Digital Pen with Keyboard Functionality

A Thesis
Submitted to the Department of Electrical and Electronic Engineering Of
BRAC University
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Declaration

We hereby declare that this thesis paper titled 'Digital Pen with keyboard functionality' is done only by our research along with the research's implementation results found by us. Any material of research or thesis used from other sources has been mentioned along with their references. This thesis has not been previously submitted for any degree by anyone else. This thesis report is being submitted to the Department of Electrical and Electronic Engineering of BRAC University.

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Abstract

Proposal for building a wireless digital pen, which can work like a keyboard but more elegantly with the help of gyro sensor and C++ program be used for writing in classrooms, conferences, at presentation or anywhere. This pen contains Gyro sensor which is on a very basic level is used to choose the angle of the advancement of the pen of the 2-axis estimation by then transmit it to microcontroller which is then scrutinized the position and differentiation it and the letter sets which starting at now been set by position with the help of C++ language. By then the microcontroller trades the data to 7-segment display and Bluetooth at the same time and exhibits the letter set or the numerical impetus on the show. Right when the desired letters all together is showed up on the show and the pined for letters all together or number is met, the Bluetooth module accumulate the information and send it to sagacious devices like PC or wireless when push button is pressed.

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Chapter 1

Introduction

1.1 Motivation:

The study system in Bangladesh is still a significant simple one. Employments of digitalized showing materials are just found in colleges however that is likewise not an immense measure of use. Numerous nations are utilizing digitalized materials for showing purposes which is making the life of understudies and additionally educators less demanding. The understudies need to record address in their note pads and for that they can't completely focus the educator's addresses and also can't completely comprehend the addresses. This framework does not bring an incredible yield. The educator likewise needs to compose and afterward after some of the time needs to wipe the load up clean once more. These are very wastage of time both for educators and understudies. Then again if a man need to compose something he may require a pen and a paper and furthermore a steady place however in the event that he is in any vehicle which is moving he can't compose appropriately, this if must be satisfied legitimately however he can lose the paper with the information which he inputted prior. A while later If he have to send it by email or other computerized way then he have to scan it again then he can send it .So, to take care of the issue of composing address on board or in paper for educators and understudies as well as for each individual , we thought of the possibility of advanced pen. It is additionally pen molded which will compose with it simply like a pen. For the issue of educators and understudies, with this pen instructors can compose the addresses in programming rather than board. The address can likewise be spared in the PC subsequent to composing and afterward the understudies can take it from that point. Along these lines, the understudies don't need to record addresses in their note pads and they can completely focus on the address and additionally comprehend it legitimately. The instructor's will likewise have the capacity to compose their workings without wiping the board. At that point for moment composing any individual can utilize it without a paper and spare it into this pen memory or on the mobile phone memory where he can see the written work of his own from that point he can send it to anyone decisively

of examining. It can likewise spare tremendous measure of information where on the off chance that we write in the paper we require extensive amount of paper which is extremely unsafe for convey, it additionally work like a perpetual ink pen since it works through an effective battery which can likewise be charged. The advanced pen likewise serves the security issue of any private data; we can compose our data without appearing to anyone and spare it to our portable or PC. Our advanced pen will ready to tackle every one of these issues with the assistance of gyro sensor and make addresses digitalized and additionally less demanding for understudies and instructors and digitalized the antiquated written work framework.

1.2 Objectives:

Comparable to address framework is tedious as well as difficult to focus on as the understudies need to take notes of the addresses continually. Our nation is very little productive while it comes to digitalized classrooms. In school, universities the instructors still compose utilizing chalks and compose on writing boards. In colleges, classrooms are advanced to very some degree however instructors still need to compose on sheets while giving addresses. Our nation is said to be digitalized inside couple of years however the address framework is as yet practically equivalent to. Different nations are making their address framework digitalized. Our nation ought to do likewise. Surrendering the well established custom of composing on load up has turned into an unquestionable requirement now to spare time and make the understudies focus exclusively on addresses. In the event that a digitalized pen is presented in classrooms, the issues of composing while at the same time tuning in to instructor's addresses will be finished. With the assistance of gyro sensor, the pen can be utilized to write in programming simply like we compose like a pen and spare the addresses in the PC saving the understudies from composing while at the same time tuning in to addresses. By presenting this pen, address can be made digitalized. Then again a researcher, an artist or a writer may need to compose whenever, they need to compose data or thought of their own. By this pen anyplace whenever they can compose and spare their data. In the writing area it can likewise be extremely useful, for writing it expels the writing dangers and time, the pen is quicker and easier to work than keyboard. Where it doesn’t need any external power supply because it has a powerful battery which also can be charged.

1.3 Features:

Our framework will have some intense elements for the clients. From the client viewpoint he/she can compose anyplace and whenever with no paper or stable place, even in the moving vehicle he/she can compose with the pen. He/she can wipe it effectively likewise with no dangers. However, the users will get the benefit as there will be a battery life like a cell phone and is rechargeable by means of a USB dock and PC, mains or in-auto charger. Finished structures or information are transferred to focal secure programming by Bluetooth blending the computerized pen to a perfect portable or by means of a USB docking station associated with a PC. The PC utilizes the web to interface with the server while the cell phone acts like a modem, sending the pen's caught electronic information by means of GPRS.On the other hand the advanced pen has additionally arrangements we actualize have the levels of security requested by us to dealing with touchy inward and client data.

Chapter 2:

History and Literature Review

As ahead of schedule as 4,000 B.C., antiquated people groups utilized rough pens comprising of empty straws or reeds that bolstered a short segment of fluid. Amid the 500's B.C., individuals started to make pens from the wing plumes of such feathered creatures as geese and swans. The pole of the plumes was solidified, and the written work tip was formed and opening to make composing simple. These plume pens were known as plume pens, and they were broadly utilized until the point that the improvement of steel-nib pens in the 1800's.

By the late 1800's, designers had culminated an early form of the wellspring pen. This pen spoke to a noteworthy change over past pens, since it included an ink supply and a hair like nourish.

Prior pens held just a little measure of ink at any given moment and must be over and again plunged in ink.

The First Fountain Pen

Fig 1.1: Fountain Pen

In 1883, L. E. Waterman, a protection salesperson, bought a written work contraption with its own ink repository. Be that as it may, when it spilled, demolishing a deal, he got a thought for a superior one and chose to make it himself. In those days a salesperson frequently wore a vest chain with a little metal compartment holding a vial of ink in one pocket and a collapsible penholder in the other. Waterman analyzed a few supposed pocket pens and saw that none of them had a system for the beyond any doubt control of ink stream. He resolved to concoct one. Applying the standard of hair like fascination, he composed a sustain with a section for air admission and three restricted openings in the base of the score. As air bubbles entombed, they squeezed against the ink in the barrel and the ink plunged through the openings in a uniform stream to the pen point.

This gadget was so novel the Patent Office allowed a patent in 1884, just a couple of months after the documenting. Waterman asserted that his new system would "keep the over the top release of the ink when the pen is being used." It was the primary pragmatic wellspring pen and

its three-gap encourage turned into the standard guideline for every single other make delivered from that point.

Waterman began gathering his pens on a kitchen table in the back of a stogie store. In September of 1885 he began to promote. After that Waterman's Ideal rode the street to fortune.

The primary pens were long tubes with a top fitted on a projection at the highest point of the barrel. The cone top, sliding over the end, did not come until 1899. Shading was first utilized as a part of 1898 with the hexagon holder. A self-filling cylinder supplanted the reloading eye dropper in 1903. In a 1908 model the barrel was made with a portable sleeve which uncovered a metal bar; by finger weight the bar crushed a delicate elastic sac. Up to this time there had been no sacks in wellspring pens.

