Lesson 10 Rhythmic Dance

Background Knowledge

- 3-Axis Digital Accelerometer
- Read the values of the x, y and z axes of the 3-axis accelerometer

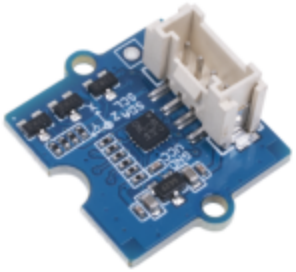
Project Making

- Project description
- Write Program
  - Task: Control RGB LED strip transform lamp efficiency via3-axis accelerometer
- Appearance Design

Do you know how human beings perceive motion?Although we have acquired the basic ability of perception from human genes, we still need to adjust to the living environment and develop in a sound way through continuous training.When we were learning to walk, from crawling to standing, and then to walking in balance, all of these are senses in the human body that are constantly developing and growing.We found that mobile phones, computers and other electronic devices can also sense motion. For example, the screen of the mobile phone will rotate with the change of direction, and shaking the mobile phone can trigger the corresponding function,thanks to the three–axis accelerometer.In this lesson, we will learn to read motion data through the 3–axis accelerometer, and control the RGB LED strip to change the lighting effect with our motion.

Background Knowledge

3–Axis Digital Accelerometer



Grove –3– Axis Digital Accelerometer(LIS3DHTR) is a kind of sensor which can measure the acceleration of objects.In the process of motion, the acceleration value is obtained by measuring the inertial force of X, Y and Z axis mass and using Newton's second law. This can be achieved through a variety of sensing elements in accelerometers.Common accelerometers include capacitive, inductive, strain, piezoresistive, piezoelectric, etc.By measuring the acceleration caused by gravity, the inclination angle of the device relative to the horizontal direction can be calculated.Triaxial accelerometers are widely used in mobile phones, health bracelets and other areas of daily life, but also in virtual games, car safety, GPS satellite navigation, robots and other fields.

Knowledge window: Application of 3–axis accelerometer

Virtual game

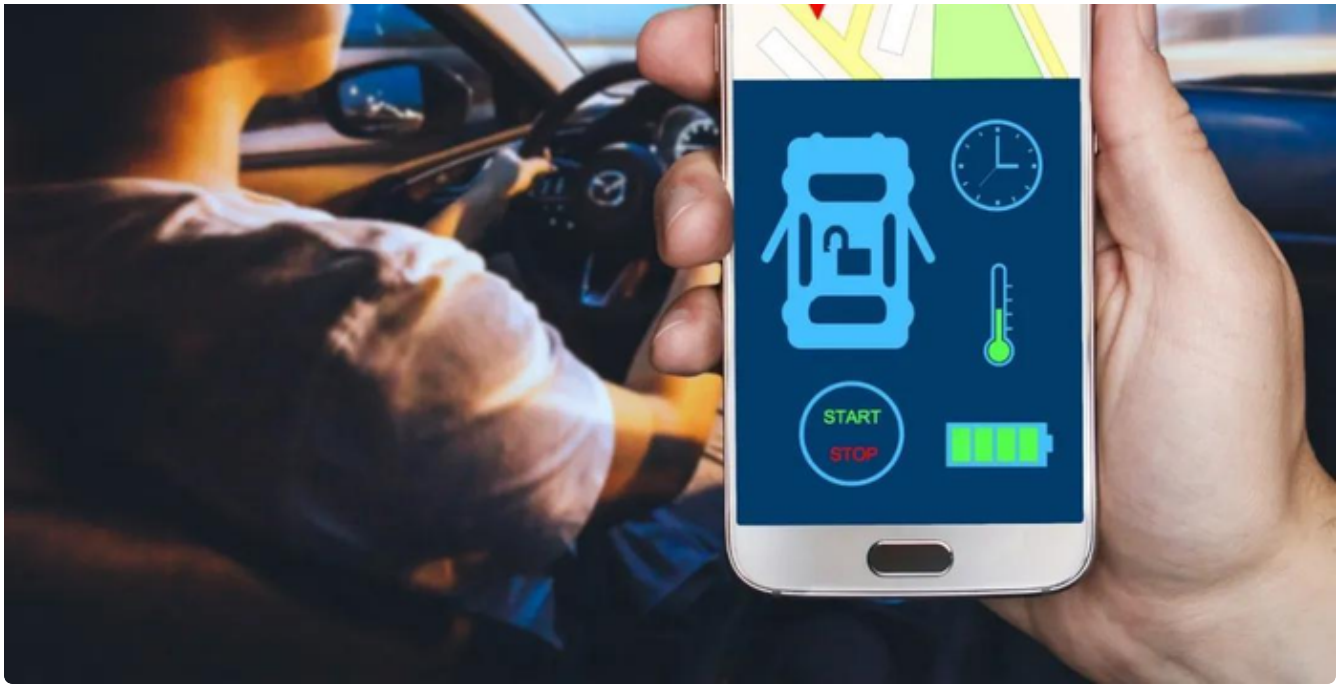
In recent years, games have developed to step out of the screen into our world.We can synchronize human movement through AR / VR and gaming controllers. These game devices can sense the acceleration of human movement and synchronize the same action of game virtual characters, so as to achieve a rich and immersive gaming experience game.

