Smart Necklace

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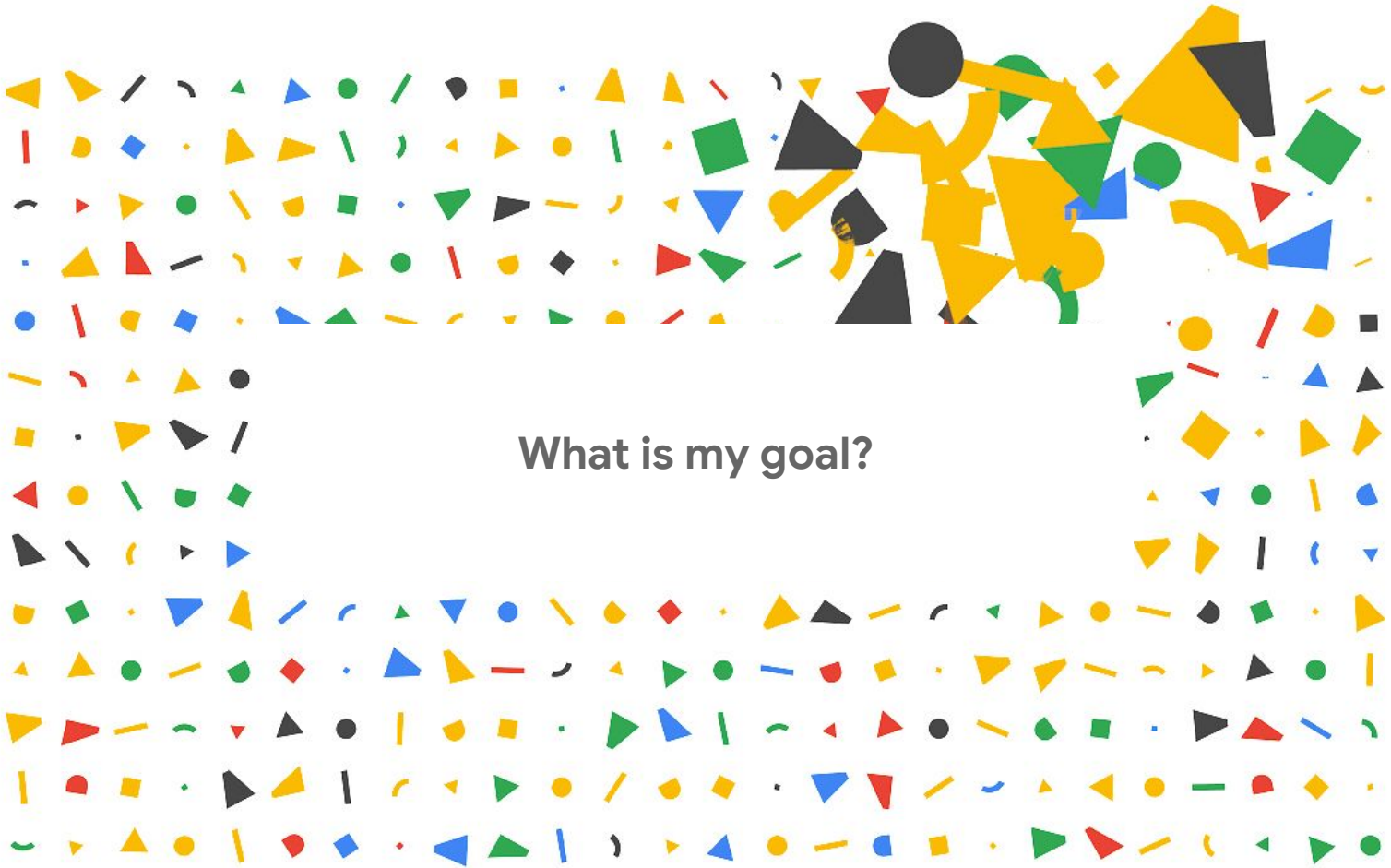
Motivation

1. Nowadays, there are a lot of wearable device, such as smart watches. I want to make a wearable and fashionable device that can take care of humans.
2. Drinking water can make ourselves healthier.
3. Currently, the only way to detect whether or not you have drank water is using a smart water bottle.


https://drinkupbottle.com.tw/


https://mashable.com/2014/04/15/google-glass-how-to-buy/

https://www.techbang.com/posts/63376-qualcomm-sends-new-products-for-google-pixel-watch-paving-the-road-wear-os-really-ready


What is my goal?