The Waterman Company (L. E. Waterman kicked the bucket in 1901) acquainted an opening sufficiently huge with concede the edge of a coin to pack the sac in 1913. Later that year the lever showed up, set in a metal lodging appended to the barrel; the lever discharged or filled the sac totally in one stroke. Changes since that time have been mostly in styling.

The main Ball Point Pen

The primary patent for a ball point pen was No. 392,046, conceded October 30, 1888, to John J. Uproarious of Weymouth, Mass. Uproarious utilized the pen to stamp cowhide textures. Another ball point pen gadget was protected by Van Vechten Riesburg in 1916. The two licenses slipped by without change restoration.

Ballpoint pens got little notice until World War 11(1939-1945). Many pilots started utilizing ballpoint pens amid this contention, in light of the fact that such pens did not spill at high elevations. After the war, ballpoint pens turned out to be progressively well known. Delicate tip pens and moving ball pens both were presented amid the 1960's.

The principal ball guide pen toward supplant the then regular "wellspring pen" was presented by Milton Reynolds in 1945. It utilized a small metal roller which moved substantial gelatin ink onto the paper. The Reynolds Pen was an unrefined written work instrument, yet it sold like "hot cakes" when initially presented at a cost of $10, utilizing the trademark "It composes submerged." Competition at long last constrained costs down to fewer than 10 pennies for ball point pens by 1960. By then the Reynolds pen had vanished from the commerce.

The advanced pen is a PC creation that transmits composing into computerized media. Advanced pen innovation was first created by the Swedish designer and business person Initiate Fahraues .It is an information gadget which catches the penmanship of a client, changes over manually written data made utilizing "pen and paper" into computerized information. The written work information can be changed over into computerized frame and transferred to a PC and showed on its screen. Because of the constant advancement of PC innovation, human PC communication procedures have turned into an imperative segment in our everyday life. Presently days advanced pen is a successful information gadget for PCs. Touch screen gadgets speak to a development far from paper, roughly 80% of organizations still utilize paper based structures. Numerous callings hand-compose their notes, tables, graphs and drawings as opposed to utilizing tablets or different Gadgets. The computer pen is comparable to a regular ink pen that writes on any surface, but it has an optical reader that used to records motion and Coordinates. The recorded data is then transmitted to a computer or mobile via a wireless transmitter. You can browse and edit your written notes .Another feature of this computer invention is that hand-written digital files can be easily converted into text fonts for use in word documents or emails. This technology is use to interact with our world like never before. We can get information about anything from anywhere within a few moments.

Chapter- 3

System overview

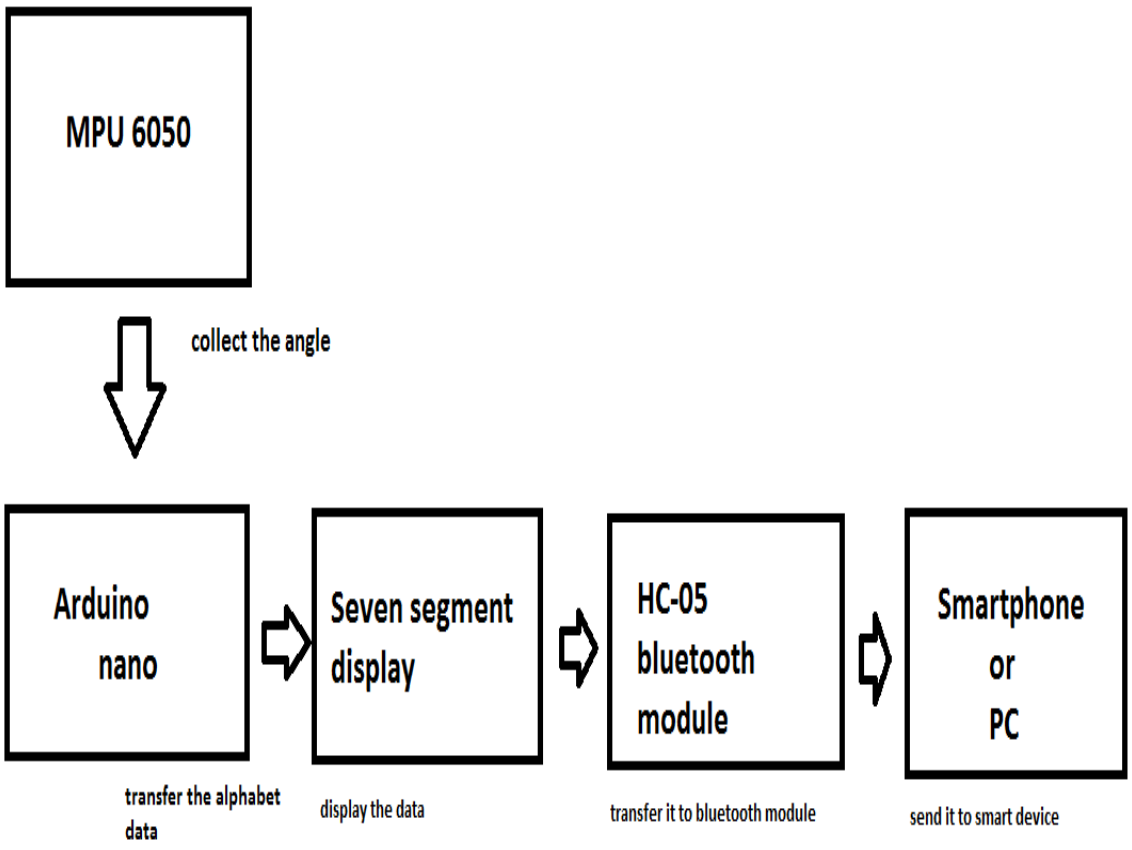

Fig 3.1.1: Block Diagram of the Whole System

MPU 6050 or Gyro sensor is fundamentally is utilized to decide the angle of the development of the pen of the 2-axis measurement at that point transmit it to microcontroller or arduino nano.

1. Which is then perused the position and contrast it and the letters in order which as of now been set by position with the assistance of C++ dialect. At that point the microcontroller exchanges the information to 7-segment display and Bluetooth at the same time and demonstrates the letters in order or the numerical incentive on the show.

2. At the point when the coveted letters in order is appeared on the show and the coveted letter set or number is met, the Bluetooth module gather the data and send it to brilliant gadgets like PC or cell phone when push catch is squeezed.