Automotive field

The application of 3–axis accelerometers in automobiles lies largely in safety systems and unmanned driving.The application of 3–axis accelerometer in automobile field is mainly in safety system and unmanned driving. Take the car body safety as an example, when the car body is impacted, the 3–axis accelerometer will detect the sudden change of acceleration and implement safety protection measures, such as timely ejection of the airbag to ensure the safety of passengers.

GPS satellite navigation

GPS navigation has brought great convenience to our life and travel. It can be used to plan routes, perform voice prompts, location, etc. It is good news for people who often travel to new cities and have a poor sense of direction.What is the role of the 3–axis accelerometer?When the signal of the satellite goes to an area of poor reception area or loses the signal in the normal environment, the 3–axis acceleration sensor based on MEMS technology cooperates with the gyroscope or electronic compass to create an azimuth reckoning system, which complements the GPS system where GPS positioning is not functioning well.



Read the values of the x, y and z axes of the 3–axis accelerometer

The key to making a project with3–axis accelerometer is to learn to read the values of3–axis accelerometer in X, Y and Z axes.Also referring to the library file,the "LIS3DHTR_IIC" example can be opened through the following path: **File → Example → Grove–3–axis–digital–accelerator–2g–to–16g–LIS3DHTR → LIS3DHTR _ IIC.** The example program reads the values of the3–axis accelerometer in the X, Y and Z axes and output through the serial monitor. The example program provides us with different setting choices by way of "//"annotation, but some additional configuration is required, as follows:

LIS.begin(WIRE);IIC initialization default value, there are 0×18 and 0×19 choice, we want to choose LIS.begin(WIRE,0×19);

LIS.setOutputDataRate(LIS3DHTR_DATARATE_50HZ); There are many choices for the output rate of the accelerometer, 50HZ is enough;

The complete procedure is as follows:

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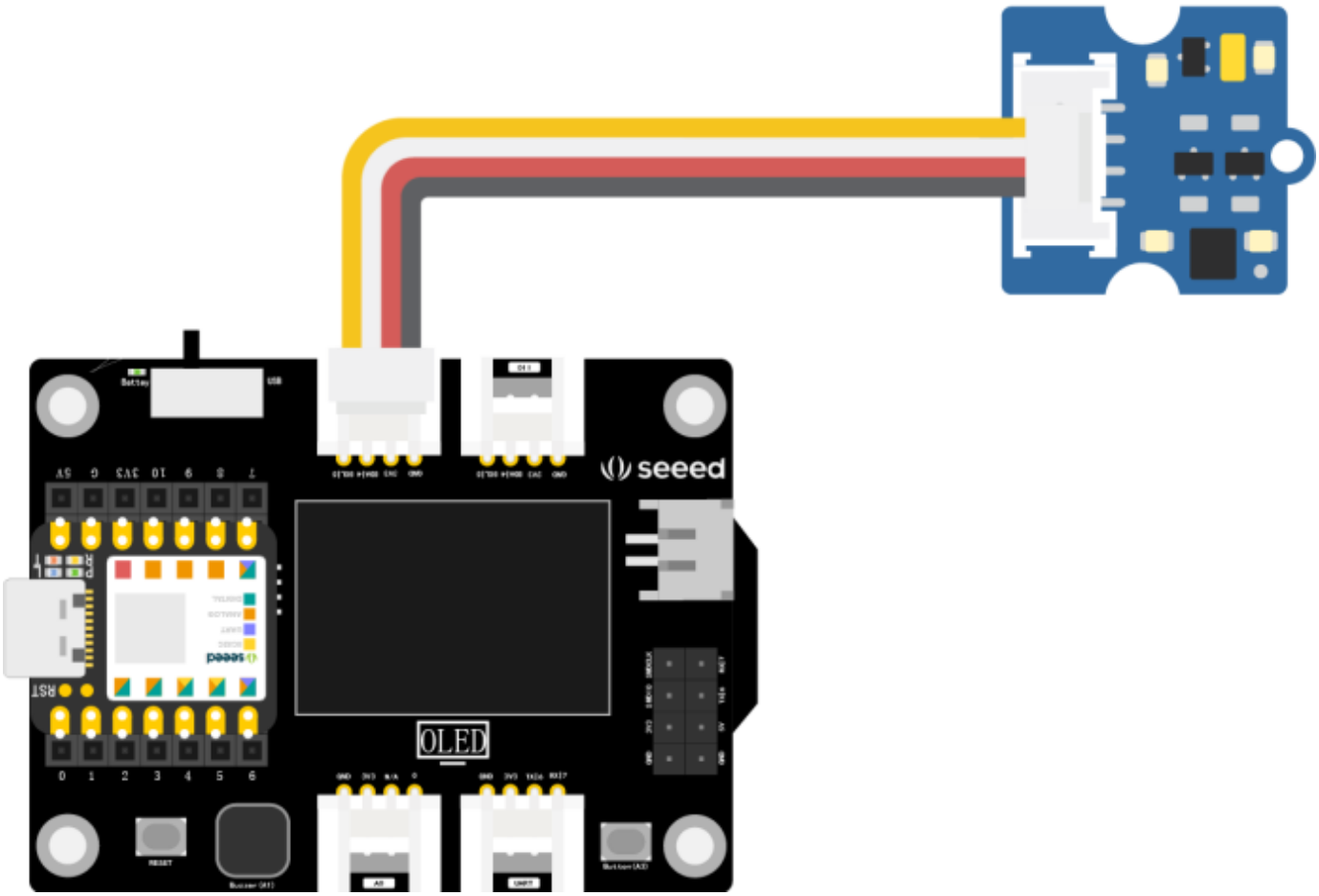
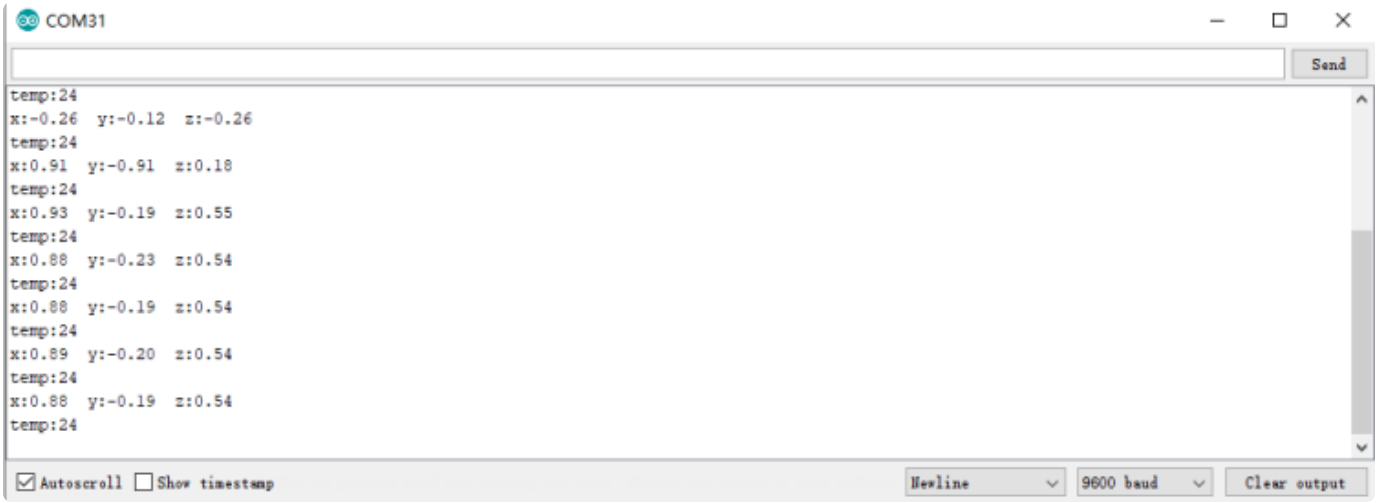
```
// This example use I2C.
#include "LIS3DHTR.h"
#include <Wire.h>
LIS3DHTR<TwoWire> LIS; //IIC
#define WIRE Wire

void setup()
{
  Serial.begin(115200);
  while (!Serial)
  {
  };
  LIS.begin(WIRE,0x19); //IIC init
  //LIS.begin(0x19);
  LIS.openTemp();  //If ADC3 is used, the temperature detection needs to be turned off.
  //  LIS.closeTemp();//default
  delay(100);
    LIS.setFullScaleRange(LIS3DHTR_RANGE_2G);
  //  LIS.setFullScaleRange(LIS3DHTR_RANGE_4G);
  //  LIS.setFullScaleRange(LIS3DHTR_RANGE_8G);
  //  LIS.setFullScaleRange(LIS3DHTR_RANGE_16G);
  //  LIS.setOutputDataRate(LIS3DHTR_DATARATE_1HZ);
  //  LIS.setOutputDataRate(LIS3DHTR_DATARATE_10HZ);
  //  LIS.setOutputDataRate(LIS3DHTR_DATARATE_25HZ);
  LIS.setOutputDataRate(LIS3DHTR_DATARATE_50HZ);
  //  LIS.setOutputDataRate(LIS3DHTR_DATARATE_100HZ);
  //  LIS.setOutputDataRate(LIS3DHTR_DATARATE_200HZ);
  //  LIS.setOutputDataRate(LIS3DHTR_DATARATE_1_6KHZ);
  //  LIS.setOutputDataRate(LIS3DHTR_DATARATE_5KHZ);
}
void loop()
{
  if (!LIS)
  {
    Serial.println("LIS3DHTR didn't connect.");
    while (1)
      ;
    return;
  }
  //3 axis
    Serial.print("x:"); Serial.print(LIS.getAccelerationX());
Serial.print("  ");
    Serial.print("y:"); Serial.print(LIS.getAccelerationY());
Serial.print("  ");
```

```
      Serial.print("z:"); Serial.println(LIS.getAccelerationZ());
    //ADC
    //    Serial.print("adc1:"); Serial.println(LIS.readbitADC1());
    //    Serial.print("adc2:"); Serial.println(LIS.readbitADC2());
    //    Serial.print("adc3:"); Serial.println(LIS.readbitADC3());

    //temperature
    Serial.print("temp:");
    Serial.println(LIS.getTemperature());
    delay(500);
  }