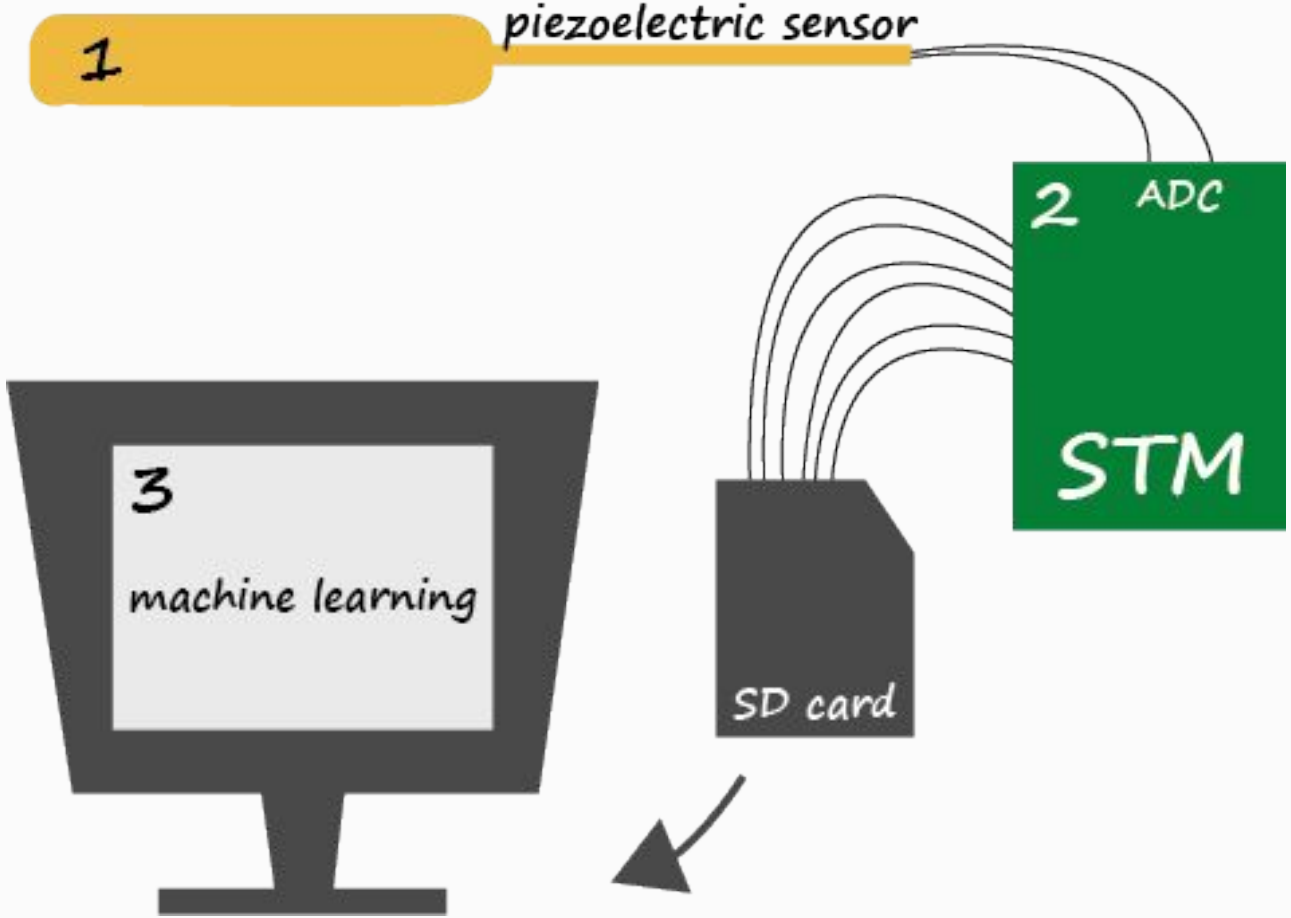
Objective

1. I want to make it a **functional device**
2. I want to make this device **fashionable**
3. I would like to make this device more **compact** and **consume less power**

How does Smart Necklace work?

Smart Necklace

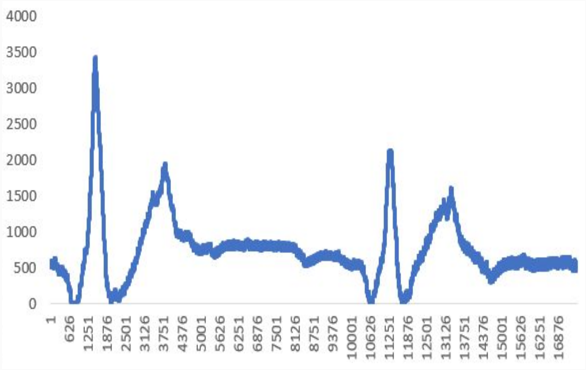
I divided this Smart Necklace into three parts. First, I used piezoelectric sensor to detect different waves. Then, I used MCU to collect data. Last, I used CNN to do machine learning.

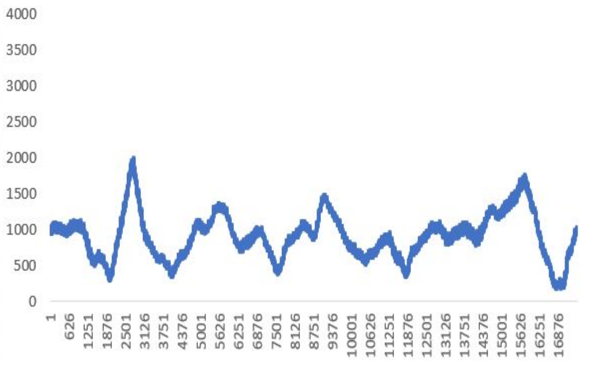


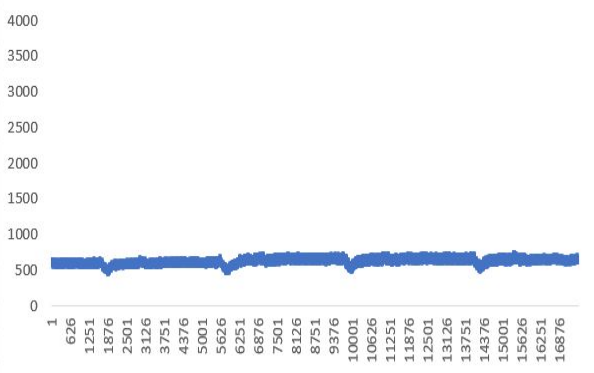
Piezoelectric sensor

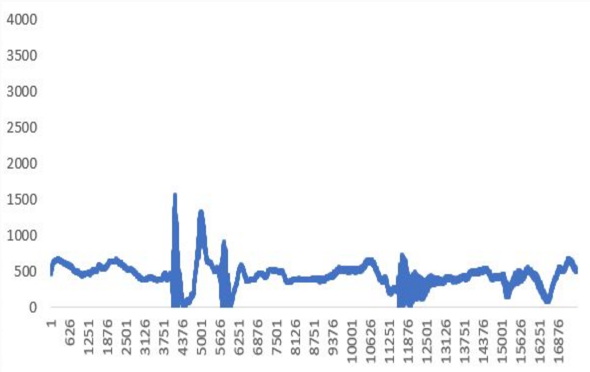
The benifits of piezoelectric sensor:

1. It is **sensitive** enough to distinguish different movements
2. This sensor requires **no battery**
3. This sensor is **compact** and **thin** enough to make it look like a necklace









Piezoelectric sensor

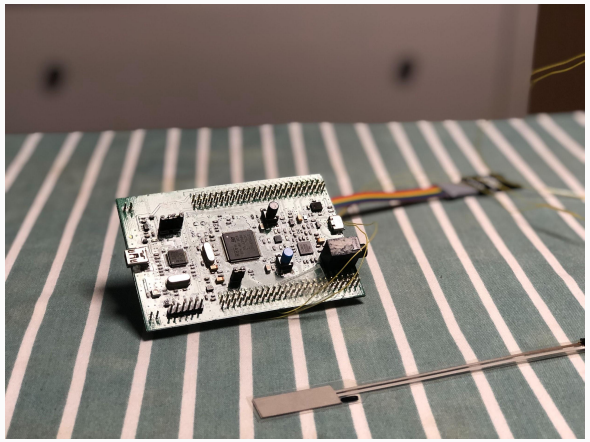
Piezoelectric Effect is the ability to generate an electric charge from mechanical stress. A power source is not needed for this effect. In the other words, you can transfer the vibration into electricity.

