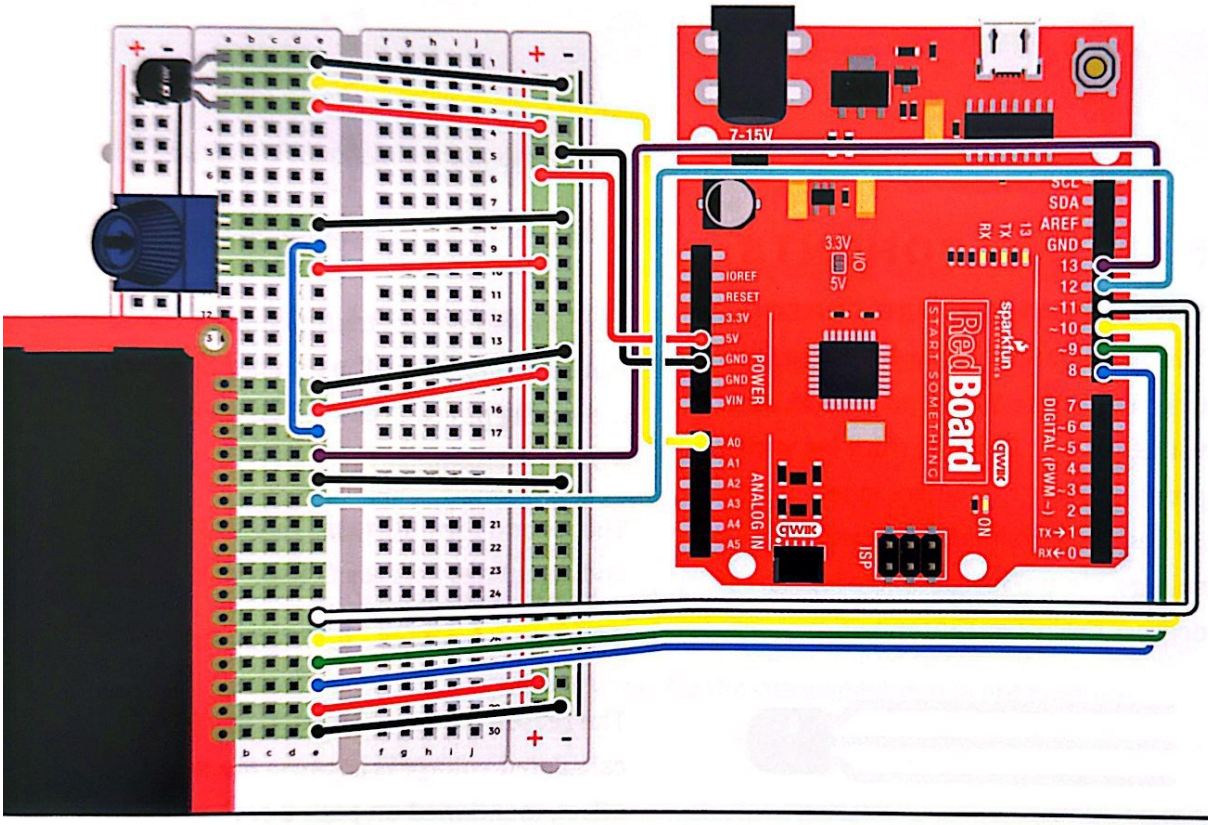
Together, these three formulas make up the algorithm that converts voltage to degrees Fahrenheit.

HOOKUP GUIDE

READY TO START HOOKING EVERYTHING UP? Check out the circuit diagram and hookup table below to see how everything is connected.



HEADS UP! Double check the polarity of the TMP36 temperature sensor before powering the RedBoard. It can become very hot if it is inserted backward!



