PROGRAMMING RESOURCES - ACTIVITY SHEET 9

MAKE A TILT SENSOR

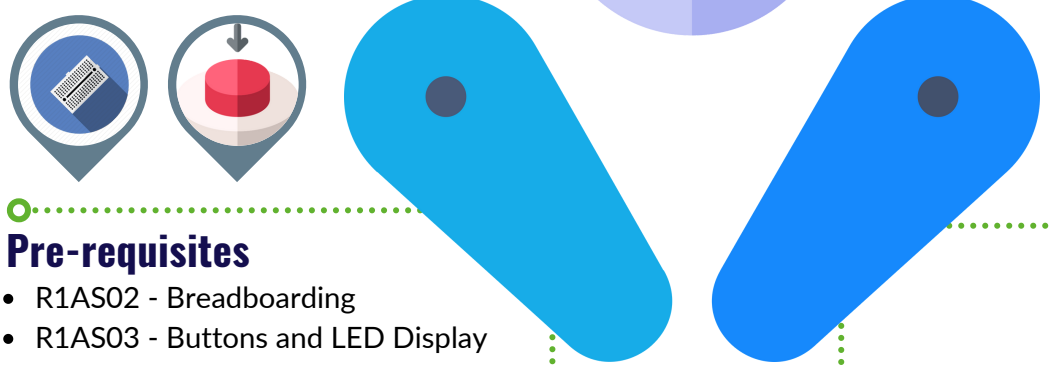
WITH THE ACCELEROMETER

#R1AS09

What is it?

Accelerometers are small sensors that can detect the force of acceleration and are great for detecting motion and orientation.

Available on



Pre-requisites

- R1AS02 - Breadboarding
- R1AS03 - Buttons and LED Display

Duration

30 minutes

Level of difficulty

Advanced

Material

- 1 Programming board "***STM32 IoT Node Board***"
- Micro-B USB Cable
- 1 set of LEDs
- 1 set of resistors
- 1 Breadboard
- Jumper wires

LEARNING OBJECTIVES

- Use an accelerometer by reading the value of the acceleration on each axis
- React to shaking with events
- Detect free-fall situation

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MAKE A TILT SENSOR WITH THE ACCELEROMETER

Acceleration makes the world go round - literally! It is the force that causes movement like a car accelerating away from a traffic light or an object falling on the ground from gravity when dropped.

To discover the potential of this motion sensor, we will write a tilt sensor that lights on a led when the acceleration is too strong. This kind of device is useful if you want to avoid cheating on classical old **pinball**.
Resource: https://en.wikipedia.org/wiki/Pinball

The 3-axis accelerometer is already embedded on the board so you do not need to connect anything to use it!

STEP 1 - MAKE IT

Wire three LEDs to the board

By using a breadboard, connect three simple LEDs to the pins of the board:

- **Green** LED to the pin **A0**
- **Blue** LED to the pin **A1**
- **Red** LED to the pin **A2**

Connect the board to the computer

With your USB Cable, connect the board to your computer by using the **micro-USB ST-LINK connector** (on the right corner of the board). If everything is going well you should see a new drive on your computer called **DIS_L4IOT**. This drive is used to program the board just by copying a binary file.

Open MakeCode

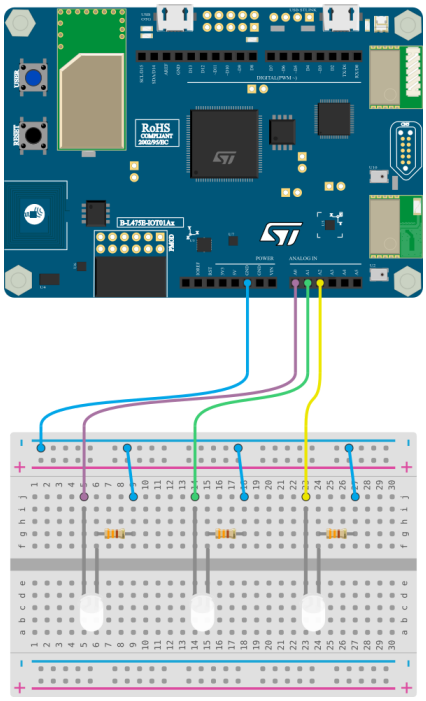
Go to the **Let's STEAM MakeCode editor**. On the home page, create a new project by clicking on the "New Project" button. Give a name to your project more expressive than "Untitled" and launch your editor.
Resource: makecode.lets-steam.eu