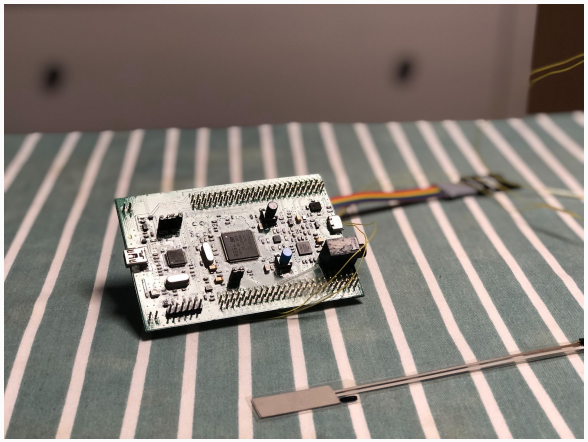
I found that when we drink or talk, the muscles in our neck move. It is during this muscle movement that a sensor is used to generate data. The Piezoelectric film sensor turns these vibrations into tiny electrical pulses, and the data can then be used for machine learning.

MCU+ADC

In the future, this MCU can be replaced by a single chip and it will be smaller. It will have a better power consumption in the future!

I used MCU to collect data and transferred the analog wave into digital signals. So I chose to use STM discovery board since it has its own ADC. The sampling frequency of Smart Necklace is 5,000Hz, and one point is about 2 bytes. Nowadays, the SD card can collect over 32G, which means this device can definitely do long-term collection.

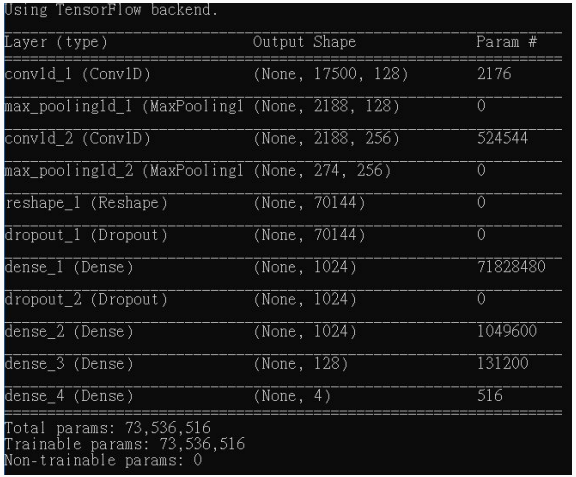


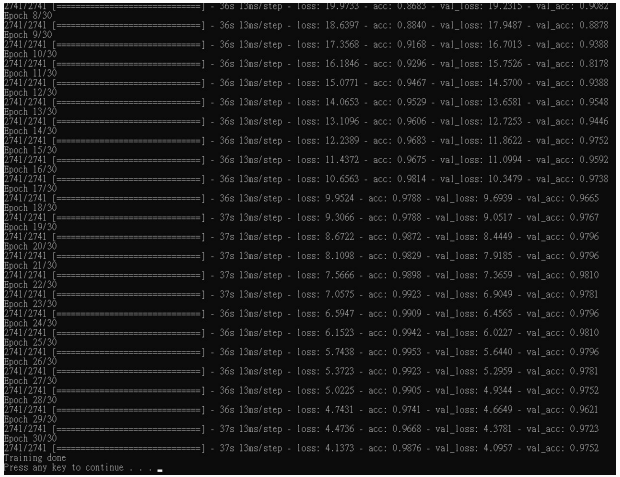


Machine learning: training

Machine Learning is a category of algorithms that allows software applications to accurately predict outcomes without being programmed. The basic premise of machine learning is to build algorithms which have the capacity to receive input data and can use statistical analysis to predict an output.

CNN model design: one dimension of convolution will be used in this study, consisting of two 1D-convolution layers followed by a maximum pooling layer. Then, full connection classifier layers consisting of four neural network layers and two dropout layers will be used for classification.

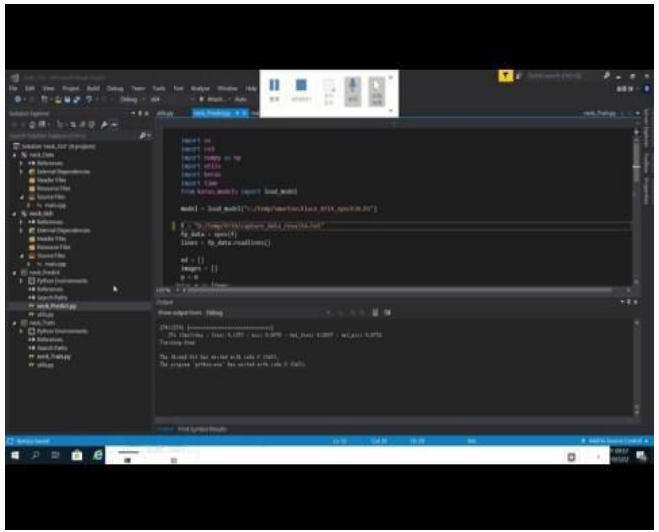




Machine learning: prediction

Machine Learning is a category of algorithms that allows software applications to accurately predict outcomes without being programmed. The basic premise of machine learning is to build algorithms which have the capacity to receive input data and can use statistical analysis to predict an output.

After training, I got a result, and then I used the result to do the prediction of a variety of movements.



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227500 0.012400 0.001040 0.079513 0.907047
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297500 0.015304 0.001892 0.108698 0.874106
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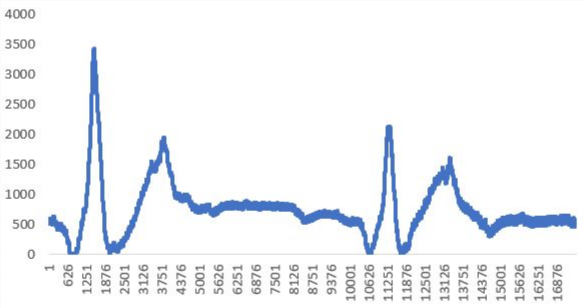
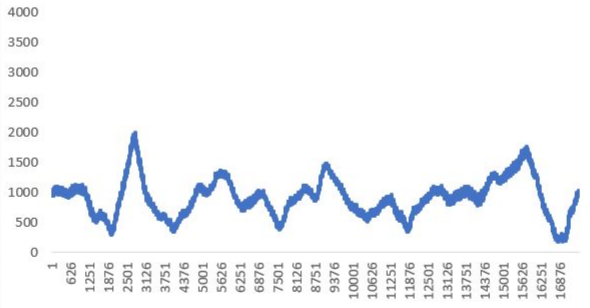
Result

Experiment 1

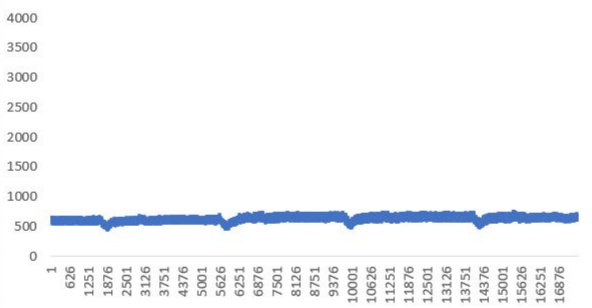
This experiment proved that our neck will create different vibration when doing different movement.