```

Next, connect the3–axis accelerometer to the IIC interface, and there are two IIC interfaces on the XIAO expansion board as shown in the following figure:



Connect XIAO to the computer with the data line and upload the program. After the program is uploaded successfully, open the serial monitor, and move the3–axis accelerometer in the directions of X, Y, and Z axes to observe the changes of the readings.



Project Making

Project description

We can add RGB LED lights to the project to achieve dazzling light effect transformation, use a 3-axis accelerometer to detect movement, and trigger different light effects based on the acceleration values in the X, Y and Z axes.

Write Program

The following steps are needed to control RGB LED strip through the 3-axis accelerometer:

- Declare the library to be used, and define the number of LED and RGB LED strip pins
- Initialise the 3-axis accelerometer and the RGB LED strip
- Set the LED strip to flash red, green and blue according to different intervals of X, Y, Z axis values from the 3-axis accelerometer

Task: Control RGB LED strip transform lamp efficiency via3-axis accelerometer

Step1:Declare the library to be used, and define the number of LED and RGB LED strip pins.

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```
#include "LIS3DHTR.h"
#include <Adafruit_NeoPixel.h>
#ifdef __AVR__
 #include <avr/power.h>
#endif

#ifdef SOFTWAREWIRE
    #include <SoftwareWire.h>
    SoftwareWire myWire(3, 2);
    LIS3DHTR<SoftwareWire> LIS; //Software I2C
    #define WIRE myWire
#else
    #include <Wire.h>
    LIS3DHTR<TwoWire> LIS; //Hardware I2C
    #define WIRE Wire
#endif

#define PIXEL_PIN 0//light strip connect to Pin 0, If you use XIAO RP2040, please change 0 to A0
#define PIXEL_COUNT 30 //number of NeoPixels
Adafruit_NeoPixel strip(PIXEL_COUNT, PIXEL_PIN, NEO_GRB + NEO_KHZ800);//declare our NeoPixel strip object
```

Step2:Initialise the 3-axis accelerometer and the RGB LED strip.

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```
void setup() {
    Serial.begin(9600);
    while (!Serial) {};
    LIS.begin(WIRE, 0x19);//IIC initialization
    delay(100);
    LIS.setOutputDataRate(LIS3DHTR_DATARATE_50HZ);//set the output rate of the accelerometer to 50Hz
    strip.begin(); //initialize NeoPixel strip object
    strip.show(); //send the updated strip colors to the hardware.
}
```

Step3:Set the LED strip to flash red, green and blue according to different intervals of X, Y, Z axis values from the 3-axis accelerometer, and the setting of the value needs us to check from a serial port monitor; when the3-axis accelerometer is moved in the x, y and z axes, the change of the

value is observed to determine; because accelerometer values can be negative, we need to take their absolute value , so that we can conveniently set the condition .To find the absolute value, use the abs()function .For example, abs (LIS. getacceleration ()), which is the absolute value of the acceleration experienced in the x–axis by a 3–axis accelerometer.

