



GE107 PROJECT

Pen Digitizer using IMU

Team Information

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❖ Brief about the project:

Most online handwriting recognition systems require the use of specific writing surfaces to extract positional data. In this project, we present an online handwriting recognition system for word recognition which is based on inertial measurement units (IMUs) for digitizing text written on paper. This is obtained using a sensor-equipped pen that provides the acceleration, angular velocity, and magnetic forces streamed using Node MCU(ESP8266). It senses data and plots 2D Data of the gyroscope. Its aim and core functionalities lie in sensing the data from the IMU sensor processing the required 2D movement and storing data into an excel file which helps plot the X-Y data. It could be used as a stylus also for sketching or writing.

❖ Specification of the solution developed:

It enables writing and plotting the data, with major components like IMU and Node MCU. This project helped in inducing creativity among us and familiarized us with new components.

❖ Hardware Description:

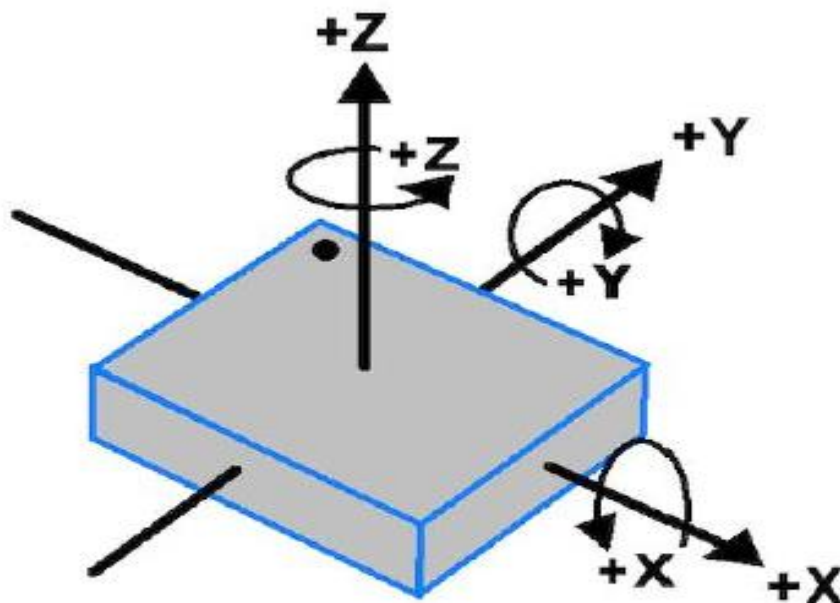
1. MPU6050:

➤ what is mpu6050?

The MPU-6050 is the world's first and only 6-a motion-tracking device designed for the low-power, low-cost, and high-performance requirements of smartphones, tablets, and wearable sensors.

➤ Introduction to MPU6050:

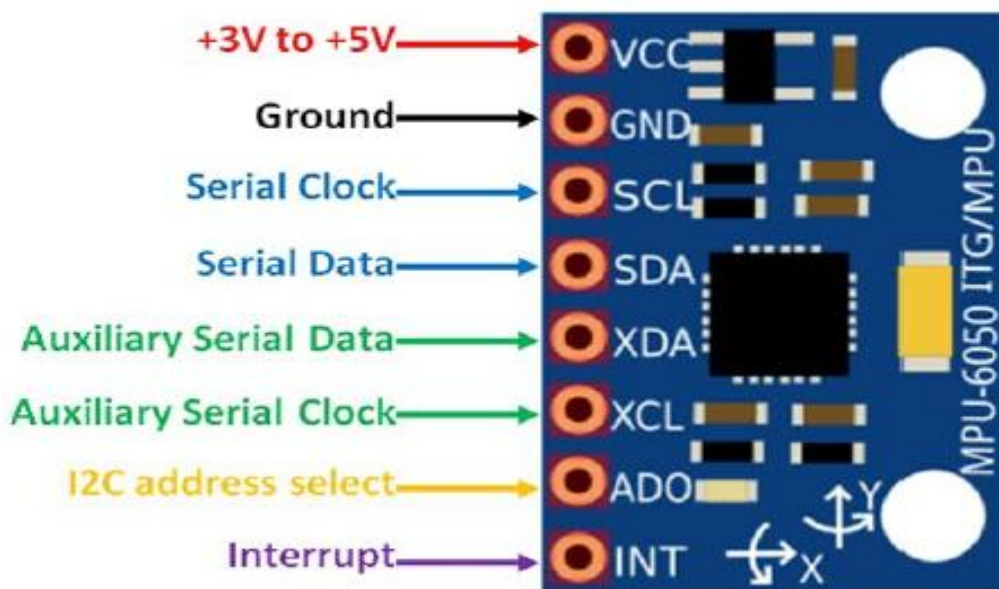
•MPU6050 is a Micro Electro-mechanical system (MEMS), it consists of A three-axis accelerometer and a three-axis gyroscope. It helps us to measure velocity, orientation, acceleration, displacement, and other motion-like features.



MPU-6050
Orientation & Polarity of Rotation

➤ **Hardware Description:**

- MPU6050 consists of a Digital Motion Processor (DMP), which has property to solve complex calculations.
- MPU6050 consists of an analog-to-digital converter hardware. Due to this feature, it captures three-dimension motion at the same time.
- This module has some famous features which are easily accessible, due to its easy availability, it can be used with a famous microcontroller like Arduino. And if you are looking for a sensor to control the motion of your Drone, Self-Balancing Robot, RC Cars, and something like this, then MPU6050 will be a good choice for you.
- This module uses the I2C module for interfacing with Arduino.
- MPU6050 is less expensive, its main feature is that it can easily combine with an accelerometer and gyro.