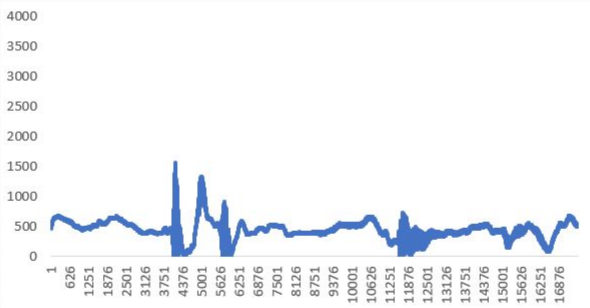
Data of consumption of water



Data of oral speech



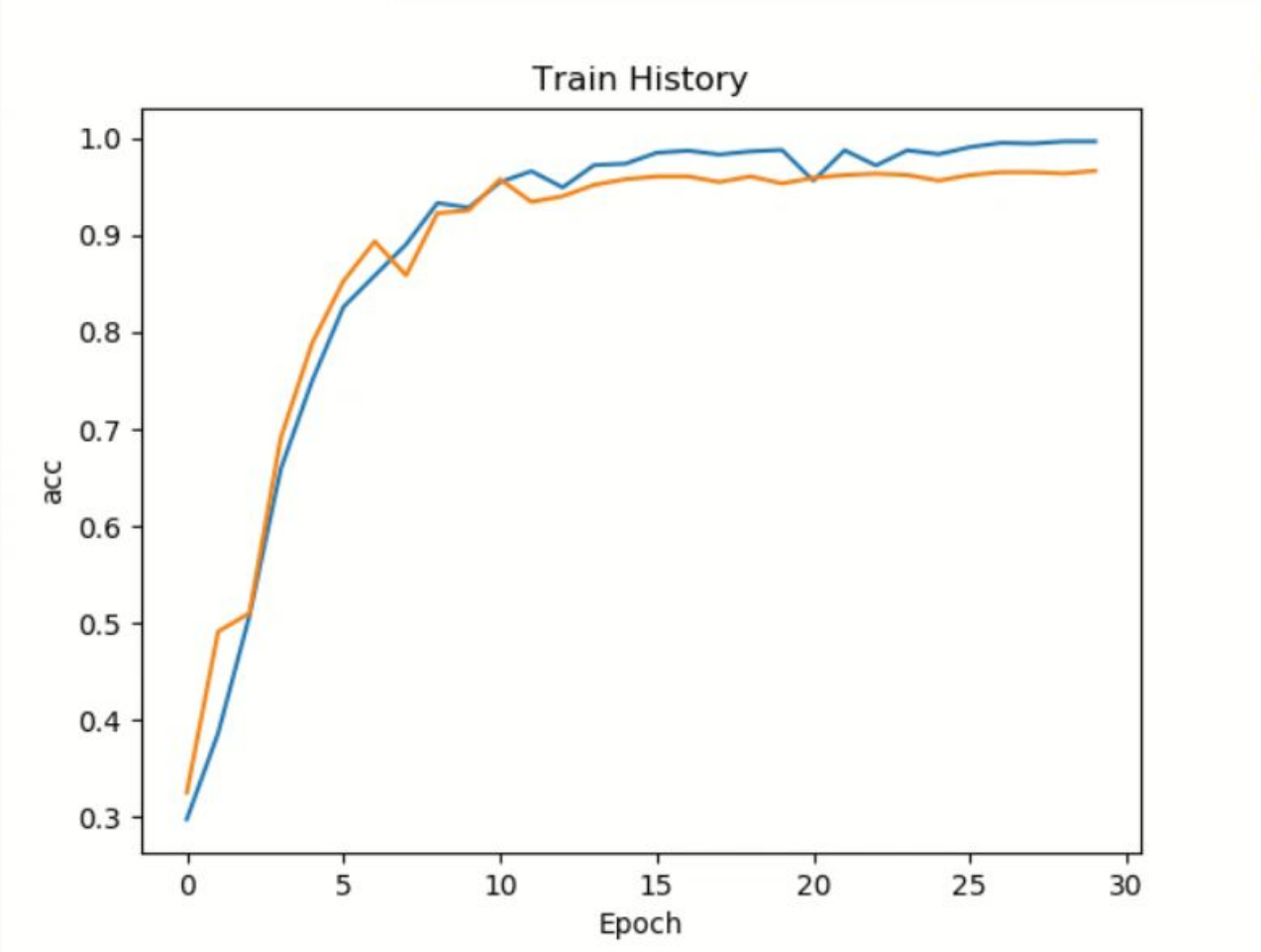
Data of heart rate



Data of coughing

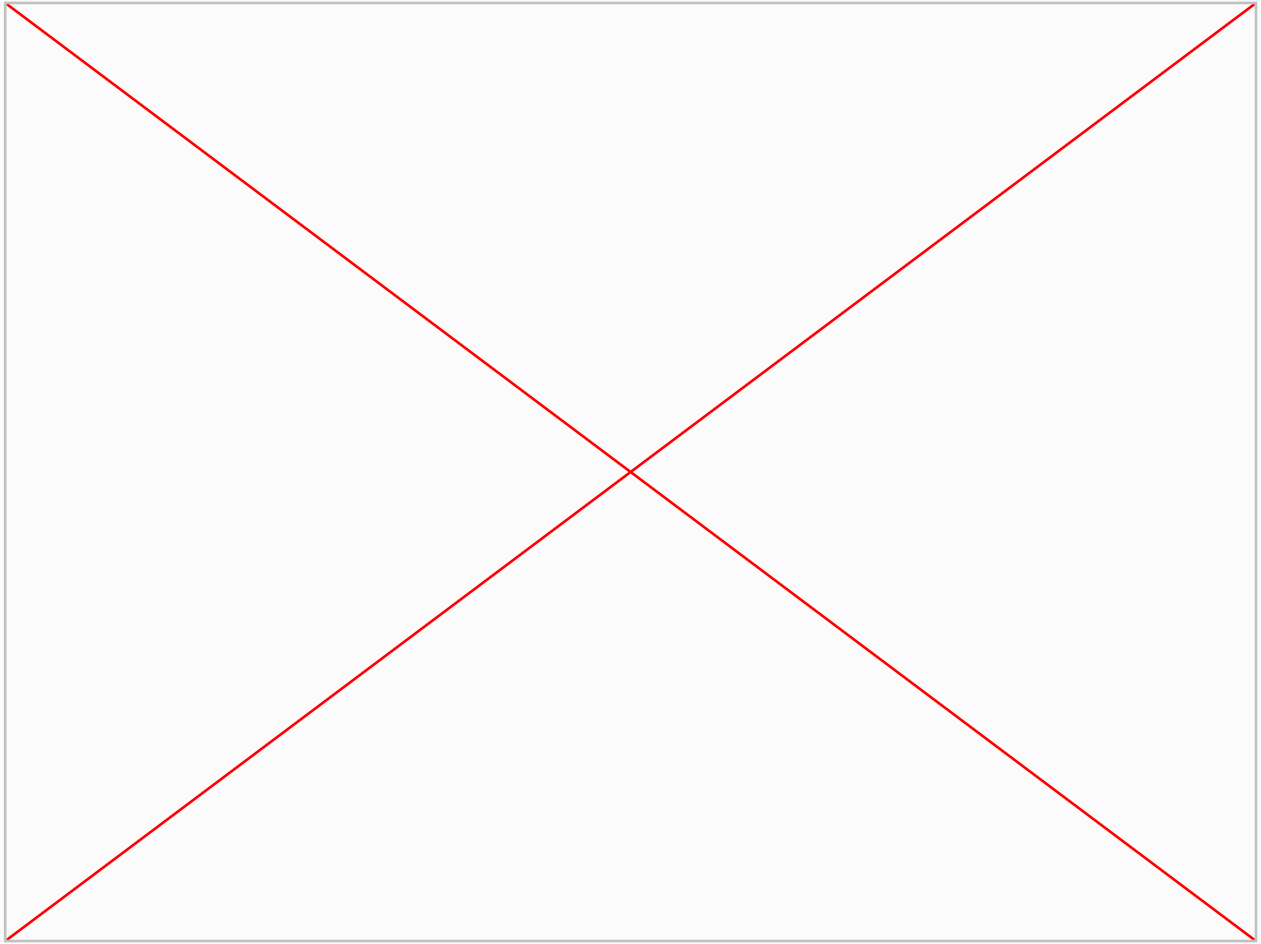
