

## Lesson 16 (GY-521 / QMI8658) Module

### Overview

In this lesson, we will learn how to use GY-521 module which is one of the best IMU (Inertia Measurement Unit) sensors, compatible with Arduino. IMU sensors like the GY-521 are used in self balancing robots, UAVs, smart phones, etc.

### Component Required:

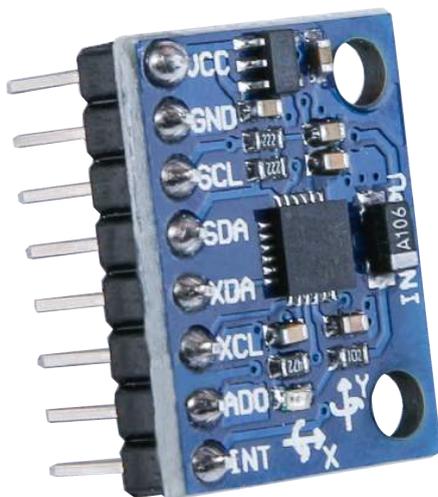
- (1) x Elegoo Uno R3
- (1) x GY-521 module
- (4) x F-M wires

### Component Introduction

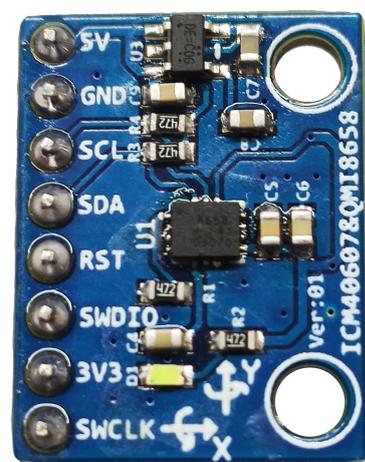
#### GY-521 SENSOR

The InvenSense GY-521 sensor contains a MEMS accelerometer and a MEMS gyro in a single chip. It is very accurate, as it contains 16-bits analog to digital conversion hardware for each channel. Therefore it captures the x, y, and z channel at the same time. The sensor uses the I2C-bus to interface with the Arduino.

The GY-521 is not expensive, especially given the fact that it combines both an accelerometer and a gyro.



