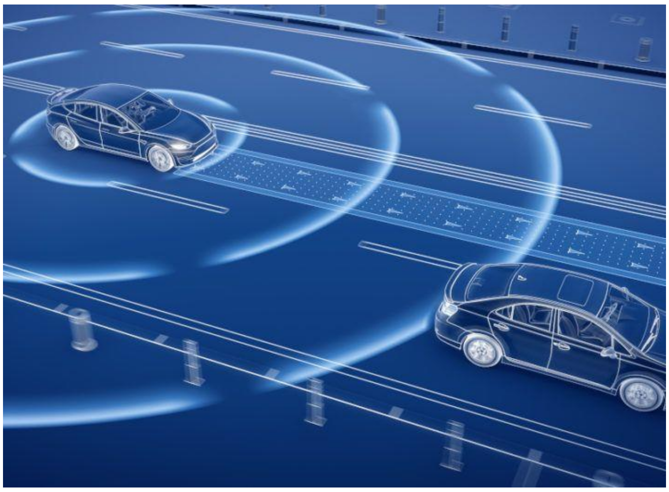
Robotics Engineer for a Day

[Click here for an instructional video to support the task]

Introduction

Robotics, Autonomous and Interactive Systems Engineers bring together expertise in electronics, computer software, and mechanics to drive innovation in autonomous vehicle guidance, healthcare, remote surgery, industrial manufacturing, and domestic assistance. Are you interested in knowing how the robotics field is shaping our future…? Or maybe you are considering a career in robotics? Then, be a **Robotics** Engineer for a Day to get insight into the engineering challenges associated with robotics and autonomous systems.

Background



Robots and Autonomous Vehicles have some awareness of its surroundings, can interact with their environment and have some ability to make independent decisions. Robots can be designed and equipped with sensors so they are aware of objects in close proximity, can recognise colours and patterns, hear and interpret sounds, feel temperature and touch, just like you and me. A robot can also be equipped with a range of actuation devices (wheels, arms & legs etc), speakers etc so they can perform tasks, navigate their environment, and interact with people and other robots.

To connect this sensory ability with functional tasks, robots need a form of intelligence where the awareness of the environment is repeatedly translated into movement and action to perform a role. The degree of autonomy of robots will depend on the range, precision and accuracy of its sensory ability and movement control, but also its ability to make complex decisions to efficiently complete a task. While standard robotics will repeat an action or task in response to a fixed signal or command, the degree of autonomy is increased as the programming of their intelligence becomes more sophisticated. Using Artificial Intelligence, and Machine Learning techniques, robots can begin to learn/map their environment and explore new ways to complete routine tasks, that are ultimately are more effective and efficient than simple command-response interactions. Imagine the role of a **Robotics** Engineer who is designing next generation Robotics to improve how we travel, shop, cook etc, revolutionising industries such as manufacture, healthcare, automotive, renewable energy, and smart cities. The fast-paced field of Robotics will have a huge influence on how we live in future.

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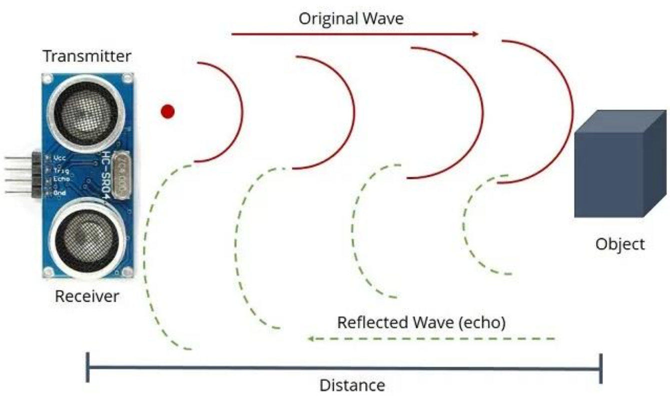
In this task you will develop a robot; a simple electro-mechanical device will be designed to move around its environment, finding and avoiding obstacles as it does so. Obstacle detection is the process of using sensors, data structures, and algorithms to detect objects or terrain types that impede motion. Processors and controllers on board are programmed to analyse sensor data and to decide on actions, such as moving the wheels in a direction to avoid a collision.