Experiment 2

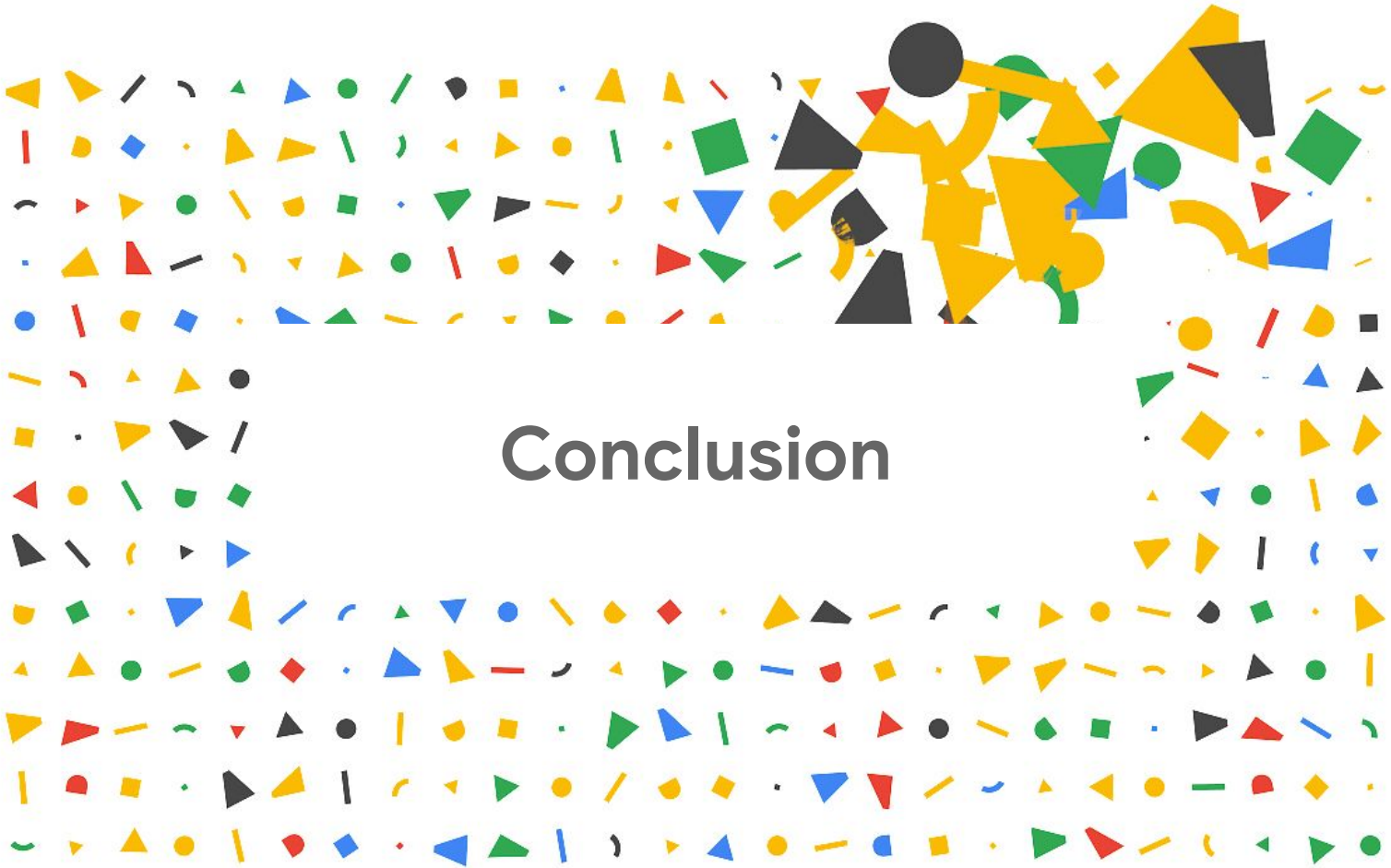
In this experiment, I have trained over 2700 pieces of data. After 30 epochs of training, I got a high accuracy rate, which is about 0.98. The graph beside shows the result.