2. **ESP8266:**

➤ **What is ESP8266 and how does it work?**

ESP8266 is a low-cost Wi-Fi module that belongs to ESP's family which you can use to control your electronics projects anywhere in the world. It has an in-built microcontroller and a 1MB flash allowing it to connect to a Wi-Fi. The TCP/IP protocol stack allows the module to communicate with Wi-Fi signals. The maximum working voltage of the module is 3.3v so you can't supply 5v as it will fry the module.

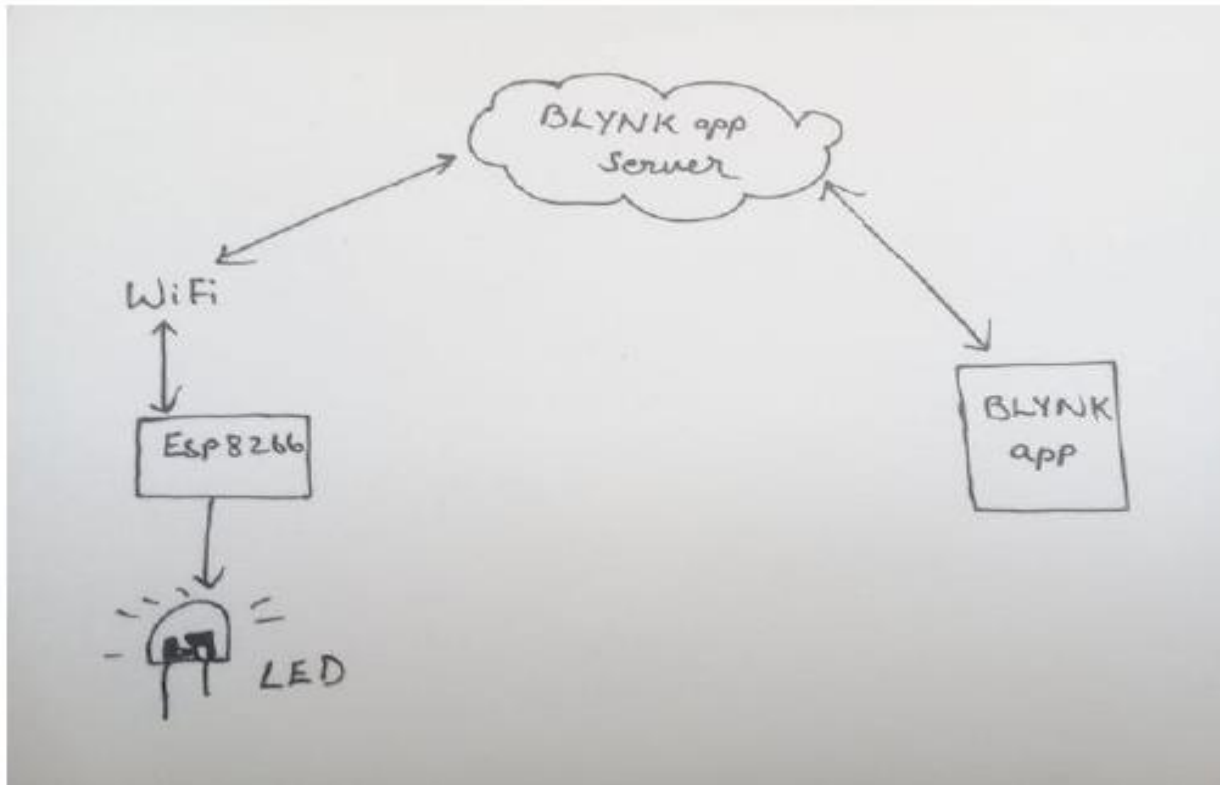
Let's take an example of controlling an LED light using ESP8266 by smartphone. The ESP8266 acts as an interpreter between the LED and the smartphone. Since we are using the Blynk app to control the LED further explanations will be based on it.

➤ **Hardware Description:**

Look at this image, the ESP8266 is connected to the nearby Wi-Fi hotspot that allows it to access the internet and sends data to the Blynk server along with an authentication code. An authentication code is then sent to

the app that has the same authentication code and then, the app receives the data to create a secure connection between the app and the ESP8266.

The data (instructions to control LED) from the Blynk app is sent to the Blynk server along with the authentication code and since the ESP8266 has already the same authentication code which is connected with the Blynk server, the server identifies the matching code, and data is sent to the corresponding ESP8266. Then the ESP8266 microcontroller turns ON the LED.