JUMPER WIRES

- 5V to 5V
- GND to GND(-)
- D8 to E28
- D9 to E27
- D10 to E26
- D11 to E25
- D12 to E20
- D13 to E18
- A0 to E2
- E30 to GND(-)
- E29 to 5V(+)
- E19 to GND(-)
- E16 to 5V(+)
- E15 to GND(-)
- E9 to E17
- E8 to GND(-)
- E10 to 5V(+)
- E1 to GND(-)
- E3 to 5V(+)

LCD SCREEN

- A15-A30 *(pin 1 on A15)*

TMP36 SENSOR

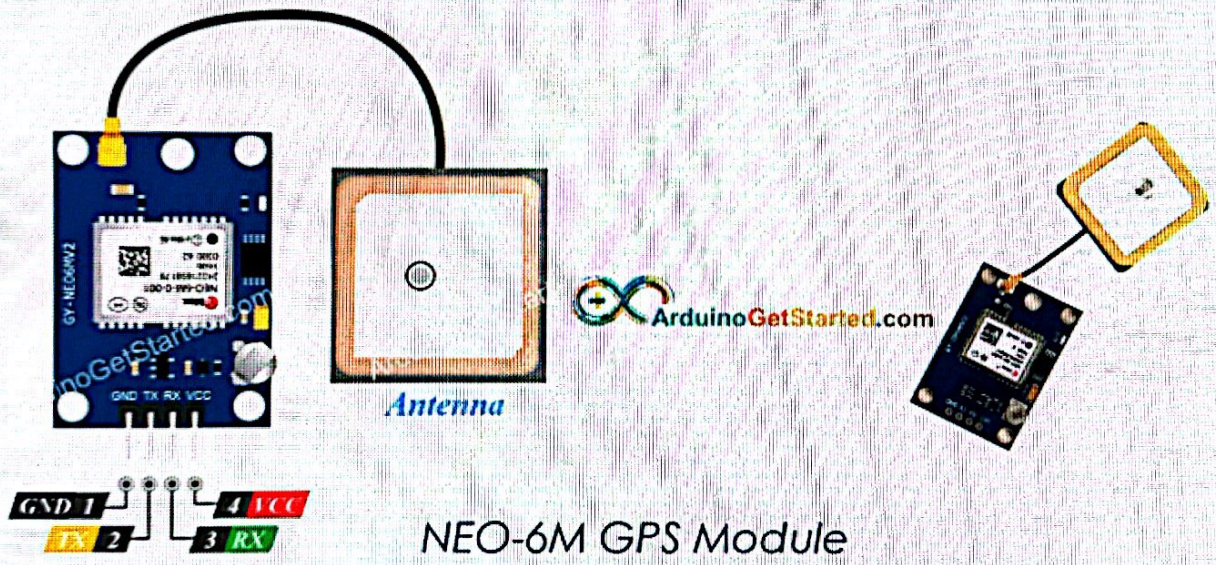
- A1 (GND) + A2 (SIG) + A3(5V)

POTENTIOMETER

- A8 + A9 + A10

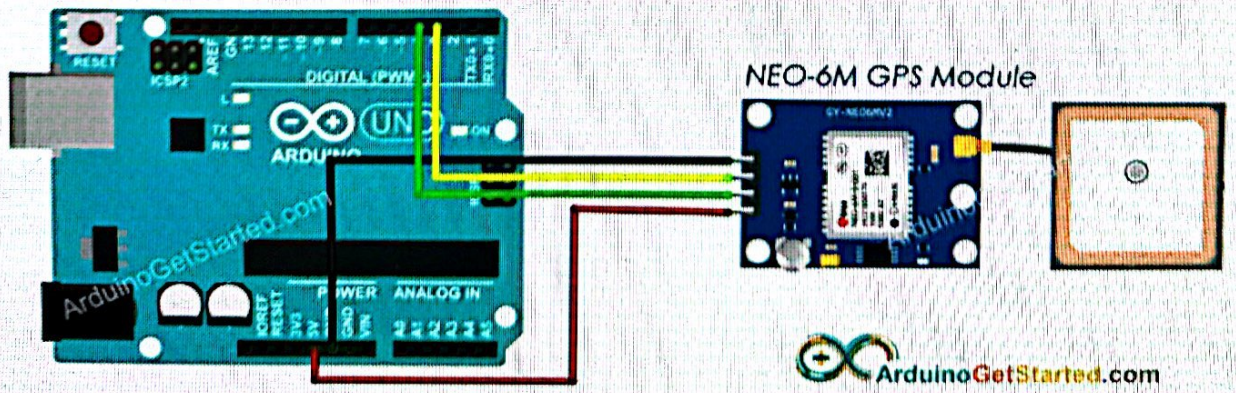
The NEO-6M GPS module includes 4 pins:

- **VCC pin:** needs to be connected to **VCC** (5V)
- **GND pin:** needs to be connected to **GND** (0V)
- **TX pin:** is used for serial communication, needs to be connect to Serial (or SoftwareSerial) RX pin on Arduino.
- **RX pin:** is used for serial communication, needs to be connect to Serial (or SoftwareSerial) TX pin on Arduino.