GY-521



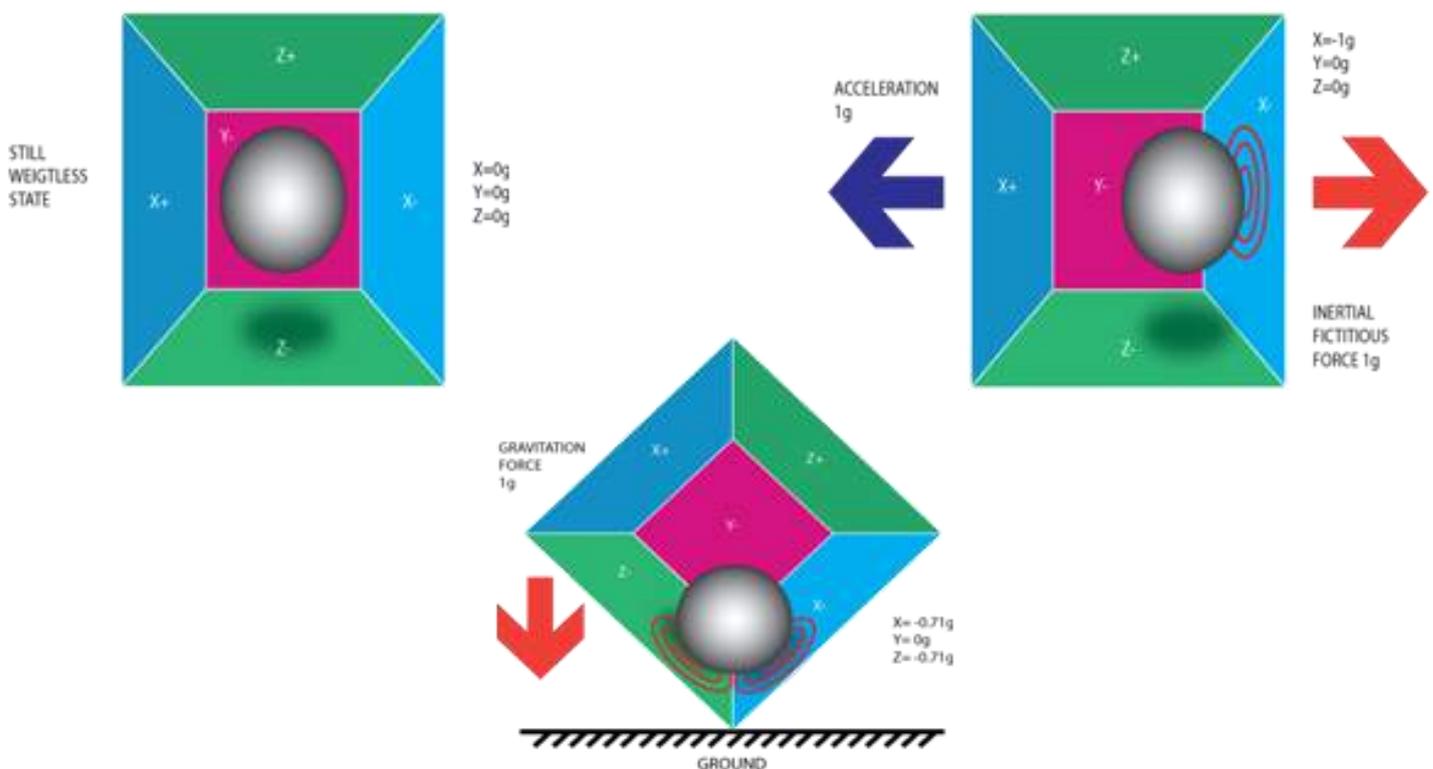
QMI-8568

IMU sensors are one of the most inevitable type of sensors used today in all kinds of electronic gadgets. They are seen in smart phones, wearables, game controllers, etc. IMU sensors help us in getting the attitude of an object, attached to the sensor in three dimensional space. These values usually in angles, thus help us to determine its attitude. Thus, they are used in smart phones to detect its orientation. And also in wearable gadgets like the nike fuel band or fit bit, which use IMU sensors to track movement.

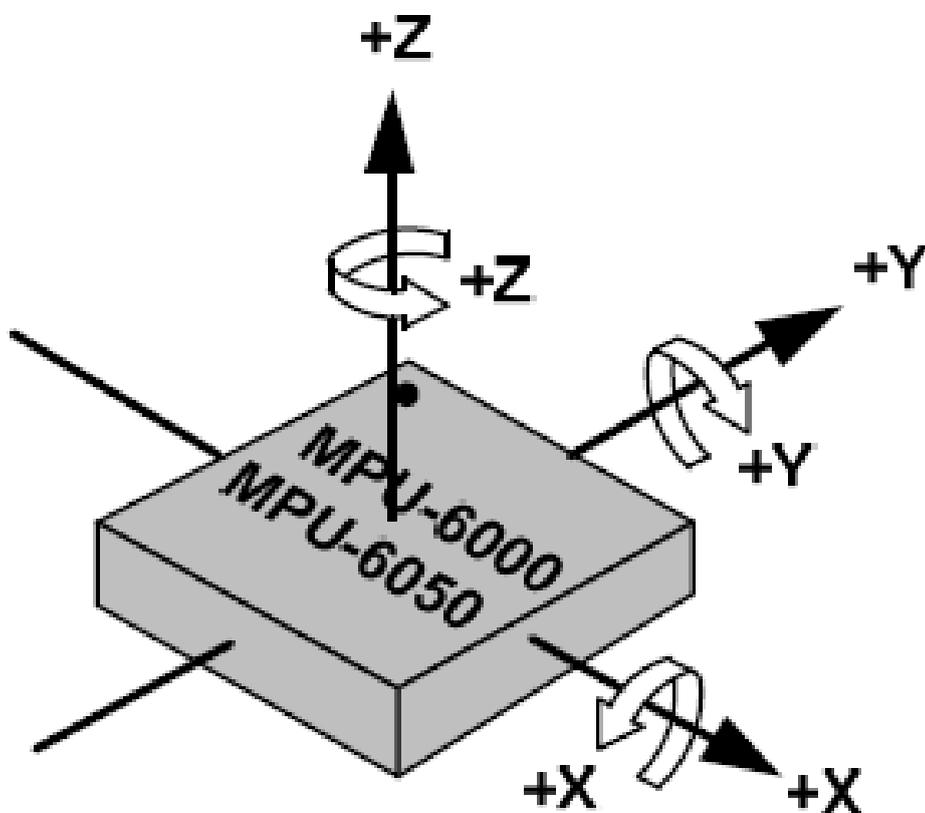
### How does it work?