➤ **ESP8266: Pinout**

pin 1 _____ Rx -- connect it to Rx of ESP

pin 2 _____ GPIO 0--connect it to ground while uploading the code to Arduino IDE

pin 3 _____ GPIO 2,

pin 4 _____ GND--connect it to ground

pin 5 _____ Tx--connect it to Tx of ESP8266

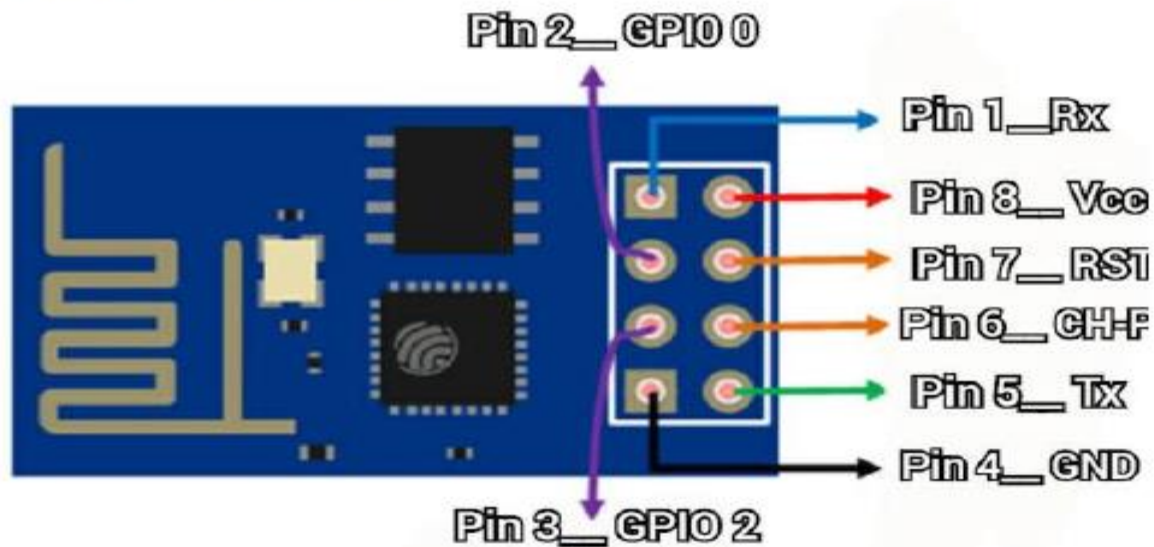
pin 6 _____ CH_PD(EN) -- connect it to 3.3v

pin 7 _____ RST (reset)--(not necessary) connect it to 3.3v for normal operation

and 0v(GND) for reset

pin 8 _____ Vcc--supply 3.3v from Arduino or an external source

ESP8266:Pinout



➤ Schematics and connection

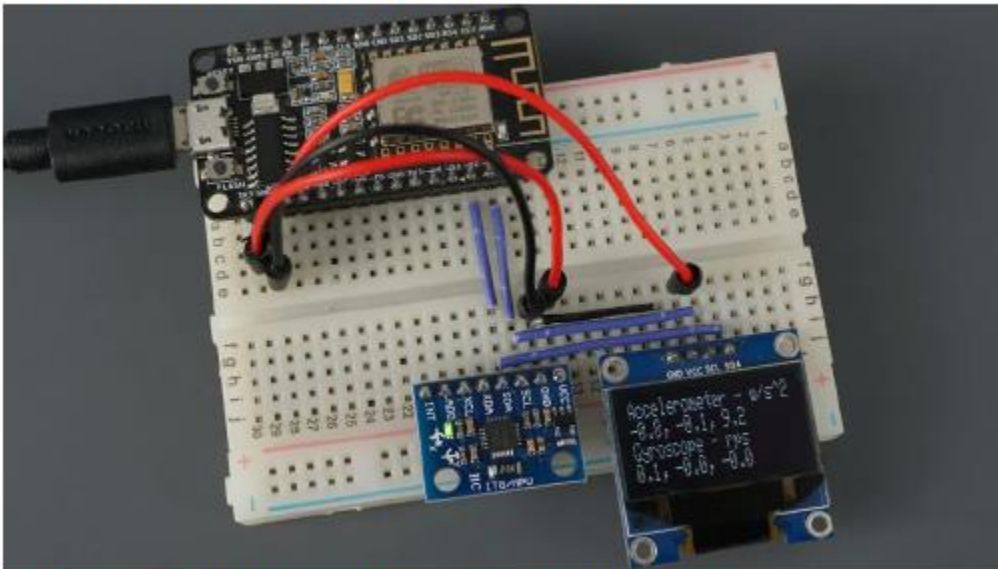
ESP8266 is used in this project. Remove the ATmega328P microcontroller from the board before starting the project.

NOTE: - Remove the GPIO 0 to GND connection when the blue LED in ESP8266 stops blinking (after uploading the code).

Now connect it according to the circuit diagram.

CIRCUIT DIAGRAM FOR CONNECTION OF ESP8266 AND MPU6050

Schematics and connection



3. USB Cable A to B 30cm:

➤ Description:

It is a Cable for Arduino UNO/MEGA (USB A to B)-1 foot, you can use it to connect NODE MCU or any board with the USB female A port of your computer. The length is approximately 52 cm. Cable color and shape may vary slightly from the image as our stock rotates.

This is a standard issue USB 2.0 cable. the kind that's usually used for printers, etc. Compatible with most SFE-designed USB boards as well

as USB Arduino boards like the Uno.

It is very important to understand that cheap USB cables or faulty USB cables may harm your Printers and cause errors again and again while printing important data. For your printers' error-free and long life you must use high-quality USB A to B printer cables. We are selling highly robust and high-quality USB 2.0 Printer cables at a reasonable price.

Connect your USB printer, scanner, and more to your computer. Transmits data at high speeds with error-free, high-performance transmission.

➤ **Features:**

- Fully compatible with the PC.
- Molded strain relief and PVC over molding to ensure a lifetime of error-free data transmissions.
- Aluminium under mold shield helps meet FCC requirements on KMI/RFI interference.
- Foil and braid shield comply with fully rated cable specifications
- reducing EMI/FRI interference.



❖ **Push Button:**

Firstly, the push button is a passive device that is used to switch between the active high and active low states. Now, let's understand what is these active high and active low state. Active low means the function gets done when input is in a low state. Active high means function gets done when input is in a high state.