Ultrasonic sensors are very common in this application; they work on a principle based on sound wave travel and reflection. The sensor sends an ultrasonic pulse that travels through the air and when it reaches an object, it will reflect (or echo) back to the sensor. By measuring the time taken for the reflected pulse to be received (heard) by the sensor, then the distance can be calculated, since the speed of the ultrasonic pulse is known.



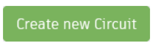
Ultrasonic Sensor

$$Distance = \frac{Total\ Time}{2} \times Speed\ of\ Sound$$

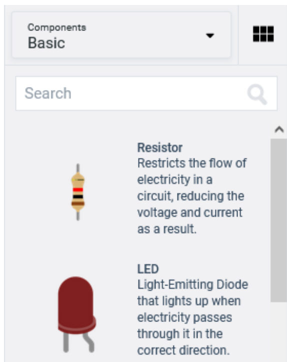
Note that the total time is divided by two, because it includes the time for the signal to travel to the object from the sensor and back again. In this task, a two wheeled robot uses a microcontroller (Arduino UNO) to send a signal to the sensor that activates the transmission of the ultrasonic signal. It then listens for the echo coming back. If an object is detected, you will programme the microcontroller to send control signals to the wheels and other components to find an alternative route to avoid the object (obstacle) and to perform other tasks.

The Task

The following steps cover the basic task procedure, that is using an Arduino board to control a single motor based on an ultrasonic sensor input. Your challenge will be to take this knowledge further and suggest a setup for a two wheeled robot, share the code with us for a practical demonstration. Support to develop your own Autonomous Vehicle can be accessed [here]() and as follows:

1. In your web browser navigate to https://www.tinkercad.com/ to access [TinkerCAD]()
2. Log in and use the circuits tab to "Create new Circuit" 

3. Use the right pane to locate, drag, and drop the components listed below; use the search function and/or expand folder to find each component:
   - Breadboard Small
   - Arduino UNO R3
   - Hobby Gearmotor
   - Ultrasonic Distance sensor
   - 9V Battery
   - H-Bridge Motor Driver L293D (this chip can drive two motors at the same time)



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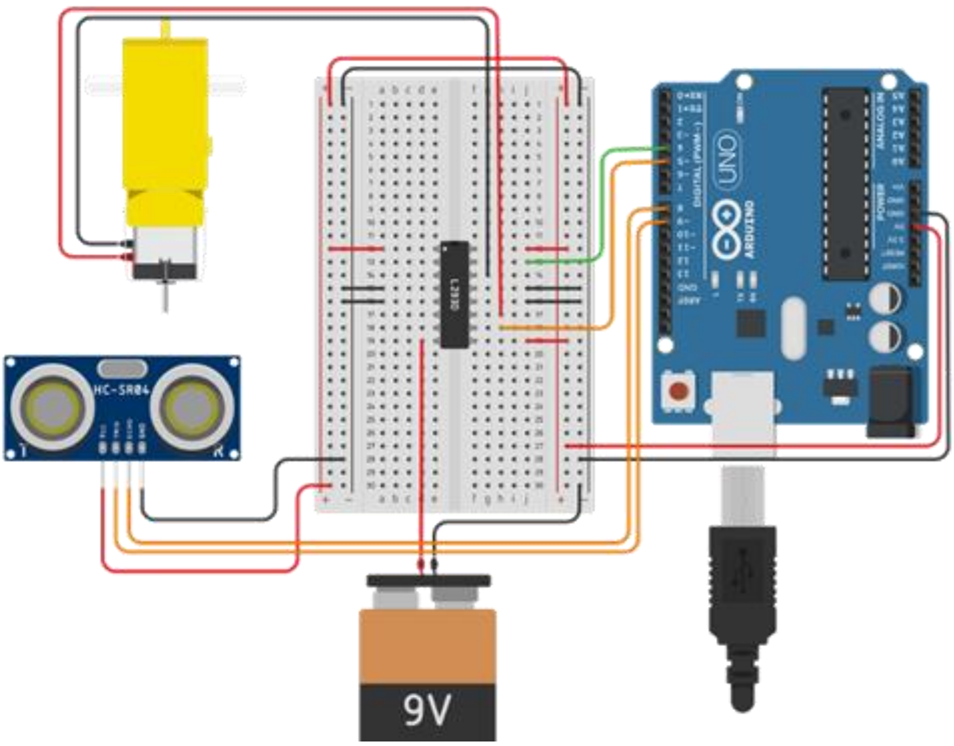
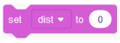
4. Start to wire the circuit as shown; connect the terminals/pins as indicated in the table. Use the mouse pointer to hover over a pin to see its function and click once on the pin to start a wire, then click multiple times to define the path of the wire before you reach its destination terminal. You can change the wire colours using the colours drop down menu. The circuit is no configured to provide power from the battery to the motor driver chip and the motor. It can also read signals from the sensor and send control signals from to the motor driver to motors that turn the wheels of the robot.