IMU sensors usually consists of two or more parts. Listing them by priority, they are : accelerometer, gyroscope, magnetometer and altimeter. The GY-521 is a 6 DOF (Degrees of Freedom) or a six axis IMU sensor, which means that it gives six values as output. Three values from the accelerometer and three from the gyroscope. The GY-521 is a sensor based on MEMS (Micro Electro Mechanical Systems) technology. Both the accelerometer and the gyroscope is embedded inside a single chip. This chip uses I2C (Inter Integrated Circuit) protocol for communication

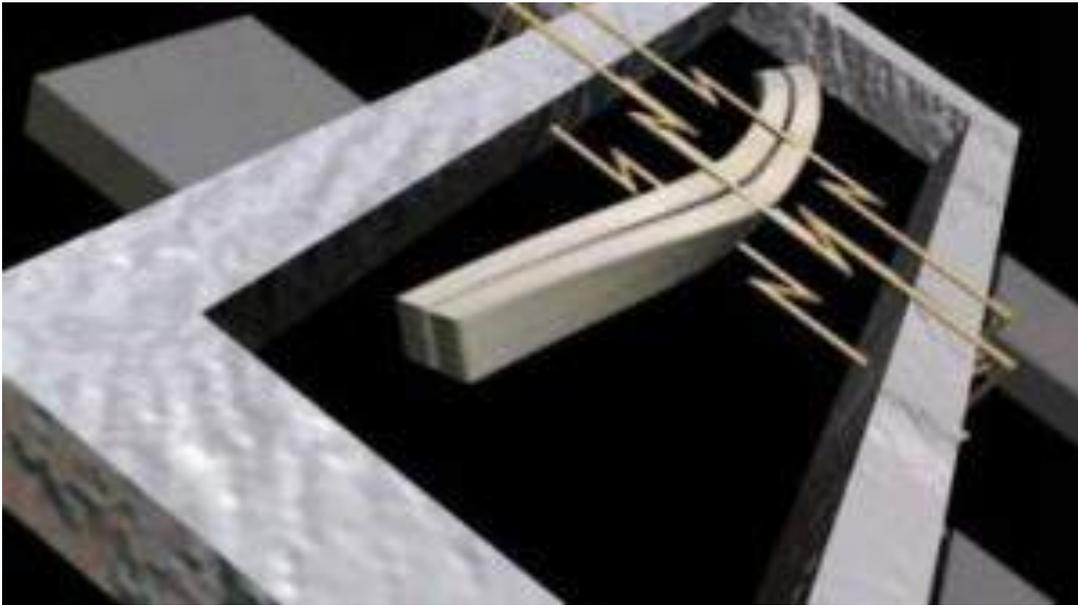
### How does an accelerometer work?



An accelerometer works on the principle of piezo electric effect. Here, imagine a cuboidal box, having a small ball inside it, like in the picture above. The walls of this box are made with piezo electric crystals. Whenever you tilt the box, the ball is forced to move in the direction of the inclination, due to gravity. The wall with which the ball collides, creates tiny piezo electric currents. There are totally, three pairs of opposite walls in a cuboid. Each pair corresponds to an axis in 3D space: X, Y and Z axes. Depending on the current produced from the piezo electric walls, we can determine the direction of inclination and its magnitude. For more information check this.