Experiment 3

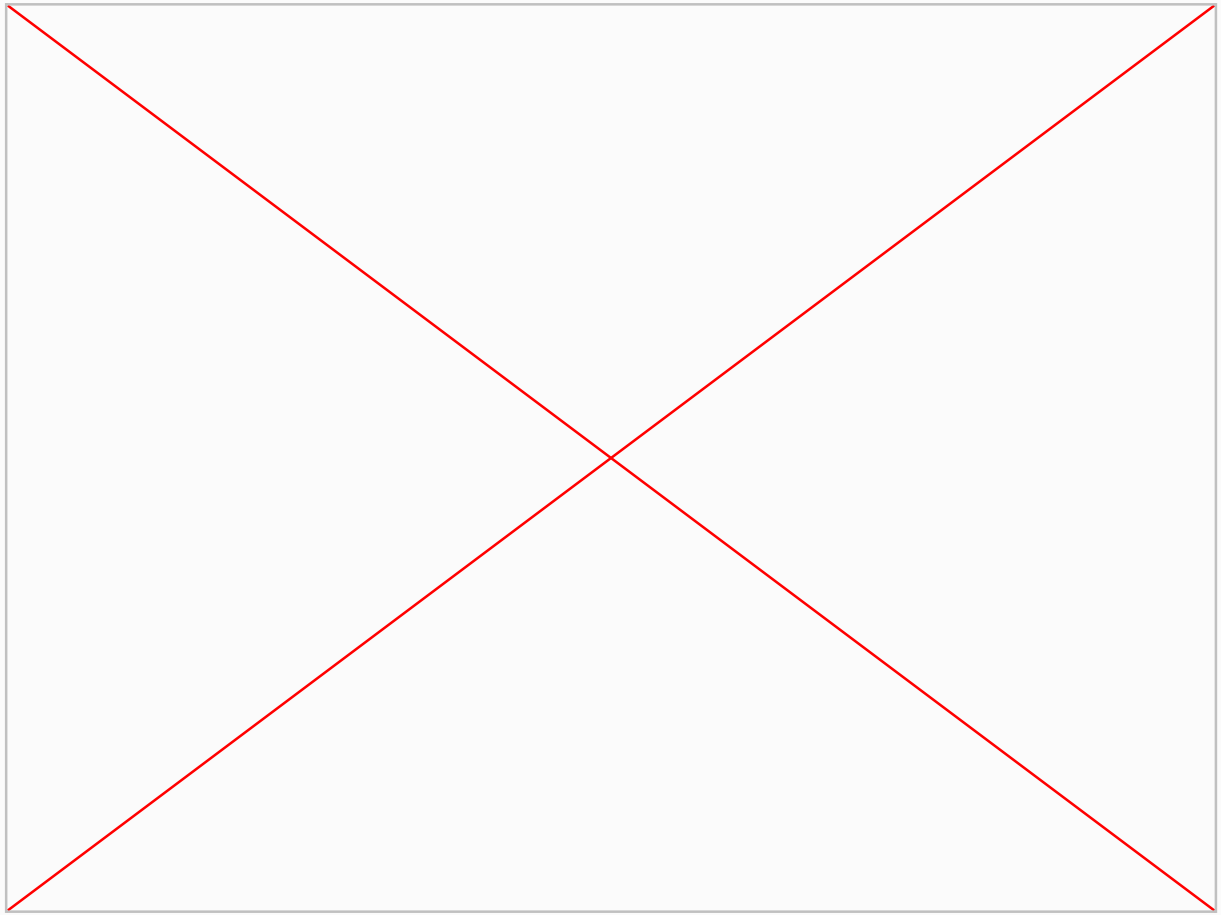
In this experiment, I did a variety of movements in 60 seconds. This video shows the result.




Conclusion

Conclusion

1. The piezoelectric sensor can distinguish different movement
2. This device can truly be used to collect data
3. After training, my device got an high accuracy rate
4. This device can truly collect a long-term data and distinguish the movement that user performs.