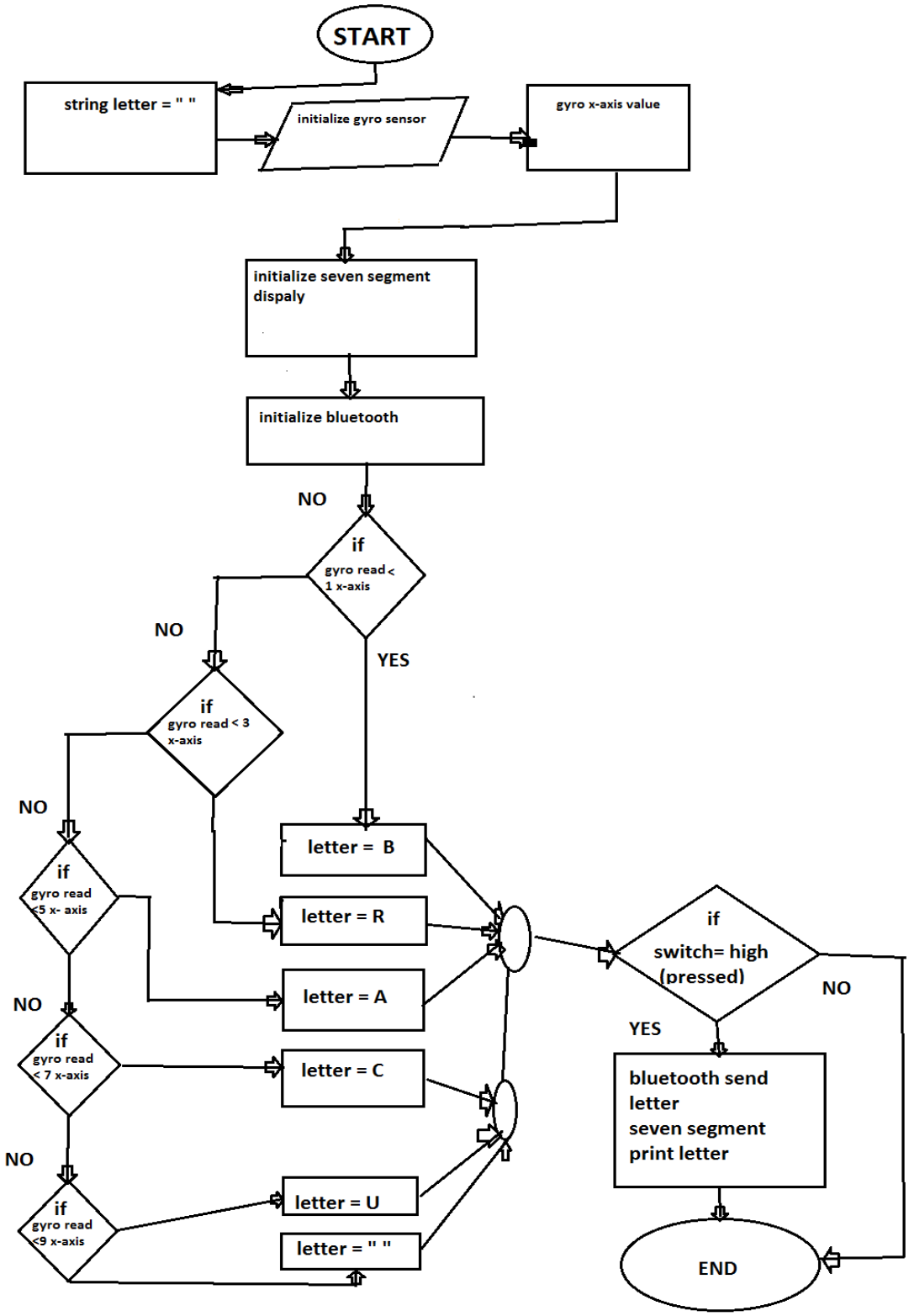

Fig 3.1.2: Flowchart of the whole system

Chapter 4:
Hardware Components

4.1 Hardware Introduction:

The principle intention of our project is to make a pen which will have the essential functionalities of a keyboard and it can likewise be used to write in classrooms, conferences, and meetings and so forth. In this section of the paper, hardware part of the project is portrayed briefly specially the hardware components of the project. Basically, the project has functionalized by two main components one is microcontroller and the other is gyro sensor with the help of C++ programming language.

Gyro sensor is basically is used to determine the angle of the movement of the pen of the 2-axis dimension then transmit it to microcontroller which is then read the position and compare it with the alphabets which already been set according to position with the help of C++ language. Then the microcontroller transfers the data to 7-segment display and Bluetooth simultaneously and shows the alphabet or the numerical value on the display. When the desired alphabet is shown on the display and the desired alphabet or number is met, the Bluetooth module collect the information and send it to smart devices like computer or Smartphone as soon as push button is pressed.

The following components we have used in the project:

- Arduino Nano
- MPU 6050 (Accelerometer and Gyro sensor)
- HC-05 Bluetooth Module
- 7-Segment Display
- Rechargeable Lithium ion battery
- On/Off Switch
- Push Button Switch
- Wire
- Charging port

4.2 Components Description:

In this part of the content, a short portrayal description of the important components will be given alongside their works in the project, information sheets and figures with pin arrangements.

MPU 6050 Gyro Sensor:

A gyroscope is a motion interface device used primarily for navigation and measurement of angular rate using Coriolis Effect. At the point when a mass is moving in a specific direction with a specific velocity and when an external angular rate will be applied as show with the green arrow a force will occur, as show with the blue red arrow at the fig 4.2.1, which will cause perpendicular displacement of the mass. This displacement will cause change in capacitance which will be measured, processed and it will correspond to a particular angular rate [4].

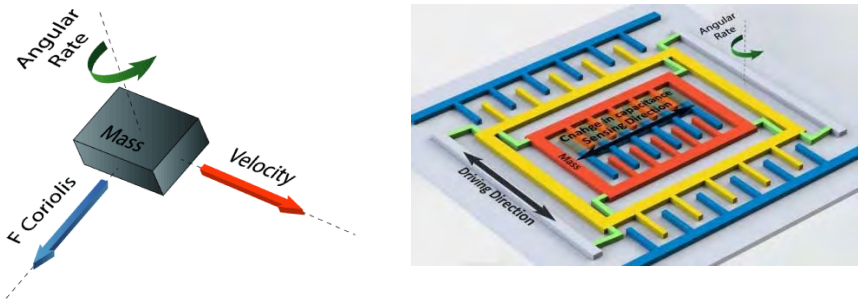

Fig 4.2.1: How the gyro sensor work

Gyroscopes measure rotational velocity in 1, 2, or 3 directions. 3-axis gyroscopes are often implemented with a 3-axis accelerometer to provide a full 6 degree-of-freedom motion tracking system. The MPU-6050 features three 16-bit ADCs for digitizing the gyroscope outputs and three 16-bit ADCs for digitizing the accelerometer outputs. The MPU-6050 uniquely enables low-power motion interface applications in portable applications with reduced processing requirements for the system processor. For power supply flexibility, the MPU-6050 operates

from VDD power supply voltage range of 2.375V-3.46V. Additionally, the MPU-6050 provides a VLOGIC reference pin (in addition to its analog supply pin: VDD), which sets the logic levels of its I^2C interface. The VLOGIC voltage may be 1.8V±5% or VDD. Auxiliary master I^2C bus for reading data from external sensors. Operational current of gyroscope is 3.6mA [5]. The gyroscope is fitted in our pen that allows it to maintain each orientation independent of the pen position. Electric contacts from Arduino connected to gyro sensor send information to the Arduino (microcontroller) about the pen's orientation.