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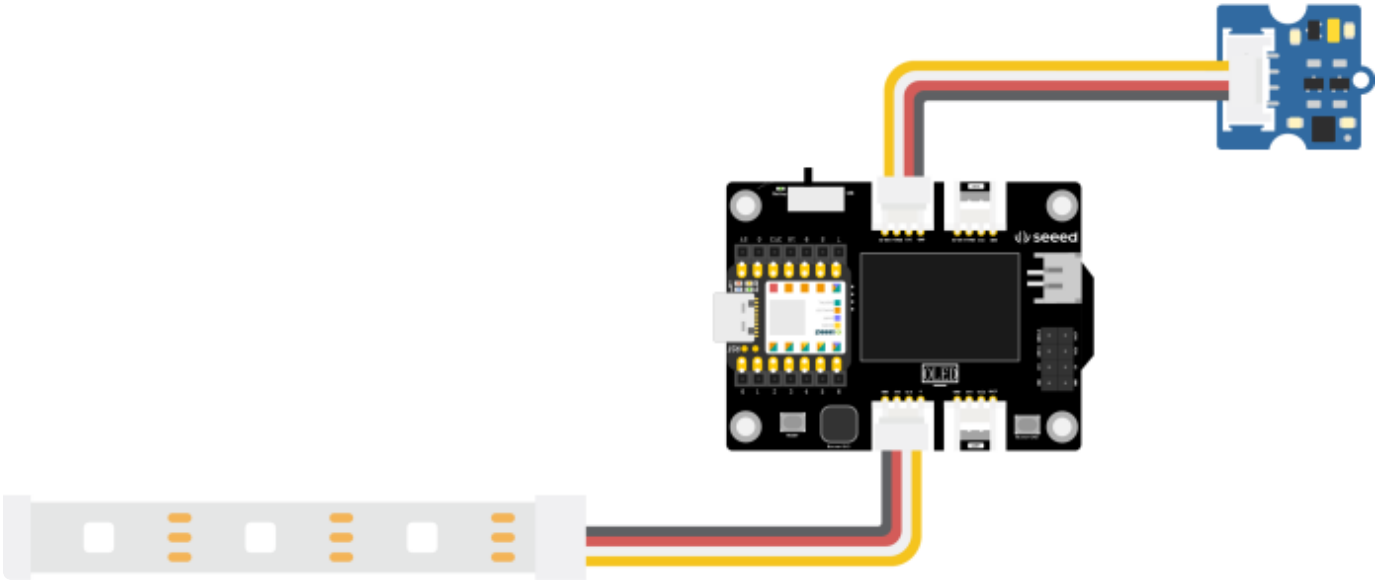
```
void loop() {
    if (!LIS) {  //check whether the 3-axis accelerometer. is connected correctly
        Serial.println("LIS3DHTR didn't connect.");
        while (1);
        return;
    }

 if ((abs(LIS.getAccelerationX()) > 0.2)) {
  theaterChase(strip.Color(127, 0, 0), 50);//red
  }
 if ((abs(LIS.getAccelerationY()) > 0.2)) {
  theaterChase(strip.Color(0, 127, 0), 50); //green
  }
 if ((abs(LIS.getAccelerationZ()) > 1.0)) {
  theaterChase(strip.Color(0, 0, 127), 50); //blue
  }
  else
  {
    strip.clear();
    strip.show();
  }

    // //3 axis
    Serial.print("x:"); Serial.print(LIS.getAccelerationX()); Serial.print("  ");
    Serial.print("y:"); Serial.print(LIS.getAccelerationY()); Serial.print("  ");
    Serial.print("z:"); Serial.println(LIS.getAccelerationZ());

    delay(500);
}
//Theater-marquee-style chasing lights. Pass in a color (32-bit value,
// a la strip.Color(r,g,b) as mentioned above), and a delay time (in ms)
// between frames.
void theaterChase(uint32_t color, int wait) {
  for(int a=0; a<10; a++) {   //repeat 10 times...
    for(int b=0; b<3; b++) { //'b' counts from 0 to 2...
      strip.clear();   // set all pixels in RAM to 0 (off)
      for(int c=b; c<strip.numPixels(); c += 3) {
        strip.setPixelColor(c, color);//set pixel 'c' to value 'color'
      }
      strip.show(); // update strip with new contents
      delay(wait); //pause for a moment
    }
```

```
43      }
44    }
```

Please see details on entire program:

Step4: Connect hardware, upload program.First, connect the RGB LED strip to the A0/D0 interface of XIAO expansion board, and connect the triaxial accelerometer to the IIC interface, as shown in the figure:



Connect XIAO to the computer with the data cable, and click the "Upload" button to upload the program to the hardware. When "Done uploading" is displayed in the debugging area,turn on the serial port monitor, and try to shake the triaxial accelerometer to the left, right and up and down to feel the change of the lamp efficiency.

Appearance Design

Imagine how cool it would be if the lights flashed along with the dance steps when you waved your arms. This is the inspiration for the rhythmic dance project , which can be combined with clothes or accessories into a wearable form factor!

Product name	Rhythmic dance
Product characteristics	Wearable, cool lighting, attitude detection
Product characteristics	The RGB LED strip exhibits different lamp effects depending on the value change detected by the triaxial accelerometer
Product function	(For example, the waterproof layer on the outside of RGB LED strip can be removed and sewn with clothes or belts, etc.)