Pin	*Connect to*
Chip Input 3	Arduino 5
Chip Input 4	Arduino 4
Chip Power	9V +VE
Chip Enable 1&2 and 3&4	BB +VE
Chip Output3	Motor +VE
Chip Output4	Motor -VE
Chip Ground	BB -VE
Sensor Trigger	Arduino 9
Sensor Echo	Arduino 8
Sensor Vcc	BB +VE
Sensor GND	BB -VE
Arduino GND	BB -VE
Arduino 5V	BB +VE
9V Battery-VE	BB -VE

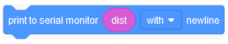


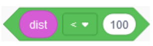
5. Click on "Code" 

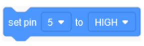
to use "Blocks + Text"

to programme the intelligence of your robot; delete any default blocks that are present
6. Start by creating a variable from the variables tab, this will represent the distance
7. Drag the auto generated "Set" block 

to the scratch editor (to the right of the "Blocks + Text" menu)
8. Use an "Input" block 

to define the sensor pins to match the hardware connected circuit
9. Use an "Output" block 

to print out the distance reading measured by the sensor
10. To design the control, use an "if-else loop" from the "Control" block, and a set the distance condition using a "Math" block 

and an "Output" block 

to send a command/control to the motor driver chip. The code for a single motor should look like the figure; ensure the specified pin numbers match the hardware connection.

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The programme starts by detecting whether an object is within a specific range (100 cm) and stops when the object is within that range.

The output blocks are programmed to control the motor driver's inputs by setting them to either 'HIGH' or 'LOW'. That is based on the driver's operation settings shown in the table below

	Pin 10 (Input 3) of L293 driver IC	***Pin 15 (input 4) of L293 driver IC***
FUNCTION	Connect to **pin 5** of the Arduino	Connect to **pin 4** of the Arduino
Motor stop	HIGH	HIGH
Motor turn Anticlockwise	LOW	HIGH
Motor turn Clockwise	HIGH	LOW
Motor stop	LOW	LOW

11. Start the simulation and adjust the blue ball in the sensing range around, to see the motors either move forward or stop based on how far the blue ball is from the sensor.
12. Based on what you have learned and achieved so far, can you try the following challenges:
    - Programme the robot to stop for 3 seconds and then move backwards for 5 seconds when it detects an object within a range of 50 cm
    - Set up the circuit for a 2-wheeled obstacle avoidance robot using two geared motors in TinkerCAD and update your scratch code
13. Take some screenshots of your design and pictures of your results/calculations and upload to the "Engineer for a Day" Padlet

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