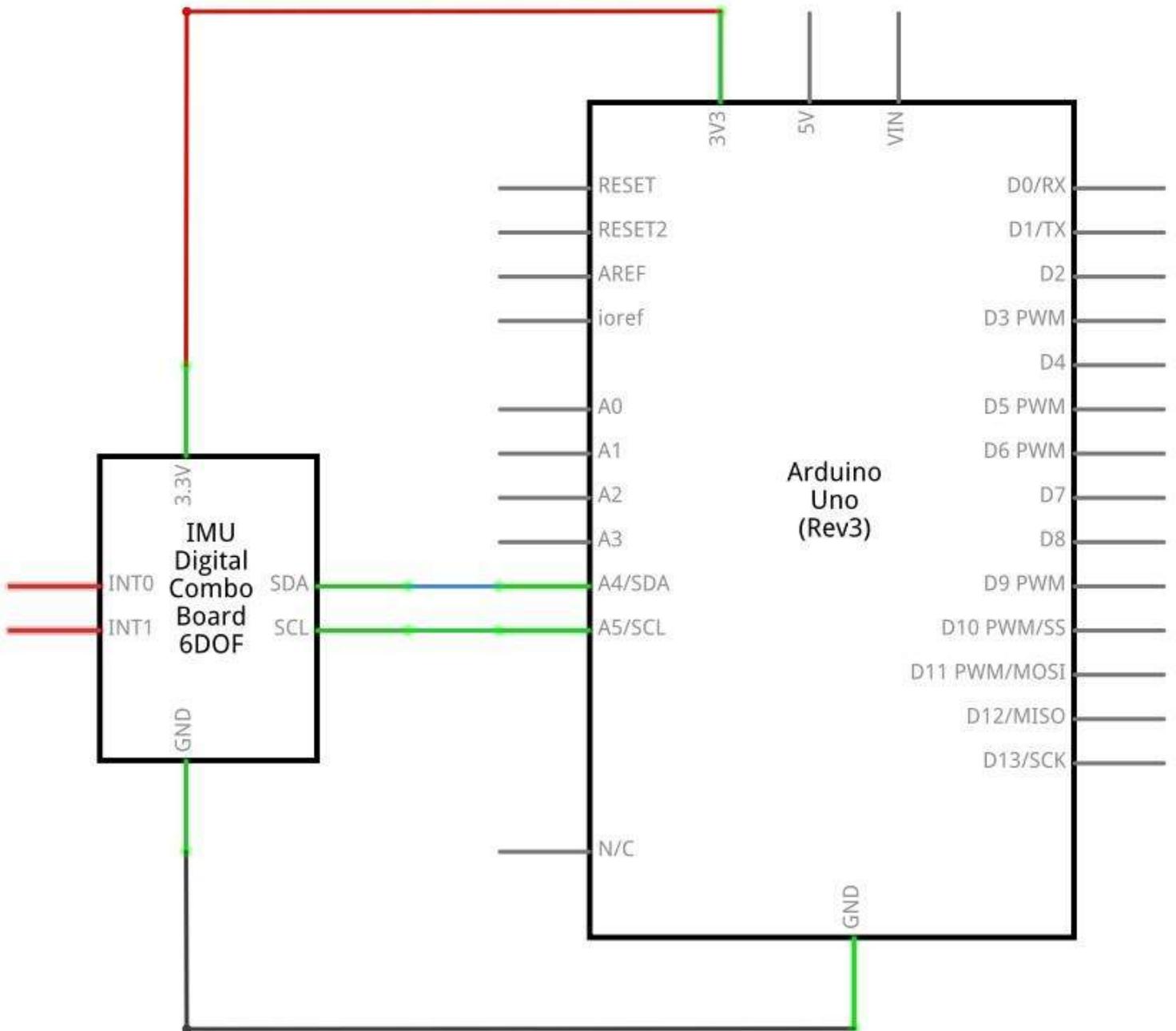
## How does a gyroscope work?