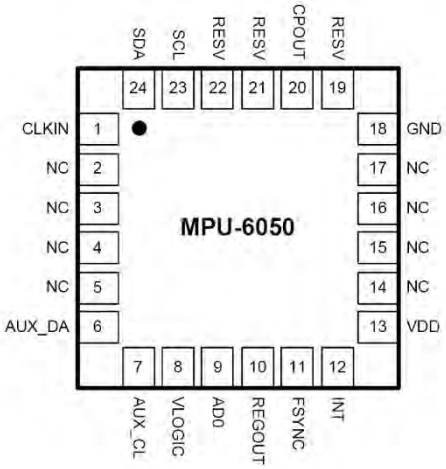

Fig 4.2.2: MPU 6050 pin layout

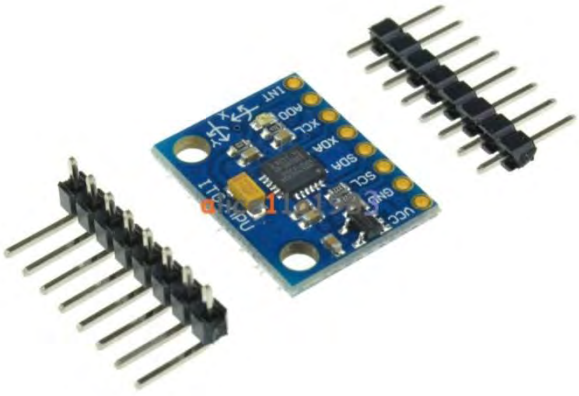

Fig 4.2.3: MPU 6050 Gyro Sensor

Arduino Nano:

Arduino is basically a development board pulled around a microcontroller. Arduino board schemes use a variety of microprocessors and controllers which are prepared with sets of digital and analog input/output pins that may be interfaced to several extension and other circuits. The microcontrollers are usually programmed using with C and C++ programming language [3]. This microcontroller is a main part in this project. Arduino works as a mother of the whole circuit. It collects the angular data from the gyro sensor and process them in programming language and detects which alphabets are at that position and transmit it to the 7-segment display and Bluetooth simultaneously.

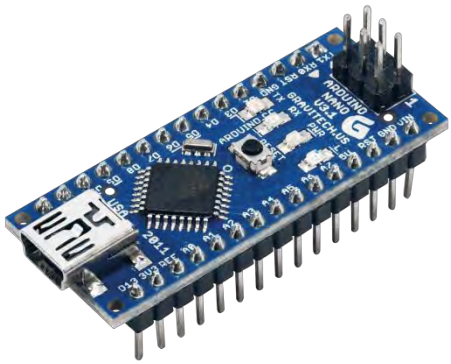

Fig 4.2.3: Arduino Nano

Specification [4]:

Microcontroller = ATmega328 Arduino Nano

Operating Voltage (logic level) = 5 V

Input Voltage(recommended) = 7-12 V

Input Voltage (limits) = 6-20 V

Digital I/O= Pins 14 (of which 6 provide PWM output)

Analog Input = Pins 8

DC Current per I/O Pin = 40 mA

Flash Memory =32 KB of which 2 KB used by boot loader

SRAM = 2 KB

EEPROM = 1 KB

7-Segment Display:

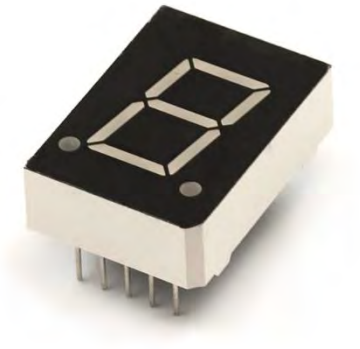

Fig 4.2.4: 7-Segment Display

The 7-segment display consists of seven LEDs arranged in a rectangular shape as shown in fig 4.2.4. Each of the LEDs are called segments as once lightened forms part of a numerical digit (both Decimal and Hex) to be displayed and additional LED is used to indicate the decimal point sometimes. This component has 9 connection pin under the display and individually each pin segments contains represent each individual LED. So by forward biasing the appropriate pins of the LED segments in a particular order some segment will get lit and others will remain off according to desired character pattern of the number or the alphabets on the display. 8 individual pin contains 8 corresponding segment LED and the other is used for common cathode or common anode [5]. When this pins are in common cathode the extra pin joined to "0" or ground, and applying the remaining individual pinsto "HIGH", or logic "1" signal through a current controlling resistor to forward bias the individual anode terminals and make the corresponding segment LEDs lighten. In this project, common cathode 7-segment displays has been used to show the desired alphabets or number.

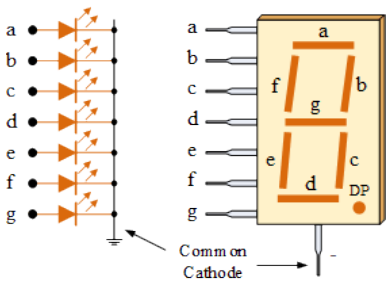

Fig 4.2.5: Common Cathode 7-segment display

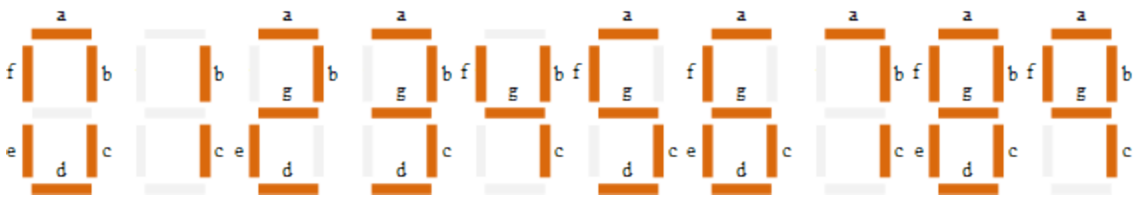

Fig 4.2.6: 7-segment display segment for all numerical numbers

Here are some examples of the display outputs with desired inputs. Both the figures are shown for the numerical number from 0 to 9. Alphabets can also be shown with the truth table it fits.

Segments Inputs							7 Segment Display Output
a	b	c	d	e	f	g	
0	0	0	0	0	0	1	0
1	0	0	1	1	1	1	1
0	0	1	0	0	1	0	2
0	0	0	0	1	1	0	3
1	0	0	1	1	0	0	4
0	1	0	0	1	0	0	5
0	1	0	0	0	0	0	6
0	0	0	1	1	1	1	7
0	0	0	0	0	0	0	8
0	0	0	0	1	1	0	9

Fig 4.2.7: Truth Table of 7-Segment Display from 0-9 numerical number

HC-05 Bluetooth Module:

HC-05 Bluetooth Module is easily operable to Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. Its communication is via serial communication which makes accessible to combine with controller or computer or Smartphone. HC-05 Bluetooth module delivers switching mode between master and slave mode which means it able to use neither receiving nor transmitting data [7]. Serial port Bluetooth module is fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate) 3Mbps Modulation with complete 2.4GHz radio transceiver and baseband [6].In this project, this Bluetooth is used to collect the numerical or alphabet data from Arduino Nano microcontroller and send it to computer or Smartphone wirelessly to users.

Fig 4.2.8: HC-05 Bluetooth module

Hardware Features [6]:

- Typical -80dBm sensitivity
- Up to +4dBm RF transmit power
- Lo Power 1.8V Operation ,1.8 to 3.6V I/O
- PIO (Programmable Input/output) control
- UART (*universal asynchronous receiver/transmitter*) interface with programmable band rate
- With integrated antenna
- With edge connector

Rechargeable Lithium Ion Battery:

We have used two 4.2 voltage of battery in series which is total of 8.4 V and the capacity of the battery is 2000mAH. Then it is converted to 5V by the voltage regulator inside the microcontroller. There are many reasons using the LIB, like it is smaller and lighter as we are using this for pen it must be lightweight factor to handle while writing. It has high energy density than other rechargeable batteries which means it has high power capacity without being too large. It has low self-discharge, it discharge slowly than other rechargeable batteries. The discharge rate of the battery is about 1.5 per month which indicates that it has a longer shelf-life. LIB has zero to insignificant memory effect, this phenomena perceived in other rechargeable batteries in which they drop their maximum energy capacity repeated recharged after being only partially discharged. It has fast charging ability than other rechargeable batteries. It has a chemistry that results in higher open-circuit voltage than other batteries like lead acid, nickel-metal hybrid, and nickel cadmium. Last but not the least, LIB has longer lifespan. It can generally deal with many charge-release cycles. Some lithium particle batteries loss 30 percent of their ability after 1000 cycles which is long enough. But also there are some cons with it which is insignificant to pros like LIB is sensitive to high temperature. Overheating or overcharged cause the battery to reduce faster than their normal scenario [8]. This battery must charge partially because it becomes unusable in deep charging. So, while using user must take those precautions.