Program your board

Inside the MakeCode Javascript Editor, copy/paste the code available in the **Code It Section** below. If not already done, think of giving a name to your project and click on the "**Download**" button. Copy the Binary file on the drive **DIS_L4IOT**, wait until the board finishes blinking!

Run, modify, play

Your program will automatically run each time you save it or reset your board (push the button labelled RESET). Try to understand the example and start to modify it by changing the thresholds to test how sensible you need to calibrate your tilt sensor. To test your tilt sensor, put the board on a table and give a little kick to the table. If your led light is on, the acceleration of your kick is strong enough!



Wiring three LEDs to the board

MAKE A TILT SENSOR WITH THE ACCELEROMETER

STEP 2 - CODE IT

```
function turnOffLEDs() {
   pins.A0.digitalWrite(false) // Green
   pins.A1.digitalWrite(false) // Blue
   pins.A2.digitalWrite(false) // Red
}

forever(function () {
   turnOffLEDs()
   // X axis: green L
   if (Math.abs(input.acceleration(Dimension.X)) > 700)
      pins.A0.digitalWrite(true)
   // Y axis: blue LED
   if (Math.abs(input.acceleration(Dimension.Y)) > 700)
      pins.A1.digitalWrite(true)
   // Z axis: red LED
            if (Math.abs(input.acceleration(Dimension.Z)) > 700)
      pins.A2.digitalWrite(true)
   pause(500)
})
```

How does it work?

The program consists of lighting a LED along the axis on which the acceleration (-1g) due to gravity is detected.

The g-force of an object is its acceleration relative to free fall. On earth, this is 1g, or 9.8 meters per second squared (m/s^2). Astronauts experience unusually high and low g-forces. G-force can also be seen on rollercoasters. When the coaster goes down the drop, you are pushed back into your seat because of g-force.

Here is the configuration of the acceleration axes / LED colors:

- X axis: green LED
- Y axis: blue LED
- Z axis: red LED

Read the value acceleration

To read the value of the acceleration, MakeCode provides the function acceleration(). The value is by default in mg. We use the absolute value function abs() to ignore the direction of the acceleration. To detect the "tilt" condition, we use a threshold of 700mg. To turn off all three LEDs at the same time and improve the expressiveness of our code, we define a function turnOffLEDs().

A Function is a block of code that executes a specific task. Like a variable, it has a name to use in many places in your program. It's really useful to simplify the code and make a block of code more expressive by giving a name that explains your intent.

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STEP 3 - IMPROVE IT

1. What happens if you **increase the time of pause()** inside your loop? How do you improve the **responsiveness of your tilt** sensor?

2. By using the value of the acceleration of the gravity (1g acceleration Z-Axis oriented), can you **determine the orientation of your board** (on the left side, on the bottom side, on the top side, on the bottom side)?

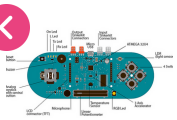
3. By using the knowledge that when a solid is in free fall, the value of the acceleration becomes close to zero very quickly, can you **modify the program to detect this situation**?

4. How can you detect if the **board is shaked** ?

GOING FURTHER

Accelerometer - Learn more about physics principles and applications of the accelerometer. *https://en.wikipedia.org/wiki/Accelerometer*

Free Fall Detection Using 3-Axis Accelerometer - The easy method to determine free-fall detection with the help of a simple 3-axis accelerometer. *https://www.hackster.io/RVLAD/free-fall-detection-using-3-axis-accelerometer-06383e*



Level Platform Using Accelerometer - Uses an accelerometer to level a platform. *https://www.hackster.io/mtashiro/level-platform-using-accelerometer-80a343*

Explore other activity sheets

R1AS12 - Motion Detection Alarm