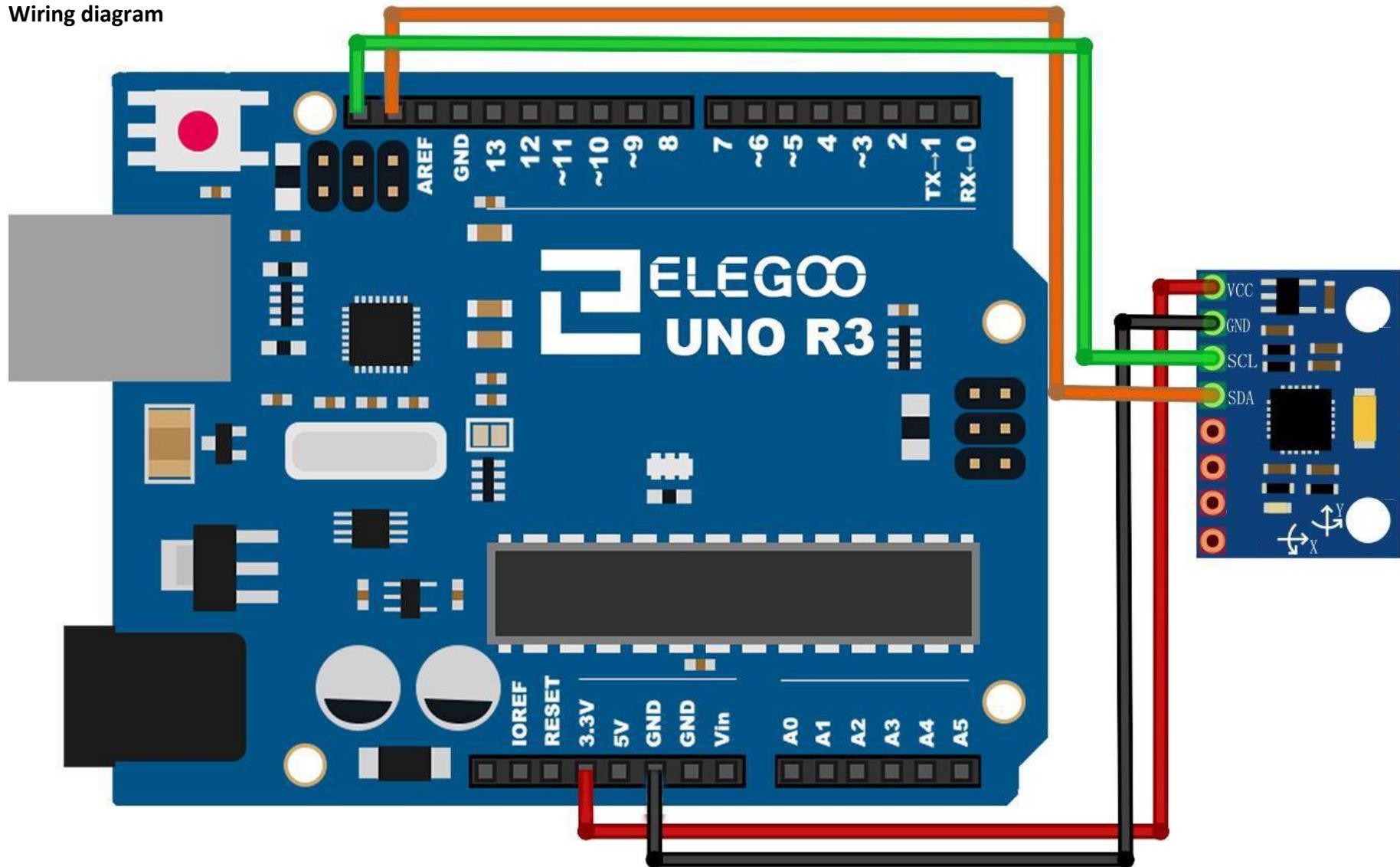
Gyroscopes work on the principle of Coriolis acceleration. Imagine that there is a fork like structure, which is in constant back and forth motion. It is held in place using piezo electric crystals. Whenever, you try to tilt this arrangement, the crystals experience a force in the direction of inclination. This is caused as a result of the inertia of the moving fork. The crystals thus produce a current in consensus with the piezo electric effect, and this current is amplified. The values are then refined by the host microcontroller.

## Connection

### Schematic



Wiring diagram



Next, we need to set up the I2C lines. For this connect the pin labelled as SDA on the GY-521 to the Arduino's analog pin 4 (SDA). And the pin labelled as SCL on the GY-521 to the Arduino's analog pin 5 (SCL). And that's it, you have finished wiring up the Arduino GY-521.

