Lab 5: Motion Detection

A) Objectives

- To detect the motion by sensor module GY-25Z
- To obtain the Euler angles (Yaw, Pitch and Roll) by serial communication (UART)

B) Background

GY-25Z module contains MPU6050 and MCU. MPU6050 provides 3-Axis gyroscope data, 3-Axis accelerometer data, and temperature data. The MCU calculates and outputs the Euler Angles (Yaw, Pitch and Roll) based on the gyroscope and accelerometer data, as shown in Fig. 1.

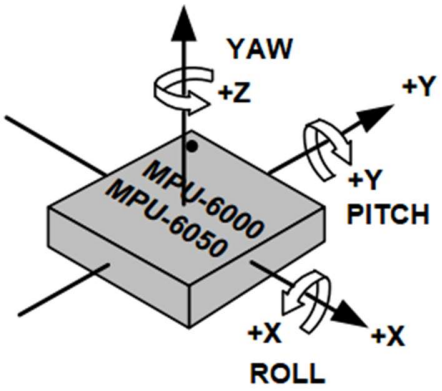

Fig. 1 – Orientation of Axis of Sensitivity and Polarity of Rotation

Communication interface: (i) Serial communication (UART) with baud rate (9600/115200); and (ii) I2C communication.

Serial communication is a process of sending and receiving data bit by bit sequentially through the transmission lines. Universal Asynchronous Receiver-Transmitter UART is one of the most used serial communication protocols. There are two signals, transmitter TX and receiver RX, to transmit and receive serial data, respectively. The baud rate is defined as the number of bits per second, which must be matched on both the transmitting and receiving devices. The UART packet consists of start bit, data frame, parity bit and stop bit as shown in Fig. 2.

Start Bit (1 bit)	Data Frame (5 to 9 Data Bits)	Parity Bits (0 to 1 bit)	Stop Bits (1 to 2 bits)

Fig. 2 – UART packet

In this lab, we use serial communication (UART) to obtain the Euler Angles from GY-25Z by Arduino Nano.

Task 1 – Get Euler Angles

As the hardware UART (TX0 and RX0) of Arduino Nano is used for Serial Monitor, we use software serial library to get the Euler Angles from GY-25Z.

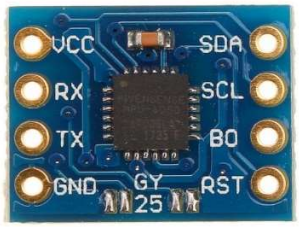

Fig. 3 – GY-25Z module

The command packet of GY-25Z consists of header, data type, numbers of data, data content and checksum.

Hardware connection:

- Connect GY-25Z (TX) to Arduino Nano D10
- Connect GY-25Z (RX) to Arduino Nano D11

Procedure:

- Set software UART pin as D10 and D11. (By library SoftwareSerial.h)
- Set baud rate as 115200.
- Wait a few seconds after power on.
- Send command (0x55, 0x10) to set GY-25Z for output the Euler Angles.
- Send command (0x56, 0x02) to set GY-25Z for output data automatically.
- Wait and receive the data packet sent from GY-25Z.

Header		Data Type	Nums of Data	Roll		Pitch		Yaw		Checksum
0x5A	0x5A	[7:0]	[7:0]	R[15:8]	R[7:0]	P[15:8]	P[7:0]	Y[15:8]	Y[7:0]	[7:0]

- Combine and rescale the received Euler Angles.
- Move your breadboard. Print the results. You can obtain the results by Serial Plotter as shown in Fig. 4:

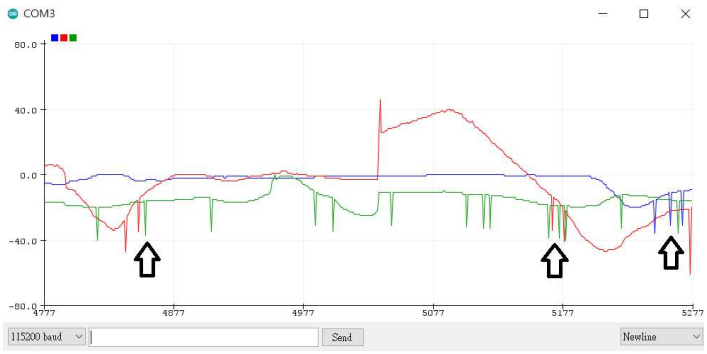

Fig. 4 – Plot of Euler Angles without error checking

Task 2 – Check the communication error

Sometimes there are errors encountered during communication (e.g. as pointed by the arrows in Fig. 4). It may be due to the noise coupled into the transmission lines or timing issues. Checksum is used for verifying the command packet of GY-25Z, which is a common and simple error checking method in communication protocol. For example, if you receive the data packet from Gy-25Z as:

0x5A, 0x5A, 0x10, 0x06, 0x00, 0x01, 0x00, 0x01, 0x00, 0x25, 0xF1

The last byte (checksum) should be equal to the sum of other bytes in the packet, i.e. checksum = 0x5A+0x5A+0x10+0x06+0x00+0x01+0x00+0x01+0x00+0x25 = 0xF1. If it is not matched, we can ignore this packet as invalid data packet.

Procedure:

- Get the data packet from GY-25Z.
- Add all bytes in the packet except the last byte.
- Compare the result with the last byte (checksum).
- If it is matched, the data received is valid.
- Plot the result again and compare with Fig. 4.

Task 3 – Determine if it is turned LEFT or RIGHT

Assume GY-25Z module is attached on the breadboard horizontally. We can determine the breadboard is turned to left or right according to YAW angle as shown in Fig. 1.

Procedure:

- Compare the current YAW angle with the previous YAW angle.
- If the current YAW angle is smaller, it is turned RIGHT.
- If the current YAW angle is larger, it is turned LEFT.