Fig 4.2.9: Lithium ion rechargeable batter

Total hours to discharge while continuous using of this pen:

$$\frac{\text{Total Capacity}}{\text{Gyro Senor OC + Arduino Nano OC + 7-Segment Display OC + HC-05 Bluetooth Module OC}}$$

$$\frac{2000\text{mAH}}{3.6\text{mA} + 40\text{ mA} + (25\text{x}7)\text{mA} + 35\text{ mA}}$$

7.886 hours

It takes around 7.886 hours for the battery of the pen to completely discharge with continuous use which is enough for a user to use for a day.

Chapter 5:

System Implementation

In this chapter, representation of the circuit is given in intensively along with the proper diagrams of the circuit to show how the circuit works.

5.1: Circuit Description: In this part of the chapter, each and every path of the circuits is specified in details.

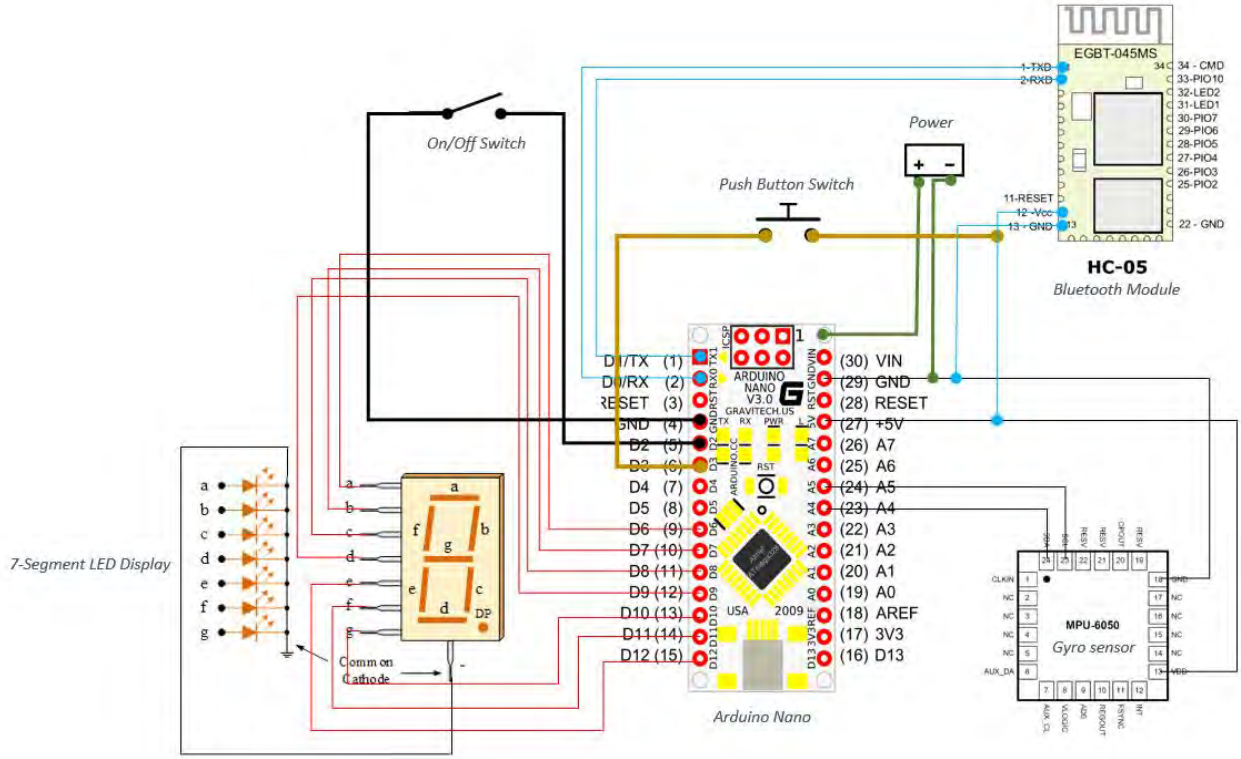

Fig 5.1.1: Circuit Diagram of the project

First, 8.4V of power is given from the lithium ion rechargeable battery to microcontroller. The positive terminal (Anode) of the battery is connected to the Vin of Arduino Nano and the negative terminal (Cathode) of the battery is connected to ground pin of the Arduino Nano. Then the voltage is converted to +5V by the voltage regulator inside the Arduino Nano. The Gyro sensor is also connected to +5V pin of the Arduino Nano to get the power and ground pun is connected to of the Arduino Nano. The gyro sensor sends its data to analog pins of the Arduino Nano through SDA and SCL pins. Then the Arduino Nano sends the data to Bluetooth module and to 7-Segment display. The power for HC-05 bluetooth module from +5V pin to Vcc pins of the module and both of GROUND pin are connected to each other. The microcontroller transmits the data to Bluetooth module through TX pin to RX pin of module and receives data from the module. The seven anode a,b,c,d,e,f,g and decimal pins of the 7-segment display are connected to digital pins of the microcontroller and cathode pins are grounded to zero. The one terminal push button is connected to one of the digital pin of microcontroller and other terminal to ground. And one the on/off switch pin is connected to digital pin of the controller and other is to ground pin.

5.2: Circuit Analysis:

The whole process of the circuit is given in a vivid way is this part of the chapter. In this part, it is explained that how each and every components work. When the switch is turned on, the battery supplies the 8.4 of the voltage and then it are converted to +5V by the voltage regulator inside the microcontroller. The MPU 6050 gyro sensor sense the object angle and movement and send those data to microcontroller Arduino Nano through SDA pin of the sensor. SCL pin of the sensor sends the clock pulse to identify the source for the I2C communication.

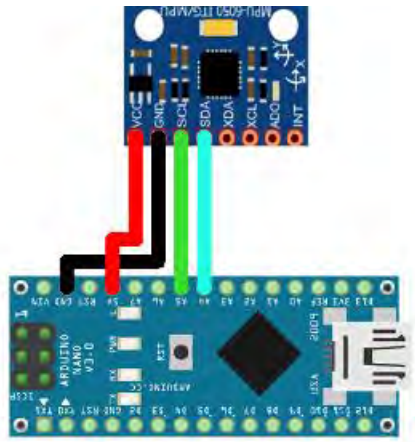

Fig 5.2.1: the connection between Arduino Nano and MPU 6050 Gyro Sensor

When the microcontroller gets the data it checks it through its coding language to match with the alphabet and numerical values. When it matches it converts the data from analog to digital one and transmit the data to HC-05 Bluetooth module through TX pin and the module receives it through the RX pin of it. When the push button is pushed the module sends the data to Bluetooth connected Smartphone or computer.