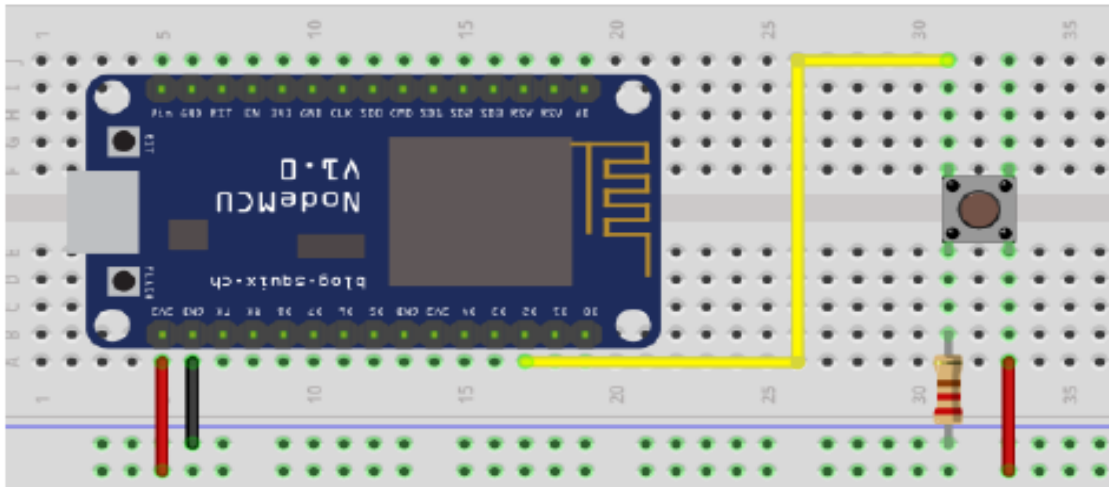
So, how does a push button switches between active high and active low states?

In the figure shown below, you can see when the button is not pressed at that The time you are getting the output is 1 whereas when we are pressing the button at that time we are getting the output as 0 as when the button is pressed it completes the circuit for discharging through the ground.

So, from the above figure, it will be clear to you that when a button is pressed it completes the circuit and changes the path and also changes its state.

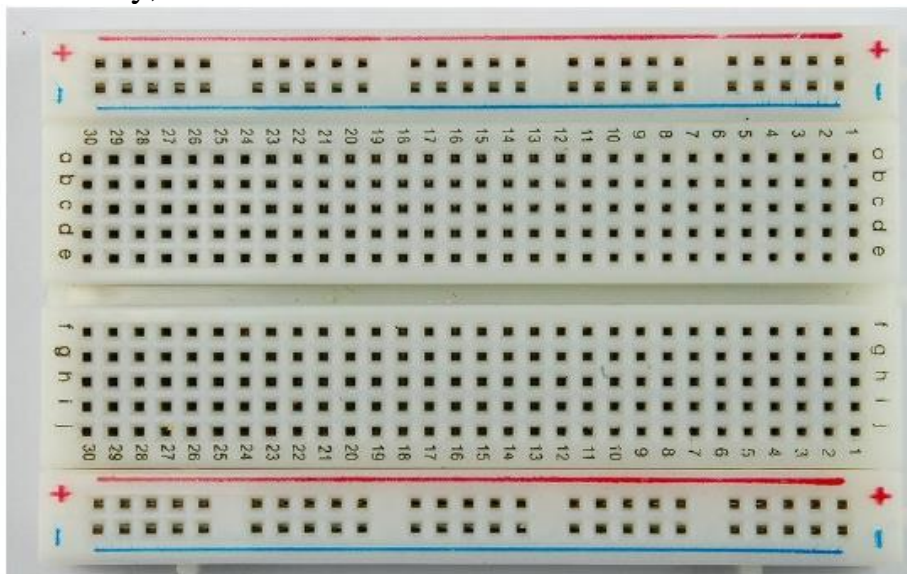
In this way, we will be using the output coming from the above circuit and will send it to the Node MCU to perform different tasks according to the present state (HIGH or LOW). Now let's interface the above circuit with Node MCU and control the LED state, i.e., turning the LED ON or OFF. So, let's make the connection for the interfacing of Node MCU with a push button and LED. Now make all the connections as shown below.

So, these are the connections to Interface Node MCU with a push button and LED. In the above circuit, we are not connecting any external LED because we are using the in-built LED of Node MCU which is connected to pin D4.



5. Breadboard:

The projects in this series of lessons all use something called Breadboard, or more accurately, Solderless Breadboard.