### **Libraries needed**

MPU-6050

### **The Code**

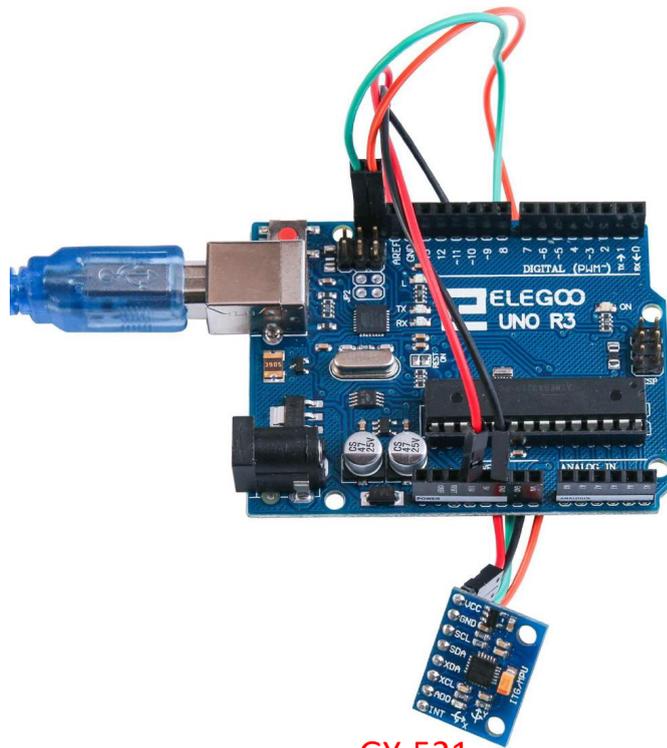
The short example sketch is a very short sketch and it shows all the raw values (accelerometer, gyro and temperature). It should work on Arduino Uno, Nano, Leonardo, and also Due.

[After wiring, please open the program in the code folder- Lesson 16 GY-521 Module and click UPLOAD to upload the program. See Lesson 2 for details about program uploading if there are any errors.](#)

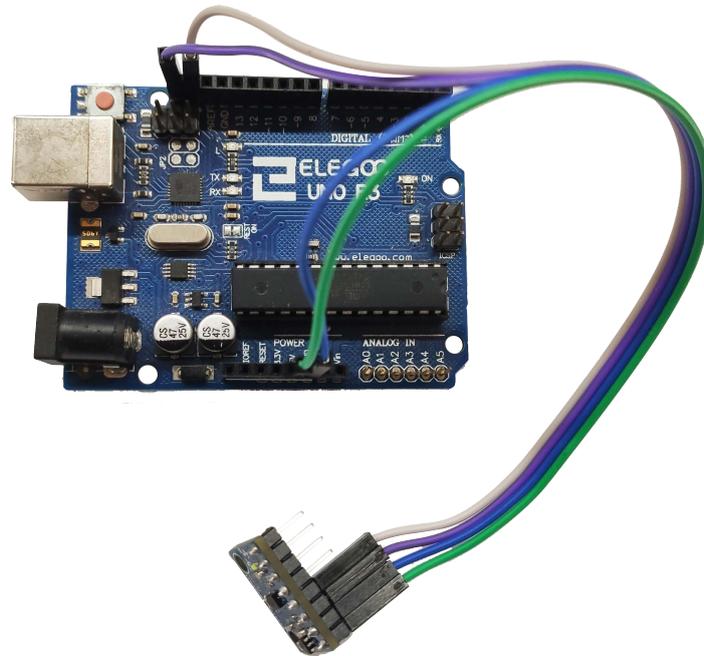
[Before you can run this, make sure that you have installed the < GY-521 > library or re-install it, if necessary. Otherwise, your code won't work.](#)

[For details about loading the library file, see Lesson 1.](#)