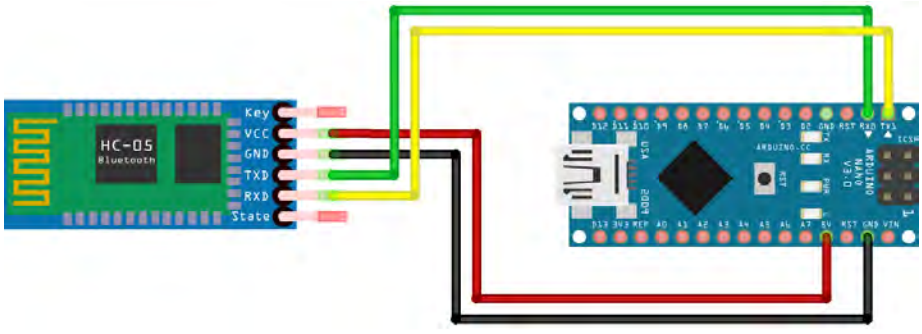

Fig 5.2.2: Connection between Arduino Nano and HC-05 Bluetooth Module

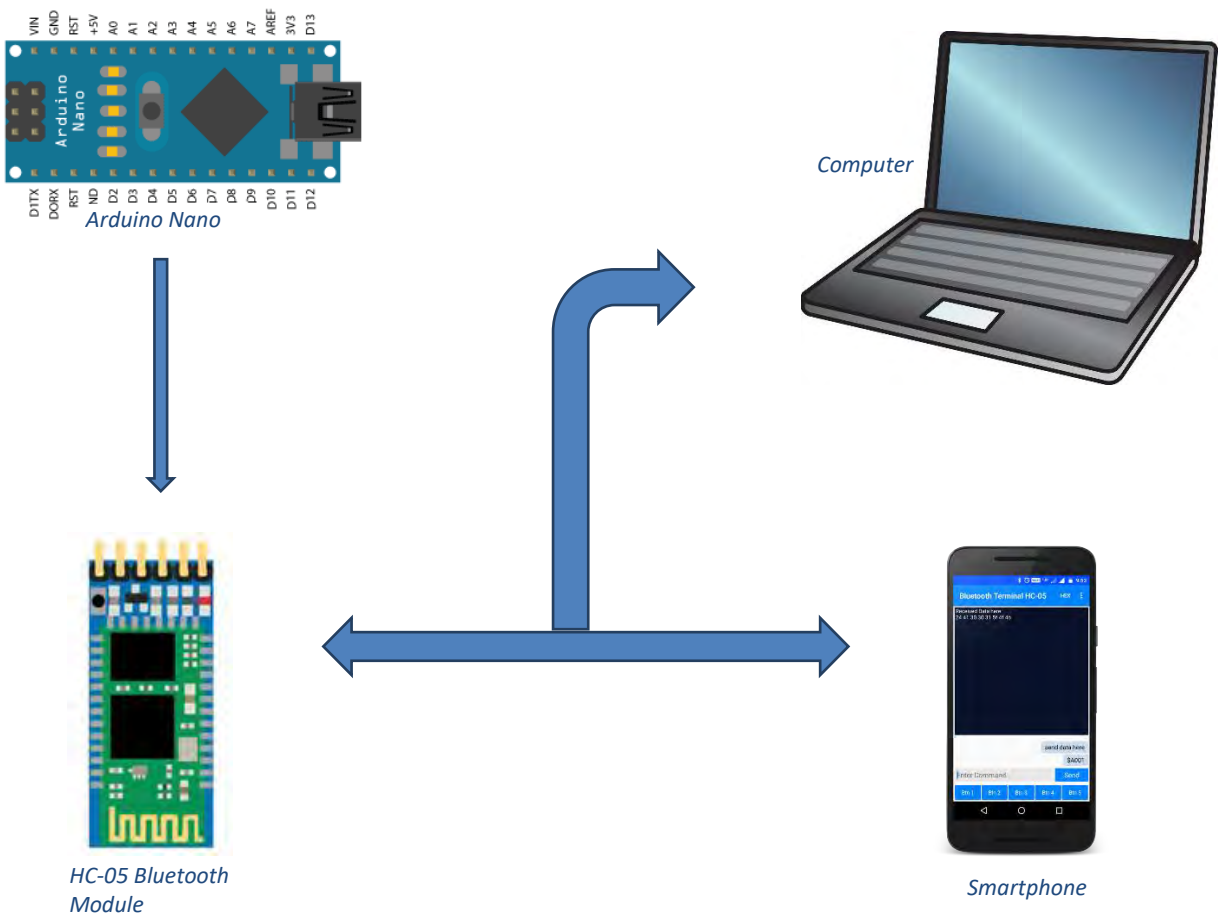

Fig 5.2.3: Data transfer from Arduino Nano to Computer or Smartphone via HC-05 Bluetooth Module.

The Arduino Nano also sends digital data to pins of 7-Segment display through digital. The segment of the LED of the display lights up depends on which pins get the signal and others don't. The user chose the desired alphabet and numerical value that looking over the display and pushes the push button to allow Bluetooth to transmit it to Smartphone or computer.

Chapter 6: Results:

6.1: Analytical Review:

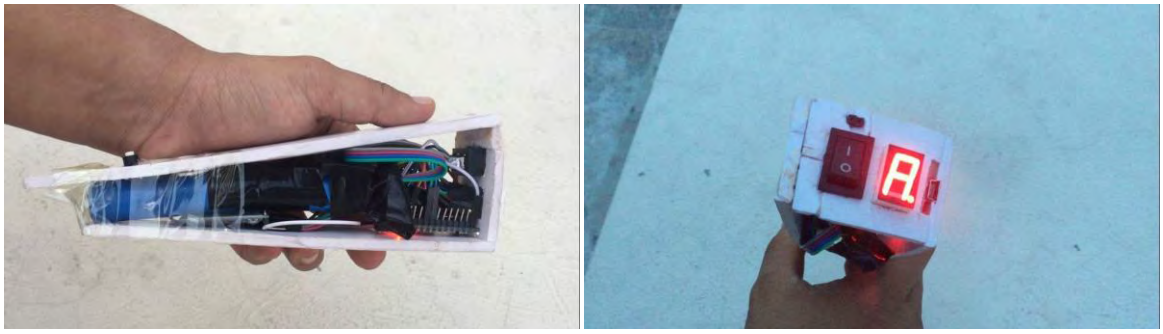

Fig 6.1.1: Current view of the Digital Pen

The analytical or methodical review of this project reflects the efficiency and faster way of writing. As the functions are discussed above, at-first the MPU-6050 Gyro Sensor collects the angular data and passes it to the Arduino Nano. The Arduino Nano with the help of C and C++ programming sends the angular data to the 7 Segment display. Subsequently the Arduino Nano sends the data to the HC-05 Bluetooth module. The device itself has an ON / OFF Switch but most importantly the whole process is controlled by a Push Button Switch. The Push Button Switch helps the user from passing the unwanted data's to the device. It has several uses in the areas of teaching, professional and even for personal use.