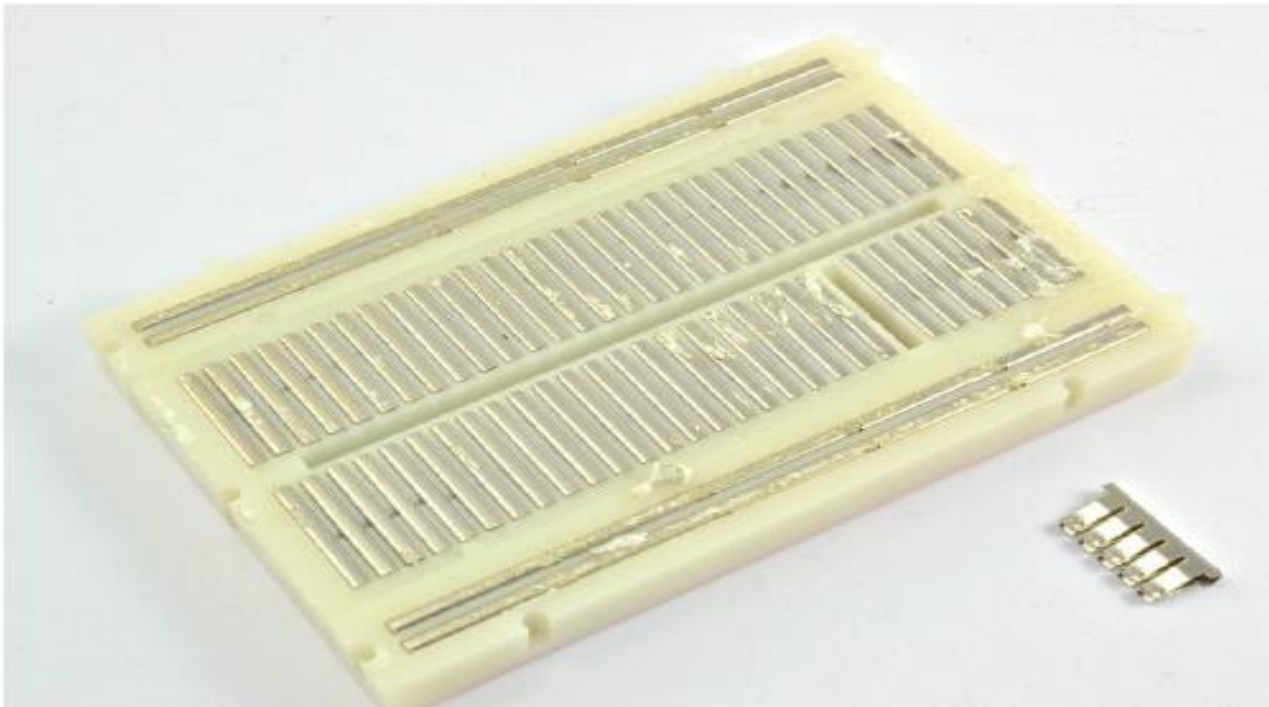


A breadboard is a way of constructing electronics without having to use a soldering iron. Components are pushed into the breadboard sockets, and extra 'jumper' wires are used to make connections.

If you were to pull the self-adhesive backing off the back of your breadboard, it would look something like this.

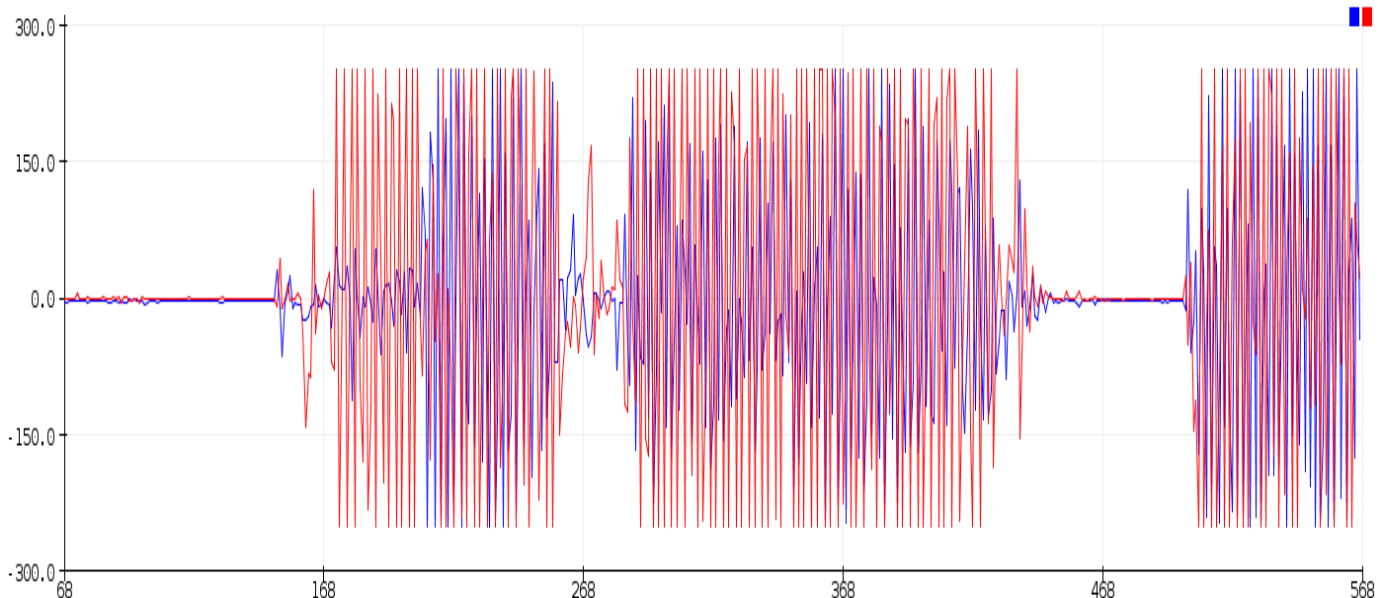
The middle section of the board has two columns, each with 30 strips of The connector, like the one pulled out and to the side of the breadboard. These connect anything that is pushed through from the front into one of those five holes.