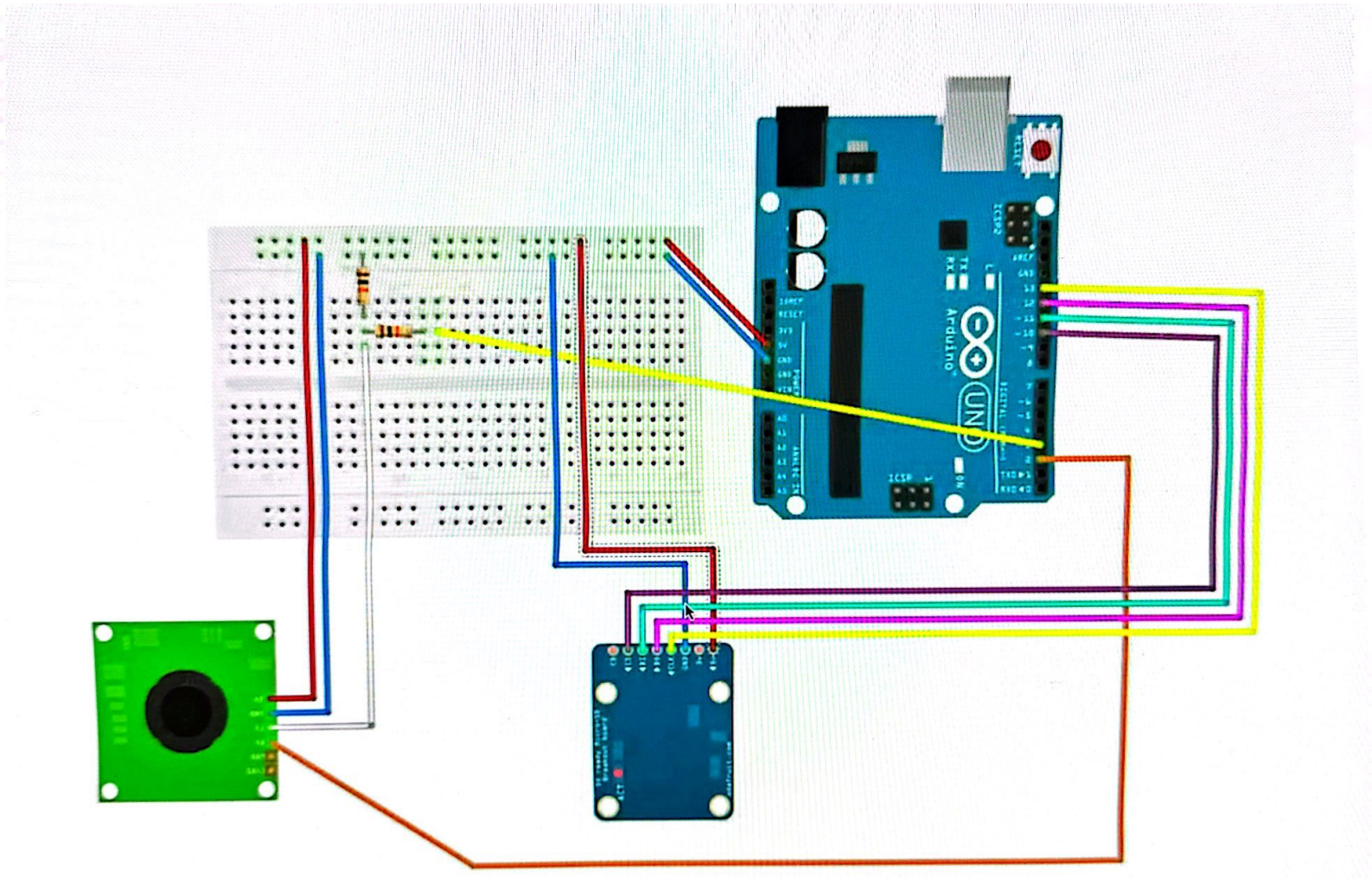


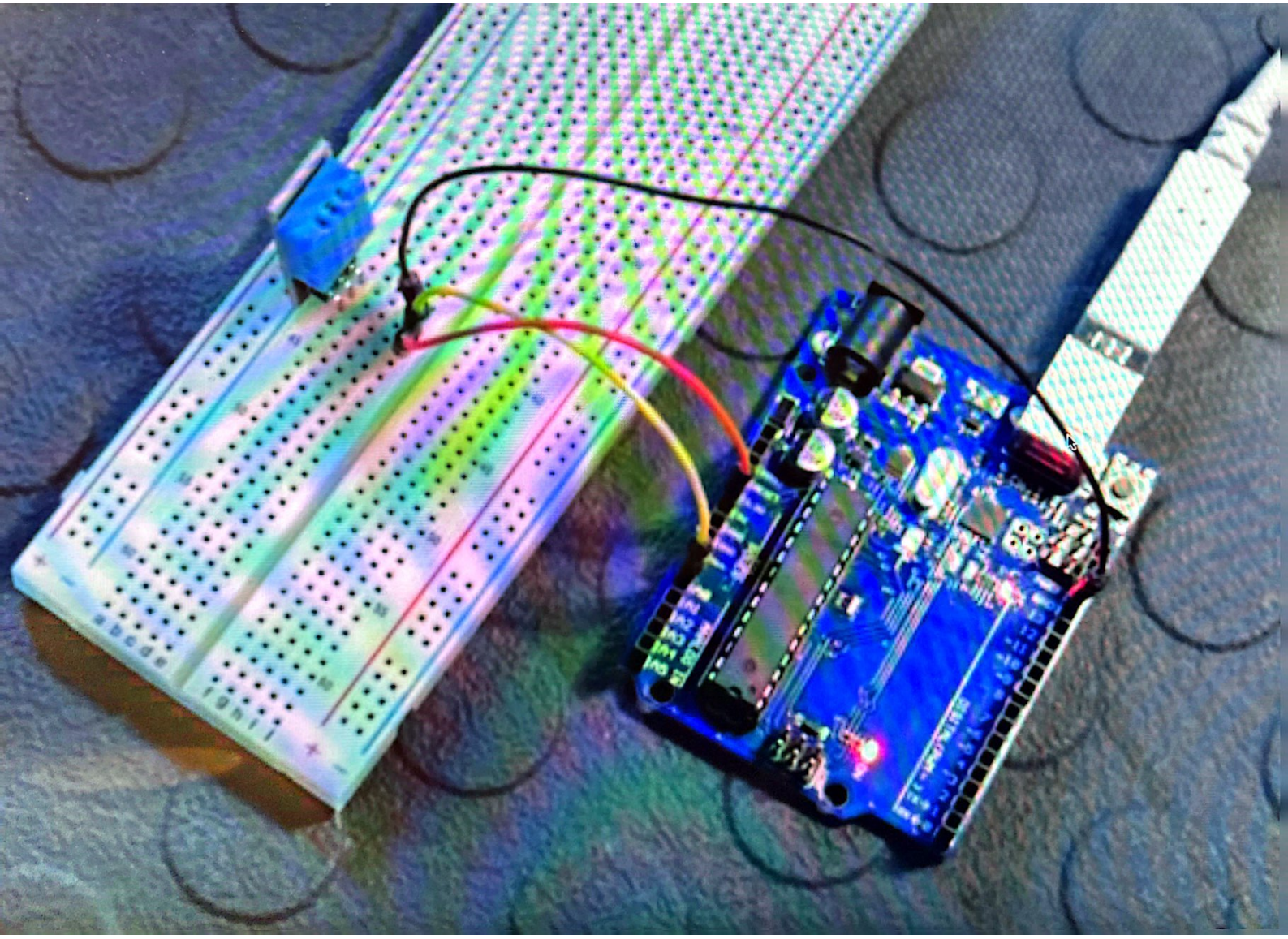
NEO-6M GPS Module

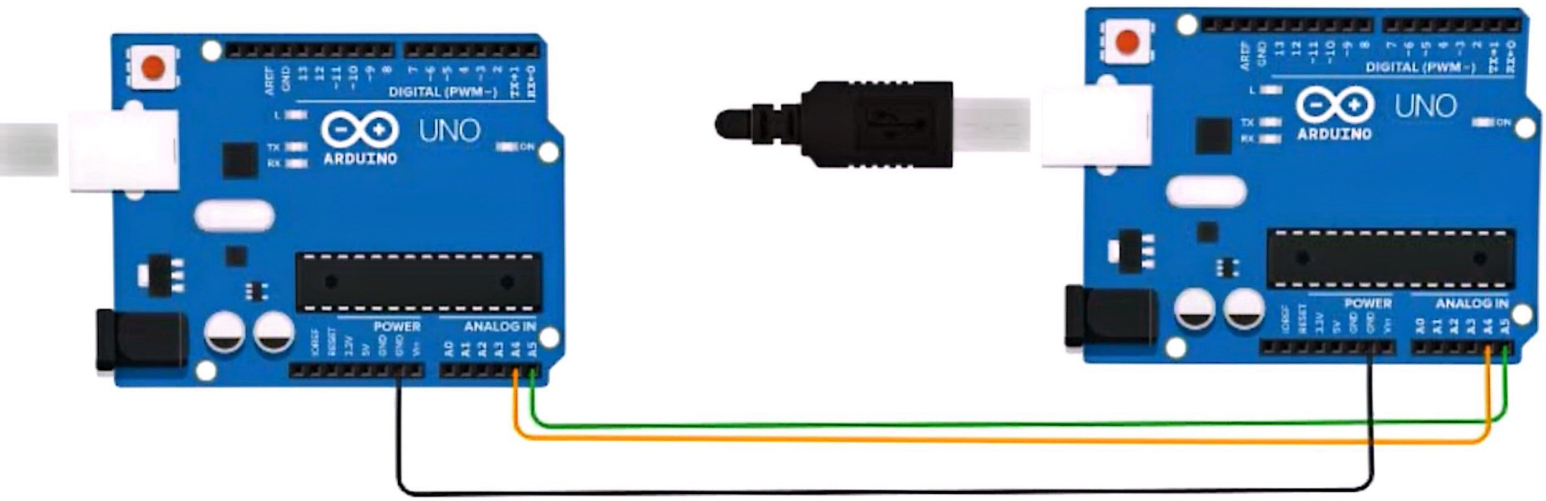
Wiring Diagram



This image is created using Fritzing. Click to enlarge image







RedBoard 1 (Top)			
IOREF		AREF	
RESET		GND	
3.3 V		13	SD Card
5V	Powering Camera/SD Breadboard	12	SD Card
GND	Powering Camera/SD Breadboard	~11	SD Card
GND	Master/ Slave Board Connections	~10	SD Card
VIN		~9	Ultrasonic Distance Sensor (Change ~5 to ~9)
		8	
A0	Humidity Sensor	7	
A1	Temprature Sensor (Change A0 to A1)	~6	Ultrasonic Distance Sensor
A2		~5	GPS Module (Change ~3 to ~5)
A3		4	GPS Module
A4	Master/ Slave Board Connections	~3	Camera Module
A5	Master/ Slave Board Connections	2	Camera Module
		1	

RedBoard 2 (Bottom)			
IOREF		AREF	
RESET		GND	
3.3 V		13	Motor Driver
5V	Powering the Bottom Breadboard	12	Motor Driver
GND	Powering the Bottom Breadboard	~11	Motor Driver
GND	Master/ Slave Board Connections	~10	Motor Driver
VIN	Motor Driver	~9	Motor Driver
		8	Motor Driver
A0		7	Switch
A1		~6	Motor Driver
A2		~5	Motor Driver
A3		4	Motor Driver
A4	Master/ Slave Board Connections	~3	Motor Driver
A5	Master/ Slave Board Connections	2	Motor Driver
		1	Motor Driver