Fig 6.1.2:7- Segment display showing "BRACU" separately

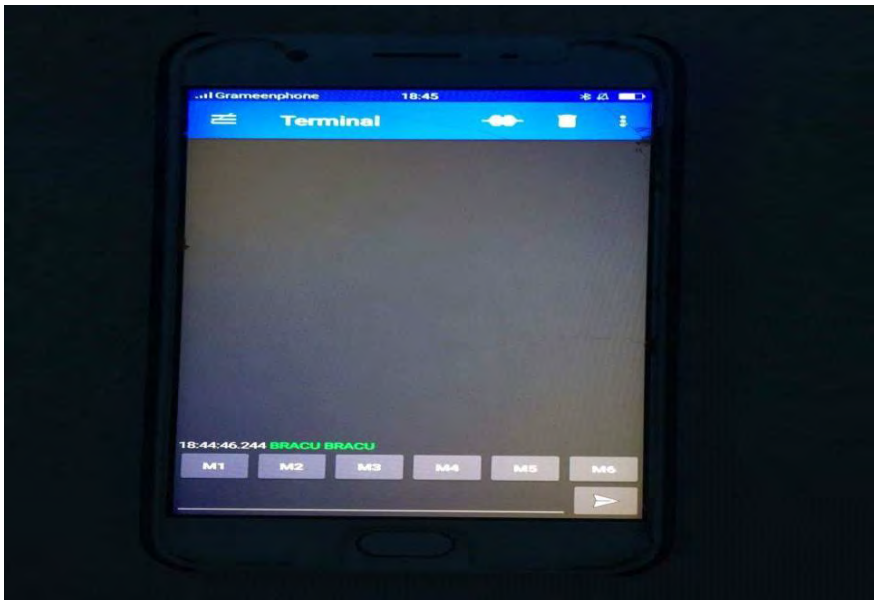

Fig 6.1.3: Displaying BRACU space BRACU in the Application

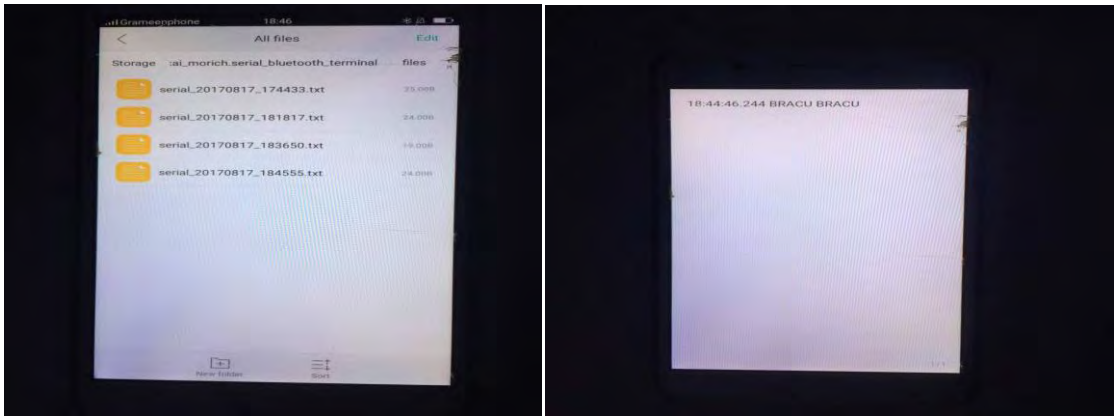

Fig 6.1.4: Saving the data as a .txt file in the device

6.2: Advantages:

There are some basic advantages of this device which makes it very user friendly. By pushing the Push Button Switch we can write any alphabet or numerical value as we do not have to use the conventional method of writing an alphabet or a numerical value. So, we can save most of our important time. Another important aspect of this device is in its efficiency. The device uses a Lithium ion rechargeable battery with the capacity of 2000mAh. It takes around 7.886 hours for the battery of the pen to completely discharge with continuous use which is enough for a user to use it a day. The writings can be saved in any mobile or computer using Bluetooth Terminal application which is very accessible in Google Play store. This application takes data's sent by the module and saves it in the device as a text file which is accessible in smart phone and other devices. It can also be displayed using another app. Though the Pen does not need any surface or any medium or any atmosphere to work on, it is very much user friendly in terms of accessibility. So the device can be useful in classrooms, offices and any other personal usage.

6.3 Limitations:

Every device in this world can have many advantages but it has some limitations as well. So, overcoming those limitations is the most important aspect of building a proper device. In our project we also faced some limitations which were very much tough to overcome. For this device the first limitation is getting the angle right so that we can obtain a specific angular data. The data can be of numerical or alphabetical order. Another limitation is human error or hand error. Though the alphabets or the numerical values are programmed in specific angles, it is a bit tricky for a human hand to get along with its specific angles. But it can be adopted easily by the user through some practice. If we think of any sorts of keyboard consisting of Alphabets or numerical values, it takes some hard practice to get it perfectly right. For the purpose of writing precisely with this pen will need some practice as well as some future improvements. The 7 Segment Display used in our device can only show 0-9 value so we had to improvise by converting the alphabetical values to 7 Segment values.

Chapter 7: Conclusion & Future Research:

7.1 Summary:

From the first fountain pen to the modern digital pens, the digitalization of pen is evolving very fast. Now-days, there are so many cool inventions going on in this modern world. We have also made our little but significant contribution towards this evolvement through our project “Digital Pen”. In our thesis project, we have used Gyro Sensor to get the angular data using Coriolis Effect. The gyro sensor will then send the specific value programmed in specific angle using C and C++ programming in Arduino Nano. The Arduino Nano is actually the mother of this device. The Arduino will pass the values to the 7-segment display subsequently in the Bluetooth module. The device has an ON/OFF button installed. The whole process of sending and receiving data is controlled by single Push Button switch. It can be displayed and saved using Bluetooth application using Bluetooth Module. The system is powered by a 2000mAh Lithium ion battery with continuous use for around 7.88 hours. Despite having both some advantages and limitations, the results of the project are quite satisfactory. Some specific progress can be adapted by the usage of more advanced and calibrated digital circuit design.

7.2 Future Progress:

In this era of digitalization, people are busy with the processing of converting information into digital format. In our particular project, we also have some plans for further research. At first, we will have further improvements in getting all the alphabets and numerical values. The whole system can be calibrated in a single pen sized device by which the practicality of using the device in real life will be proven. In our current device, the data is saved in another mobile device using Bluetooth Module. In our future progress, we will have an in-board saving SD-card. The card will contain all the data’s written by the Digital Pen. The Gyroscopes measure

rotational velocity in 1, 2, or 3 directions. 3-axis gyroscopes are often implemented with a 3-axis accelerometer to provide a full 6 degree-of-freedom motion tracking system. In further progress, we can use other LED displays instead of using 7-segment though we cannot display all the alphabets in 7-segment.We can use more efficient and smaller battery to get make it more presentable and practical. Though it is a proto type, we have given our fullest efforts to get the basic analytical preview of it. In further mass production, we can easily reduce the size and make it efficient and user friendly. The mass production of this Digital Pen will eventually have a futuristic affect on the digitalization of pen. So, there are several improvements to be taken so that we can have a practical and efficient device.