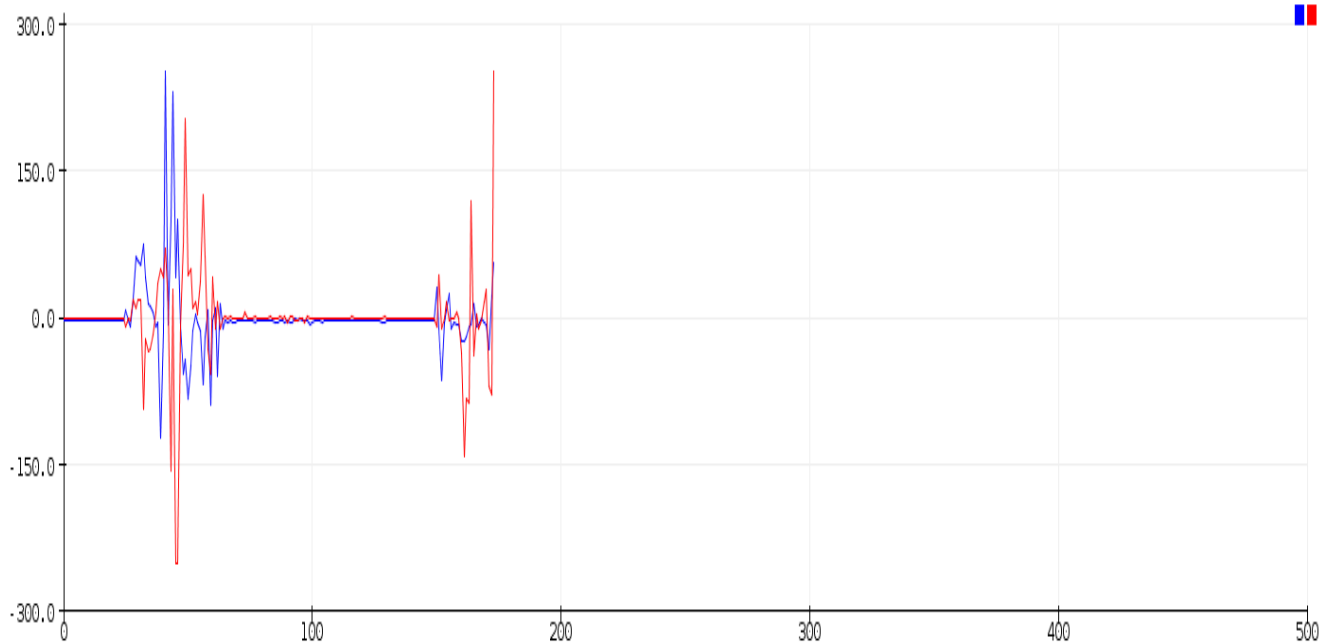
On either edge of the board are much longer sections of the clip that join together the columns of holes marked by the blue and red lines on the front of the breadboard. These are generally used for GND (blue) and 5V (red).



❖ Sample Test Cases:

➤ Input data in X/Y vs Time format in Serial plotter





➤ Data stored in Arduino spreadsheet

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ArduSpreadsheet 1.1

Save/Append

92 Clear table

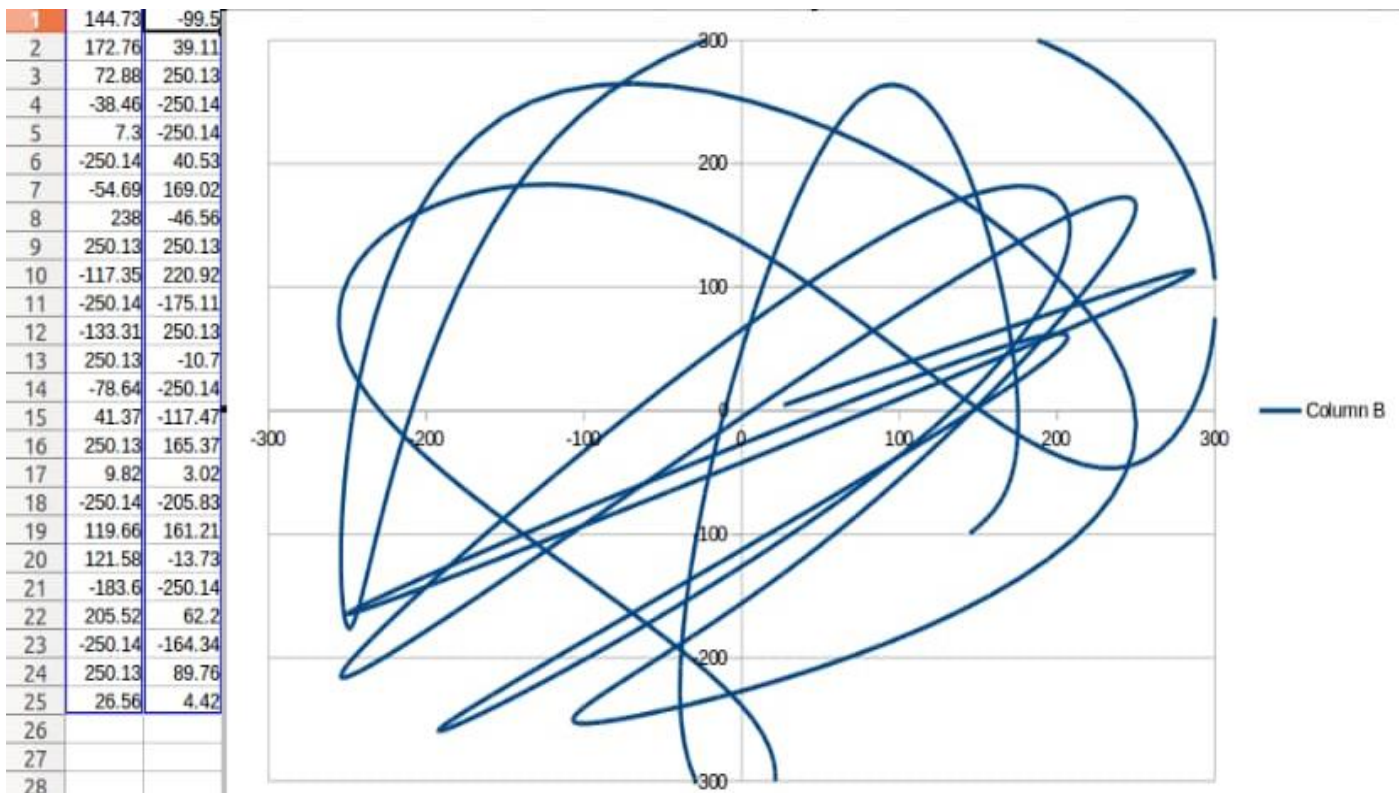
A
Gx: 250.13 Gy: 250.13
Gx: -183.68 Gy: -250.14
Gx: -102.16 Gy: 108.96
Gx: 156.40 Gy: 237.17
Gx: -200.41 Gy: 126.00
Gx: 250.13 Gy: 250.13
Gx: -222.85 Gy: -250.14
Gx: 184.32 Gy: 180.82
Gx: -199.32 Gy: -250.14
Gx: 27.09 Gy: 250.13
Gx: -49.79 Gy: -250.14
Gx: -185.98 Gy: 250.13
Gx: 250.13 Gy: 202.26
Gx: -231.65 Gy: -250.14
Gx: -56.66 Gy: 98.73
Gx: 1.89 Gy: -182.39
Gx: -237.47 Gy: 250.13
Gx: 250.13 Gy: 250.13
Gx: 21.71 Gy: -250.14
Gx: -223.87 Gy: 225.47
Gx: 250.13 Gy: 83.02
Gx: -85.66 Gy: -250.14
Gx: -220.12 Gy: 230.72
Gx: 250.13 Gy: 194.41