## Example picture



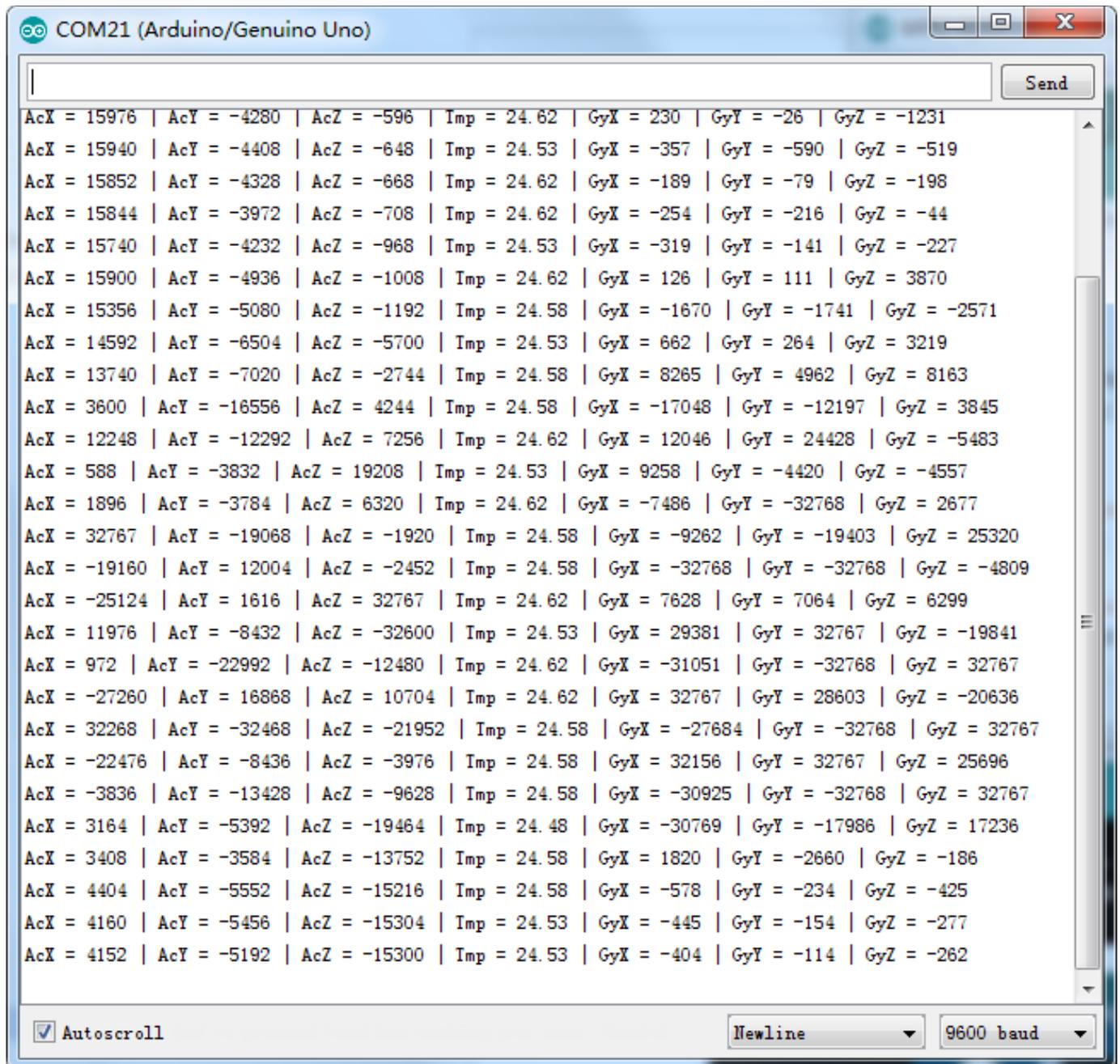
GY-521



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Open the monitor then you can see the data as blow:

[Click the Serial Monitor button to turn on the serial monitor.](#) The basics about the serial monitor are introduced in details in [Lesson 1](#).