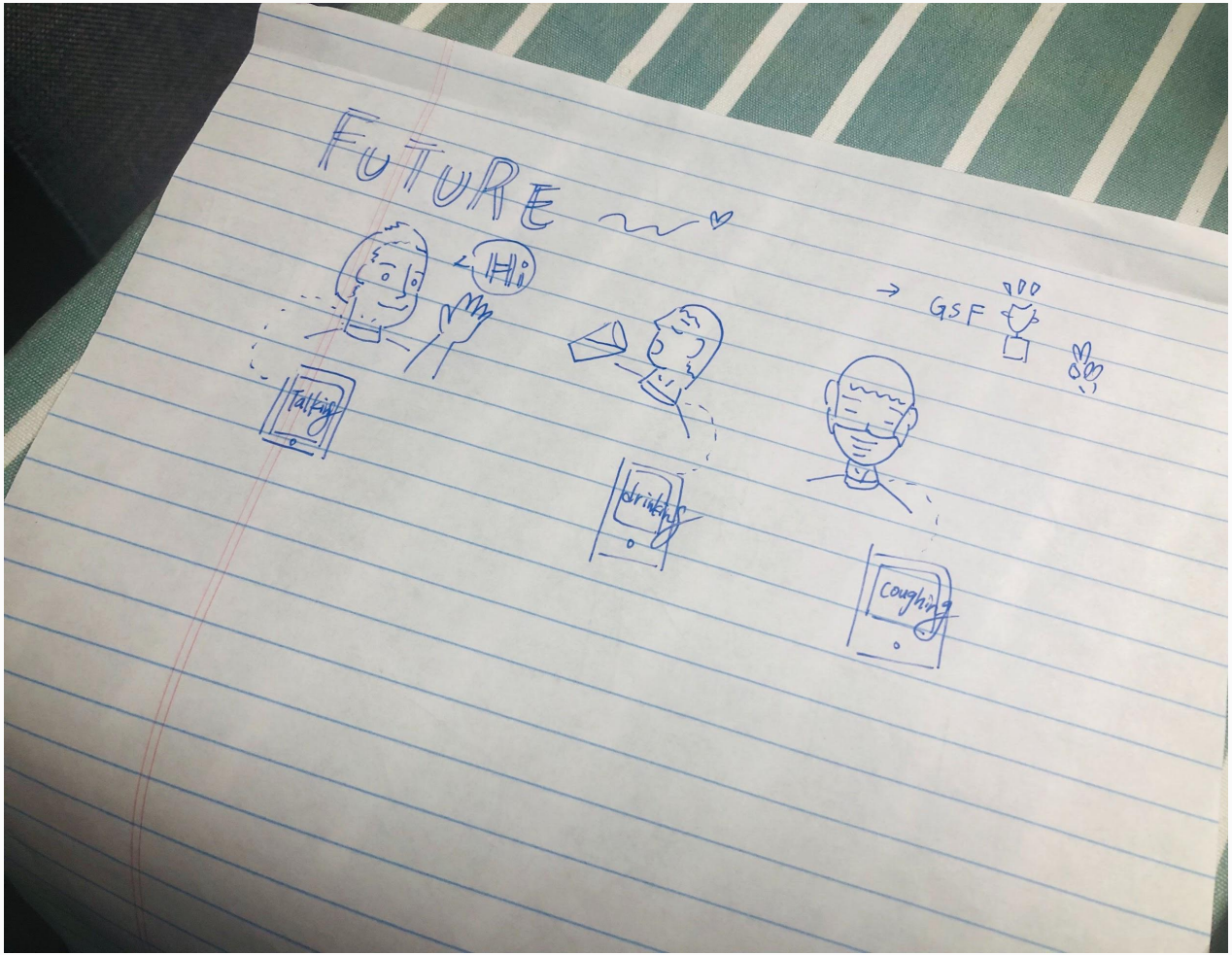

Impact

Contribution

This device is especially useful in terms of helping the elderly. We are now entering the era of an aging society and there are a more and more old people living alone. It can help caretakers know whether the elderly are drinking enough water and also sent out the warning.

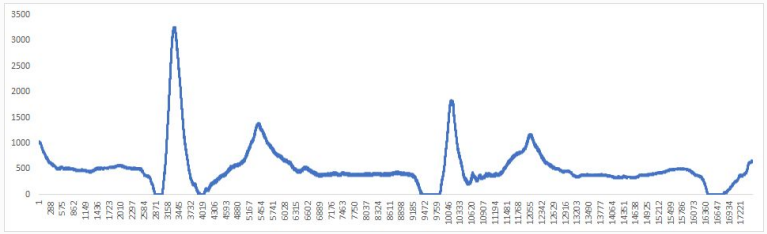
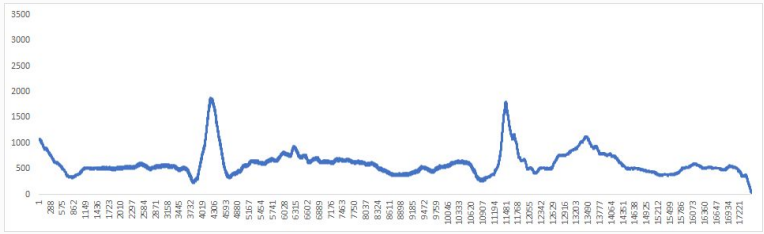
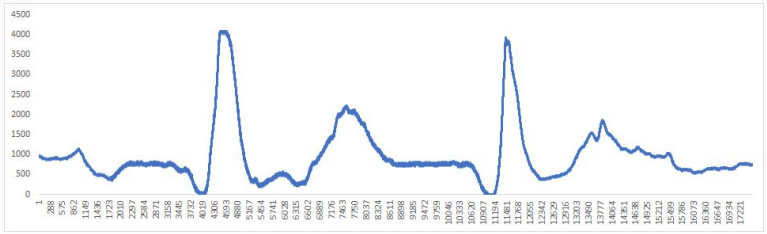
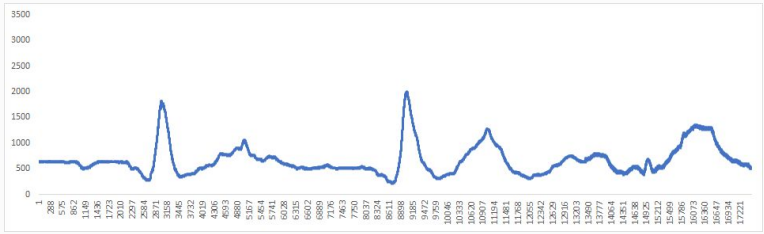
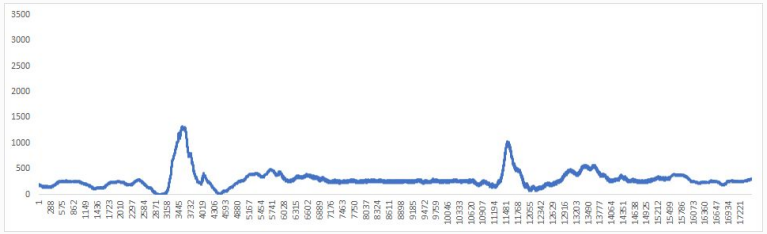
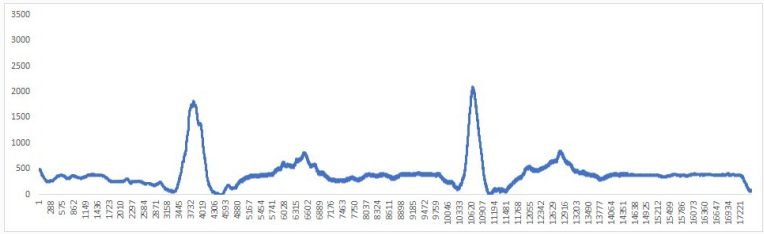
Future work

1. I want to make this device more **functional**
2. I will make this device more **compact**
3. I will investigate into **different fashion choices** and user experience in the hope to introduce a more **user-friendly wearable device**
4. In the future, I want to make this device **wireless** and connect it with a smartphone, so the user can check the data in real time