☐ Add timestamps
 Column separator \t (tab)
ttyUSB0
9600
Start
Stop

➤ Data stored LibreOffice spreadsheet

	A	B	C
1	-250.14	-242.05	
2	-122.76	-250.14	
3	-20.43	-250.14	
4	-28.83	-100.76	
5	35.45	250.13	
6	202.97	250.13	
7	190.98	65.11	
8	174.56	37.4	
9	14.44	2.95	
10	-220.56	-78.62	
11	-250.14	-120.7	
12	-28.75	-228.83	
13	-5.19	-128.69	
14	-4.44	9.6	
15	-1.65	209.76	
16	250.13	250.13	
17	250.13	250.13	
18	199.87	-70.12	
19	26.19	-97.17	
20	-105.83	-17.3	
21	-237.63	-57.44	
22	-250.14	-242.6	
23	-69.54	-250.14	
24	32.54	-206.81	
25	36.34	-68.18	
26	-7.89	139.57	
27	70.12	250.13	

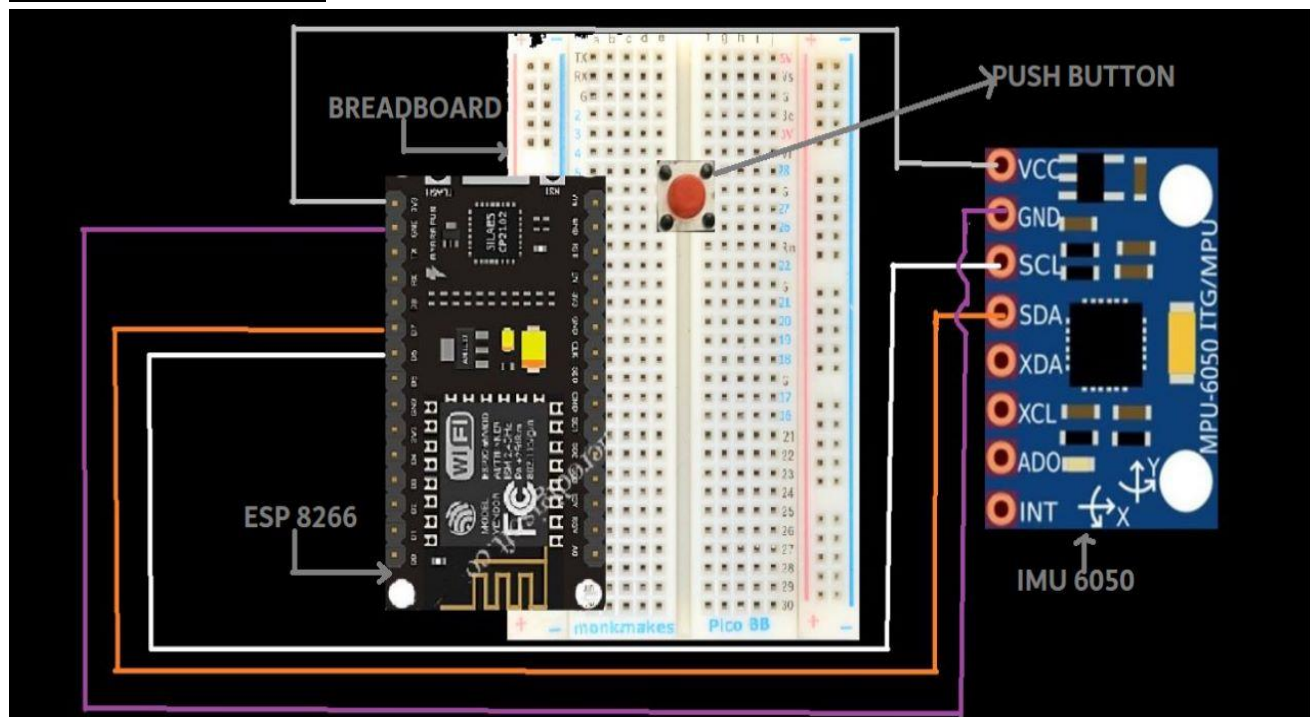
➤ Graphical representation of data:



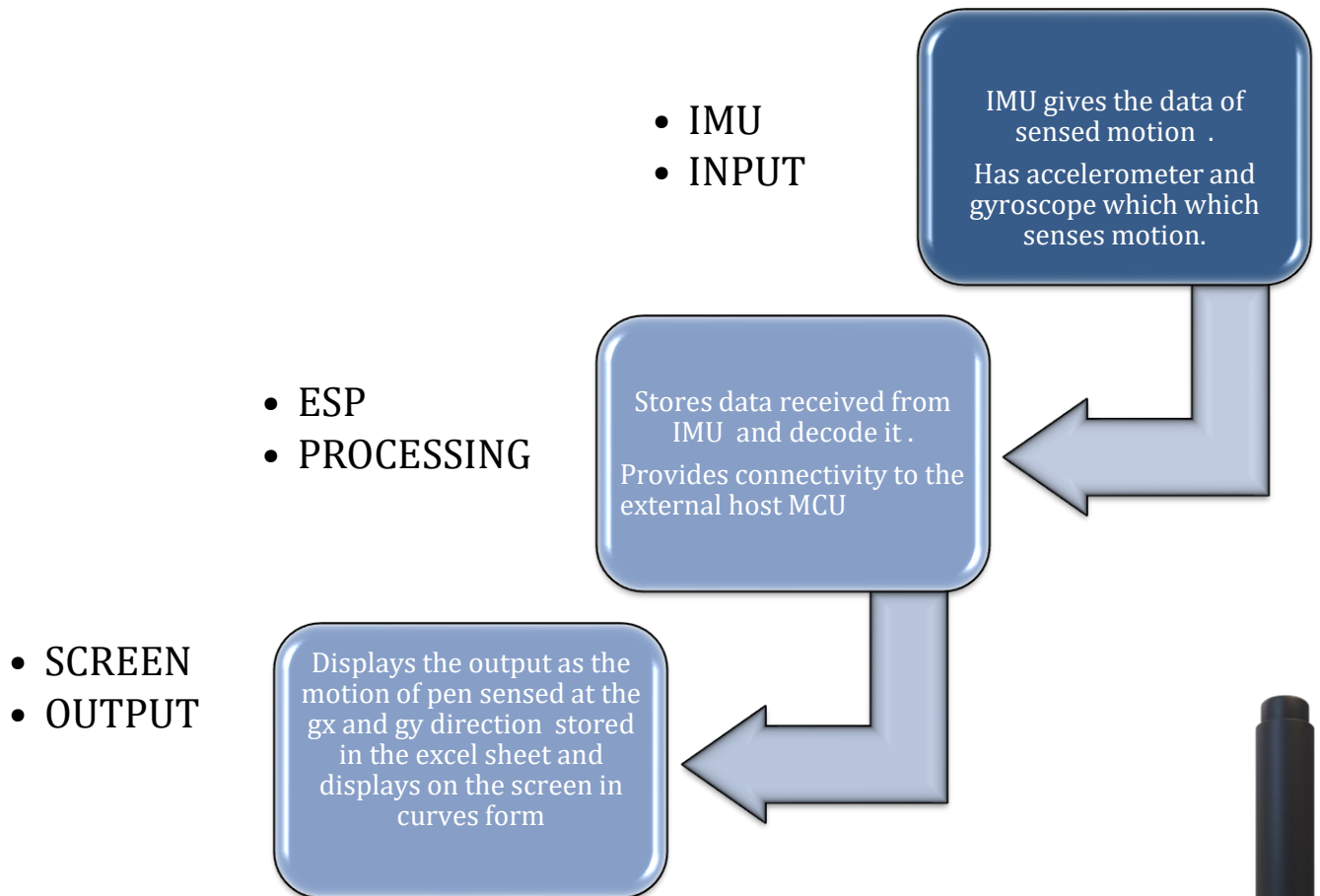
❖ Software Used:

- **Arduino Software (IDE):** - In addition to a text editor for writing code, a message area, a text console, a toolbar with buttons for frequently used operations, and a number of menus, the Arduino Integrated Development Environment, sometimes known as the Arduino Software (IDE), is also available. In order to upload programs and communicate with them, it connects to the Arduino hardware. Sketches are computer programmes created using the Arduino Software (IDE). These drawings are created in a text editor and saved as files with the .ino extension. The editor offers functions for text replacement and text searching. When saving and exporting, the message section provides feedback and shows errors. The console shows text generated by the Arduino Software (IDE), including error messages in their entirety and other data. The configured board and serial port are visible in the window's bottom right corner. You may create, open, and save sketches, validate and upload programs, open the serial monitor, and more using the toolbar buttons.
- **Generic ESP8266 Module:** - The ESP8266 chip is now supported in the Arduino environment thanks to this effort. It enables you to create sketches using well-known Arduino libraries and functions and run them directly on the ESP8266 without the need for an additional microcontroller. The ESP8266 Arduino core includes libraries to do OTA updates, create HTTP, mDNS, SSDP, and DNS servers, set up WiFi TCP and UDP communications, deal with servos, SD cards, SPI, and I2C peripherals, and more.

❖ Circuit Diagram:



❖ Data Flow:



❖ Different Modules:

» The ESP is connected to the display device (screen) via a USB cable. The USB cable provides voltage to the tools used and helps in transferring code to ESP (via Arduino IDE)

» Pins on IMU:

- VCC stands for voltage at the common collector. V in the circuit is the supply voltage.
- GND is the reference point in the circuit.
- SLC
- SDA

» Pins on ESP: There are 9 pins as D0, D1, D3.....D8, G, 3v.

- Here we use only 4 pins as D6, D7, G and 3v connected to
- SLC, SDA, VCC, and GND respectively of the ESP.
- In the code, D6 and D7 are denoted as 12 and 13 respectively.

❖ **Conclusion:**

In this project, a pen digitizer using an IMU sensor was designed to improve the writing experience by writing digitally on the computer screen. The graphical representation of data is typically based on the movement sensed by the IMU sensor. Moreover, this is an easy-to-use object. This can have various foregoing applications like writing on a tablet or a smart board. It is also available in the market in the form of a stylus pen. This was designed as a user-friendly device that is more convenient to use with a tablet instead of carrying a copy and a pen every time.

❖ **Future Advancements:**

One of the major fields in which this device can have some future advancements in the coming times is that the data need to be stored in a CSV file and then imported to the LibreOffice software for plotting the values. Thus, the values are plotted statically and need to be selected manually. This can be automated to automatically update the data values in the LibreOffice spreadsheet and plot the graph. Furthermore, suggestions for any other advancement are heartily welcome.