The screenshot shows the 'COM21 (Arduino/Genuino Uno)' serial monitor window. The window title bar includes the Arduino logo, the port name, and standard window controls. A 'Send' button is located in the top right corner of the text area. The main area contains a list of 30 lines of sensor data, each line representing a single data point. The data is formatted as follows: `AcX = [value] | AcY = [value] | AcZ = [value] | Imp = [value] | GyX = [value] | GyY = [value] | GyZ = [value]`. The values for AcX range from 4152 to 15976, AcY from -5192 to -4280, AcZ from -15300 to -596, Imp from 24.48 to 24.62, GyX from -31051 to 230, GyY from -32768 to 111, and GyZ from -262 to 8163. At the bottom of the window, there is a checked 'Autoscroll' checkbox, a 'Newline' dropdown menu, and a '9600 baud' dropdown menu.

```
AcX = 15976 | AcY = -4280 | AcZ = -596 | Imp = 24.62 | GyX = 230 | GyY = -26 | GyZ = -1231
AcX = 15940 | AcY = -4408 | AcZ = -648 | Imp = 24.53 | GyX = -357 | GyY = -590 | GyZ = -519
AcX = 15852 | AcY = -4328 | AcZ = -668 | Imp = 24.62 | GyX = -189 | GyY = -79 | GyZ = -198
AcX = 15844 | AcY = -3972 | AcZ = -708 | Imp = 24.62 | GyX = -254 | GyY = -216 | GyZ = -44
AcX = 15740 | AcY = -4232 | AcZ = -968 | Imp = 24.53 | GyX = -319 | GyY = -141 | GyZ = -227
AcX = 15900 | AcY = -4936 | AcZ = -1008 | Imp = 24.62 | GyX = 126 | GyY = 111 | GyZ = 3870
AcX = 15356 | AcY = -5080 | AcZ = -1192 | Imp = 24.58 | GyX = -1670 | GyY = -1741 | GyZ = -2571
AcX = 14592 | AcY = -6504 | AcZ = -5700 | Imp = 24.53 | GyX = 662 | GyY = 264 | GyZ = 3219
AcX = 13740 | AcY = -7020 | AcZ = -2744 | Imp = 24.58 | GyX = 8265 | GyY = 4962 | GyZ = 8163
AcX = 3600 | AcY = -16556 | AcZ = 4244 | Imp = 24.58 | GyX = -17048 | GyY = -12197 | GyZ = 3845
AcX = 12248 | AcY = -12292 | AcZ = 7256 | Imp = 24.62 | GyX = 12046 | GyY = 24428 | GyZ = -5483
AcX = 588 | AcY = -3832 | AcZ = 19208 | Imp = 24.53 | GyX = 9258 | GyY = -4420 | GyZ = -4557
AcX = 1896 | AcY = -3784 | AcZ = 6320 | Imp = 24.62 | GyX = -7486 | GyY = -32768 | GyZ = 2677
AcX = 32767 | AcY = -19068 | AcZ = -1920 | Imp = 24.58 | GyX = -9262 | GyY = -19403 | GyZ = 25320
AcX = -19160 | AcY = 12004 | AcZ = -2452 | Imp = 24.58 | GyX = -32768 | GyY = -32768 | GyZ = -4809
AcX = -25124 | AcY = 1616 | AcZ = 32767 | Imp = 24.62 | GyX = 7628 | GyY = 7064 | GyZ = 6299
AcX = 11976 | AcY = -8432 | AcZ = -32600 | Imp = 24.53 | GyX = 29381 | GyY = 32767 | GyZ = -19841
AcX = 972 | AcY = -22992 | AcZ = -12480 | Imp = 24.62 | GyX = -31051 | GyY = -32768 | GyZ = 32767
AcX = -27260 | AcY = 16868 | AcZ = 10704 | Imp = 24.62 | GyX = 32767 | GyY = 28603 | GyZ = -20636
AcX = 32268 | AcY = -32468 | AcZ = -21952 | Imp = 24.58 | GyX = -27684 | GyY = -32768 | GyZ = 32767
AcX = -22476 | AcY = -8436 | AcZ = -3976 | Imp = 24.58 | GyX = 32156 | GyY = 32767 | GyZ = 25696
AcX = -3836 | AcY = -13428 | AcZ = -9628 | Imp = 24.58 | GyX = -30925 | GyY = -32768 | GyZ = 32767
AcX = 3164 | AcY = -5392 | AcZ = -19464 | Imp = 24.48 | GyX = -30769 | GyY = -17986 | GyZ = 17236
AcX = 3408 | AcY = -3584 | AcZ = -13752 | Imp = 24.58 | GyX = 1820 | GyY = -2660 | GyZ = -186
AcX = 4404 | AcY = -5552 | AcZ = -15216 | Imp = 24.58 | GyX = -578 | GyY = -234 | GyZ = -425
AcX = 4160 | AcY = -5456 | AcZ = -15304 | Imp = 24.53 | GyX = -445 | GyY = -154 | GyZ = -277
AcX = 4152 | AcY = -5192 | AcZ = -15300 | Imp = 24.53 | GyX = -404 | GyY = -114 | GyZ = -262
```