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## Digit Recognition From Wrist Movements

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### Abstract

In this paper, we focus on major drawbacks and security fragility associated with wrist wearable devices. Hardware such as accelerometer and gyroscope and other sensors included in wearable devices such as apple watch etc. These Sensors can give you enough data to uniquely identify wrist movements and information to identify what is being written by you or what hand signals you use daily. Here in this paper we are going to discuss the recognizing the digit written by user using the same arrangements and data.

### 1. Introduction

smart tech are becoming more and more available to common people these days because of their cheap rates. Hand accessorizes plays main role in this like apple watch or any other smart watch. They are much more capable of than just show you time and track your pulse, it fervently has many hardware such as IF sensor, accelerometer, gyroscope, barometer, etc. These sensors or hardware allows us to track some personal biometric that include implication for health and productivity benefits. But these are the useful cases in which we can make most of those wearable devices but the output variety of these sensors are vast and all use cases are not yet been seen. Exploration of new ways to use this data output could result in advantage as well as disadvantage. We will see the potential disadvantage of this data by capturing and predicting hand written digits from the user.

One's hand / wrist undergoes fine movements and orientation changes in x,y and z frame, when writing different digits or alphabets, we will focus on 0 and 1 for this experiment.

By having this data and properly recognizing the digit written by user from it has security implications which include some foul individuals gaining this sensitive data and information from users of these devices. Information like which is in the form of digits such as social security number, credit card information, medical record number etc. These Devices are also connected to internet with IoT, which means the data could be on the cloud in a blink of an eye and we all know the risk involving in it. Machine learning models which is used to classify hand written digits can be used on this data to gain this sensitive information in minutes.

## 2. Research Work

Common smart watches like apple watch, fitbit and Samsung Galaxy watch contain these type of hardware which is capable of capturing every movements and orientation from users wrist.

Accelerometers and gyroscope can capture enough data to classify the digits, some studies also shows that accelerometer mounted on these device have the sensitivity to identify the shakes associated with some neuromuscular diseases and its symptoms, such as Parkinson's and seizures, Writing is a fine motor task and this theory leads us to the conclusion that the data from accelerometer can be used to correctly identify the digit written by the users of these wearable device.

These watches are connected to internet that means they are IoT devices which can provide a never ending data stream and can results in a huge amount of data. Machines and deep learning algorithms offer many techniques to study and help make sens of all data and also correlate them to some particular task such as recognizing digits and some personal performance of health etc.

## 3. Hardware Designs

We needed accelerometer and gyroscope which are common among these devices and also are ideal for capturing the movements and orientations. The accelerometer can sense and gives us data of hand acceleration on three axis x,y,z and the gyroscope can give us the angle or titling movements during writing of any digit in the x,y,z plane. We made our own device with these qualities. It gave us more freedom on data and capturing the data more accurately and label that dat for the experiment.



We used Ada fruit MPU6050 for the sensor and Arduino Nano board as our experimental micro controller, MPU6050 is basically a sensor for motion processing devices. It is the world first six dimension motions tracking devices. It was designed for low cost and high performances smartphones, tablets and other wearable sensors. It is capable of processing nine axis algorithms, it captures motions in x,y,z axis at the same time. Basically it has both the sensors we need that are accelerometer and gyroscope. The MPU6050 is micro electro

mechanical system which have 3 axis accelerometer and 3 axis gyroscope inside it. It helps us to measure acceleration, velocity, orientation, displacement and many other related parameters of a system or object.



Arduino nano is preferred board for many projects as it is very small and easy to use micro controller board, it is flexible and breadboard friendly micro controller board developed by Arduino.cc in Italy based on ATmega328p IC. The small footprint and low price made it ideal for us to use it our experiment.

## 4. Data Collection

The sensor are attached to the wrist or on a pen like device which can be held by the user as those devices are used commonly. We wrote out numbers to fill 10 by 10 cm region, all the readings were recorded on click of a button, which has to be pressed at start and let loose when finished the number. The data got by writing these numbers are stored into an excel file with the exact labeling to the data as what digit it belongs to. We take digits 1 and zero only for this experiment.

Collected over 200 writing samples which consist of 100 data samples of zero and 100 data samples of ones.

6 data fields are recorded for each time we wrote numbers shown in table below. These fields were acceleration from accelerometer for all the three axis (x,y,z) and tilting angles recordings from gyroscope in three planes (x,y,z).

Table 1: List of features recorded for the training purpose of our model

Metrics	Axis	Value Type	Feature Count
Acceleration	X,y,z	Maximum,mean , minimum	9
Pitch angle	X,y,z	Maximum, mean, minimum	9
Total			18

These data are being stored in the excel sheet for further used to train the model also created more such data set for testing purpose and some real time data from the device.

## 5. Future Work

We are hoping to make this device as real as possible and also to explore the data and model for left handed person. By theory we can say that the human's left hand is the exact copy of right hand so by changing signs and direction from our data should work for left handed person but this hypothesis has to be tested. More data from left hand users is needed to test this theory. Also we are trying to get more relevant data from these and any other sensors we can get from these wearable devices. We made a simpler model for this experiment and used only two sets of digits as our testing but in future we can work on every other characters and all the digits, it will require a more complicated machine learning algorithm and model. There are more powerful tools to this task for recognizing all the 10 digits which is not explored by us in this experiment.

## 6. References

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