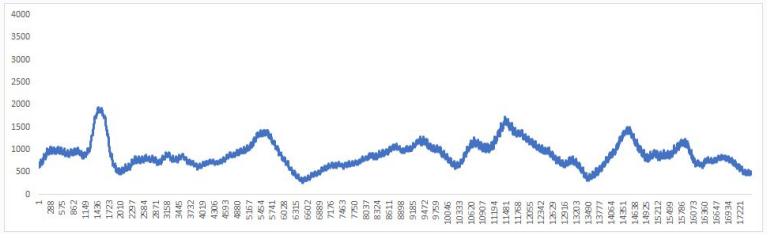
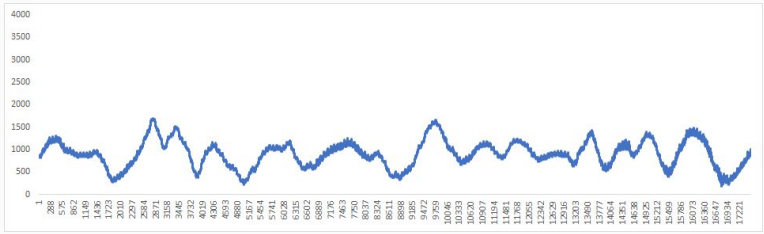
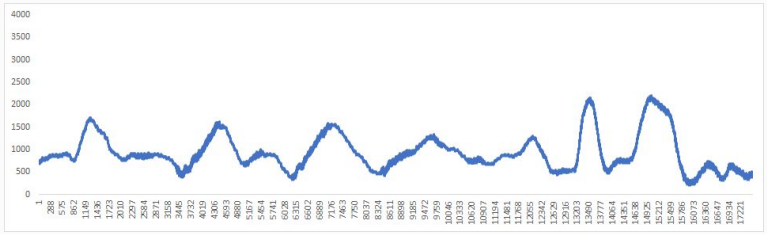
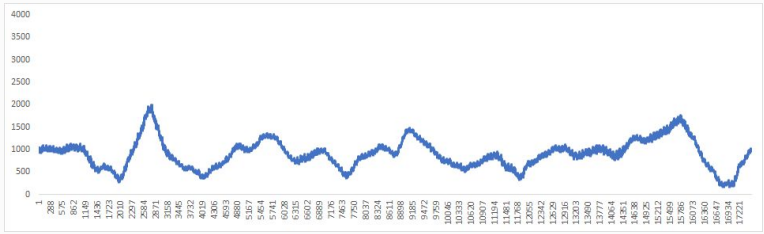
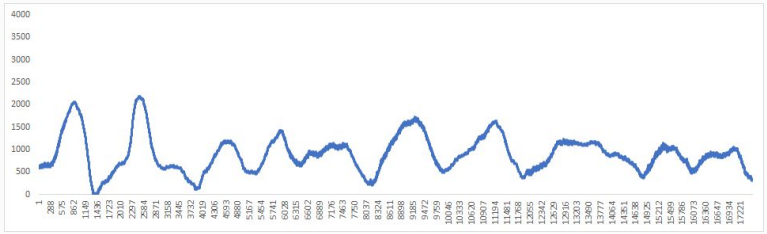
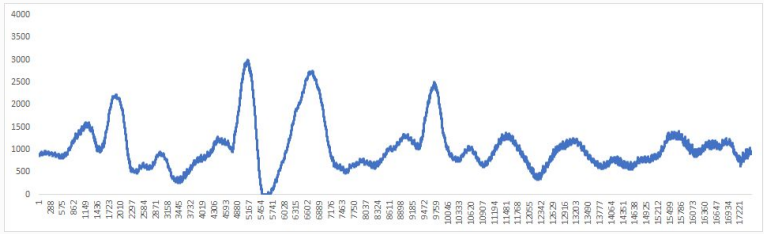


It’s Q&A time!

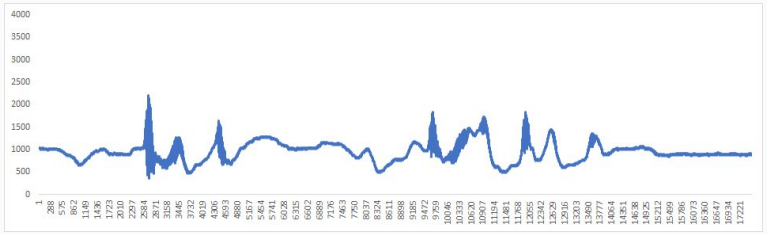
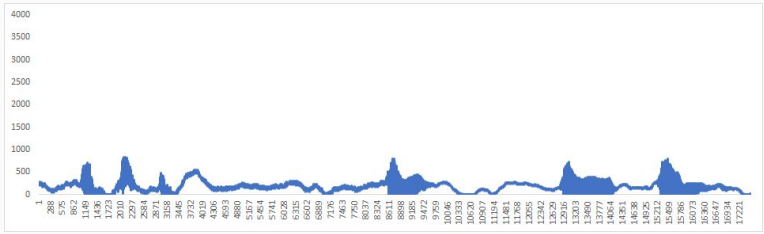
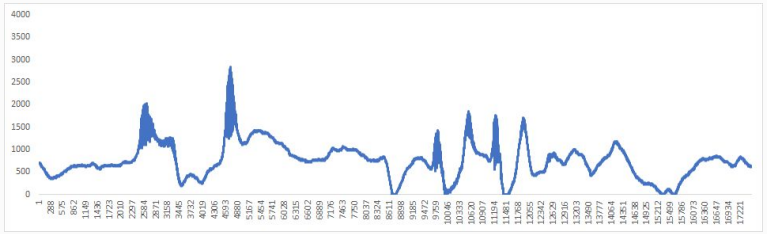
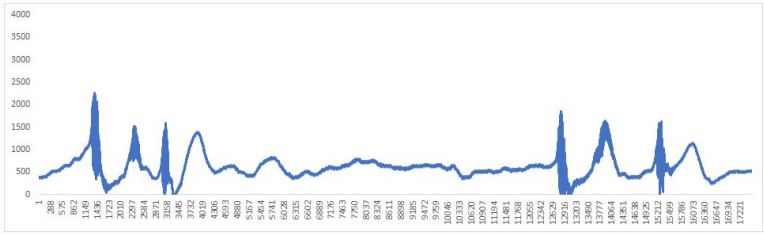
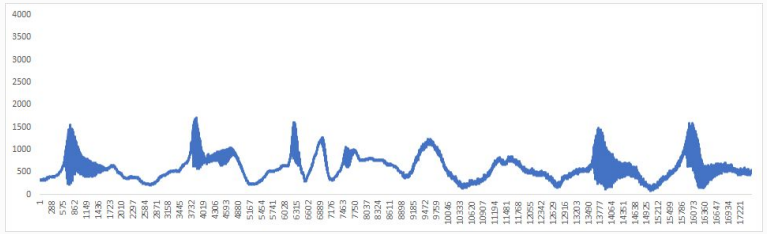
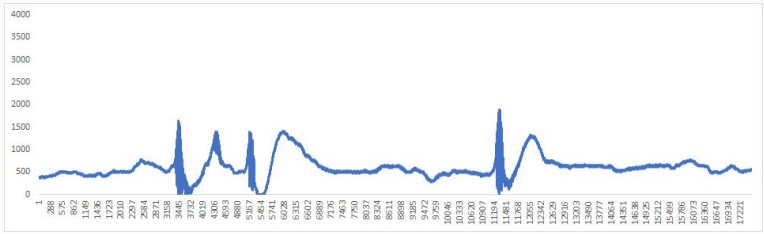
Experiment 1: data of consumption of water

Experiment 1: data of consumption of oral speech

Experiment 1: data of coughing

Experiment 1: data of heart rate