References:

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3. http://www.historyofpencils.com/writing-instruments-history/digital-pen/
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Appendix:

Codes Used for the project:

```
#include <Wire.h>
#include <I2Cdev.h>
#include <MPU6050.h>
#include <SoftwareSerial.h>
SoftwareSerial myserial(4, 3); // RX, TX

int L1 = 5;
int L2 = 6;
int L3 = 7;
int L4 = 8;
int L5 = 9;
int L6 = 10;
int L7 = 11;
int L8 = 2;
int swt = 12;
String data = " ";
int px;
int py;
int pz;

MPU6050 mpu;
int16_t ax, ay, az, gx, gy, gz;

//16540,-1584,-4420
//15828,-960,-7152
//16328,-3756,980
//16484,3340,-1644
//16000,-4336,-4756
//14336,-8596,-4172
//14384,8488,-1876
//12768,904,-12692
//14576,-4800,5488
//13136,-6164,7192

void setup() {
  // put your setup code here, to run once:

  Serial.begin(9600);
  Wire.begin();
  pinMode(L1, OUTPUT);
  pinMode(L2, OUTPUT);
```

```
  pinMode(L3, OUTPUT);
  pinMode(L4, OUTPUT);
  pinMode(L5, OUTPUT);
  pinMode(L6, OUTPUT);
  pinMode(L7, OUTPUT);
  pinMode(L8, OUTPUT);
  pinMode(13, OUTPUT);
  digitalWrite(13, LOW);
  pinMode(swt, INPUT_PULLUP);
  mpu.initialize();
  if (!mpu.testConnection()) {
    while (1);
  }
  Serial.println("Digitalpen Writing Start:");
}

void loop() {
  // put your main code here, to run repeatedly:
  mpu.getMotion6(&ax, &ay, &az, &gx, &gy, &gz);
  px = map(ax, -16000, 16000, 0, 15);
  py = map(ay, -16000, 16000, 0, 15);
  pz = map(az, -16000, 16000, 0, 17);
//  Serial.print(px);
//  Serial.print("--");
//  Serial.print(py);
//  Serial.print("--");
//  Serial.println(pz);
  delay(100);

  if (digitalRead(swt)==LOW){
  Serial.print(data);
  delay(500);
    }
  if (px>12 && pz==3 ) {
    B();
    data= "B";
  }
  else if (px>12 && pz==4 ) {
    R();
    data= "R";
  }
  else if (px>12 && pz==5 ) {
    A();
    data= "A";
  }
  else if (px>12 && pz==6 ) {
    C();
    data= "C";
  }
```

```
  else if (px>12 && pz==7  ) {
    U();
    data= "U";
  }

  else {
    digitalWrite(L1, LOW);
    digitalWrite(L2, LOW);
    digitalWrite(L3, LOW);
    digitalWrite(L4, LOW);
    digitalWrite(L5, LOW);
    digitalWrite(L6, LOW);
    digitalWrite(L7, LOW);
    digitalWrite(L8, HIGH);
    data= " ";
  }
}

void one() {
  digitalWrite(L1, LOW);
  digitalWrite(L2, HIGH);
  digitalWrite(L3, HIGH);
  digitalWrite(L4, LOW);
  digitalWrite(L5, LOW);
  digitalWrite(L6, LOW);
  digitalWrite(L7, LOW);
  digitalWrite(L8, LOW);

}

void A() {
  digitalWrite(L1, HIGH);
  digitalWrite(L2, HIGH);
  digitalWrite(L3, HIGH);
  digitalWrite(L4, LOW);
  digitalWrite(L5, HIGH);
  digitalWrite(L6, HIGH);
  digitalWrite(L7, HIGH);
  digitalWrite(L8, LOW);
}

void B() {
  digitalWrite(L1, HIGH);
  digitalWrite(L2, HIGH);
  digitalWrite(L3, HIGH);
  digitalWrite(L4, HIGH);
  digitalWrite(L5, HIGH);
  digitalWrite(L6, HIGH);
  digitalWrite(L7, HIGH);
```

```
  digitalWrite(L8, LOW);
}

void R() {
  digitalWrite(L1, HIGH);
  digitalWrite(L2, HIGH);
  digitalWrite(L3, HIGH);
  digitalWrite(L4, LOW);
  digitalWrite(L5, HIGH);
  digitalWrite(L6, HIGH);
  digitalWrite(L7, HIGH);
  digitalWrite(L8, HIGH);
}

void C() {
  digitalWrite(L1, HIGH);
  digitalWrite(L2, LOW);
  digitalWrite(L3, LOW);
  digitalWrite(L4, HIGH);
  digitalWrite(L5, HIGH);
  digitalWrite(L6, HIGH);
  digitalWrite(L7, LOW);
  digitalWrite(L8, LOW);
}

void U() {
  digitalWrite(L1, LOW);
  digitalWrite(L2, HIGH);
  digitalWrite(L3, HIGH);
  digitalWrite(L4, HIGH);
  digitalWrite(L5, HIGH);
  digitalWrite(L6, HIGH);
  digitalWrite(L7, LOW);
  digitalWrite(L8, LOW);
}

void two() {
  digitalWrite(L1, HIGH);
  digitalWrite(L2, HIGH);
  digitalWrite(L3, LOW);
  digitalWrite(L4, HIGH);
  digitalWrite(L5, HIGH);
  digitalWrite(L6, LOW);
  digitalWrite(L7, HIGH);
  digitalWrite(L8, LOW);
}

void three() {
  digitalWrite(L1, HIGH);
```

```
  digitalWrite(L2, HIGH);
  digitalWrite(L3, HIGH);
  digitalWrite(L4, HIGH);
  digitalWrite(L5, LOW);
  digitalWrite(L6, LOW);
  digitalWrite(L7, HIGH);
  digitalWrite(L8, LOW);
}

void four() {
  digitalWrite(L1, LOW);
  digitalWrite(L2, HIGH);
  digitalWrite(L3, HIGH);
  digitalWrite(L4, LOW);
  digitalWrite(L5, LOW);
  digitalWrite(L6, HIGH);
  digitalWrite(L7, HIGH);
  digitalWrite(L8, LOW);
}

void five() {
  digitalWrite(L1, HIGH);
  digitalWrite(L2, LOW);
  digitalWrite(L3, HIGH);
  digitalWrite(L4, HIGH);
  digitalWrite(L5, LOW);
  digitalWrite(L6, HIGH);
  digitalWrite(L7, HIGH);
  digitalWrite(L8, LOW);
}

void six() {
  digitalWrite(L1, HIGH);
  digitalWrite(L2, LOW);
  digitalWrite(L3, HIGH);
  digitalWrite(L4, HIGH);
  digitalWrite(L5, HIGH);
  digitalWrite(L6, HIGH);
  digitalWrite(L7, HIGH);
  digitalWrite(L8, LOW);
}

void seven() {
  digitalWrite(L1, HIGH);
  digitalWrite(L2, HIGH);
  digitalWrite(L3, HIGH);
  digitalWrite(L4, LOW);
  digitalWrite(L5, LOW);
  digitalWrite(L6, LOW);
```

```
  digitalWrite(L7, LOW);
  digitalWrite(L8, LOW);
}

void EIGHT() {
  digitalWrite(L1, HIGH);
  digitalWrite(L2, HIGH);
  digitalWrite(L3, HIGH);
  digitalWrite(L4, HIGH);
  digitalWrite(L5, HIGH);
  digitalWrite(L6, HIGH);
  digitalWrite(L7, HIGH);
  digitalWrite(L8, LOW);
}

void nine() {
  digitalWrite(L1, HIGH);
  digitalWrite(L2, HIGH);
  digitalWrite(L3, HIGH);
  digitalWrite(L4, HIGH);
  digitalWrite(L5, LOW);
  digitalWrite(L6, HIGH);
  digitalWrite(L7, HIGH);
  digitalWrite(L8, LOW);
}

void zero() {
  digitalWrite(L1, HIGH);
  digitalWrite(L2, HIGH);
  digitalWrite(L3, HIGH);
  digitalWrite(L4, HIGH);
  digitalWrite(L5, HIGH);
  digitalWrite(L6, HIGH);
  digitalWrite(L7, LOW);
  digitalWrite(L8, LOW);
}

void E() {
  digitalWrite(L1, HIGH);
  digitalWrite(L2, LOW);
  digitalWrite(L3, LOW);
  digitalWrite(L4, HIGH);
  digitalWrite(L5, HIGH);
  digitalWrite(L6, HIGH);
  digitalWrite(L7, HIGH);
  digitalWrite(L8, LOW);
}
```