平石研究室

簡易脳波センサーを利用したデータマイニングによる状態分類に関する研究

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1. Introduction

Studying brain waves helps making humans life much easier and convenient. By using simple brain-wave sensor, the research about analysis[1)] of concentration level in basketball free throw and darts game has been done in our laboratory and the example of robot control[2)] using simple brain-wave sensor has been reported. The brain-wave data was classified into only two classes (concentration and relaxation), and users can move the robot only when they concentrate. In this research, I challenged to classify more classes. I tested 5 classes and I wanted to see if using more classes will give you more options to do in the results.

2. Approach and methods

In this lab we are using simple brain wave sensor that used in simple games to analyze the data and make new function or made a new use of brain waves. A simple brain wave sensor, which is used for some games has been introduced and it measures brain waves using one or two electrodes.

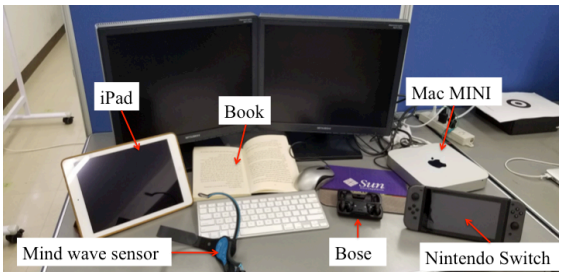

Fig.1 Experiment Tools

As shown in fig.1 these are the hardware used for this experiment (Mac Mini, Nintendo switch, Novel, Bose headphone, a screen for watching Netflix (phone or iPad), Neurosky mind wave sensor). In this experiment we have 5 states divided into 2 main stats:

A. Concentration which has (playing the switch and reading the book).
B. Relaxation which has (listening to classic or jazz music and watching chilling movies)

The last state is facing the wall and not thinking of anything so it's in between concentration and relaxation.

3. Experiment

Before we dive in to explain the experiment we must explain how we took the data and what exactly are the 5 states and I did the testament with my own brain wave.

1. gaming seat
   We adopted the Nintendo switch and played legend of Zelda because it's an intense game so the concentration gets high.
2. reading books seat
   In this seat we have to choose a simple novel so that the experimenter doesn't put so much effort on reading so we have to provide a suitable language.
3. doing nothing state
   In this state the experimenter should face a white wall or board and not doing anything as much as he can according to the time giving by the experiment .
4. Listening to music
   In this seat the experimenter should listen to music to be relaxed and we advise classical or jazz music to provide any distortion.
5. watching chilling movies
   In this seat the experimenter should watch a relaxed movie like movies about nature etc., we advise using Netflix because it has so many genre and to provide any distortion as well.

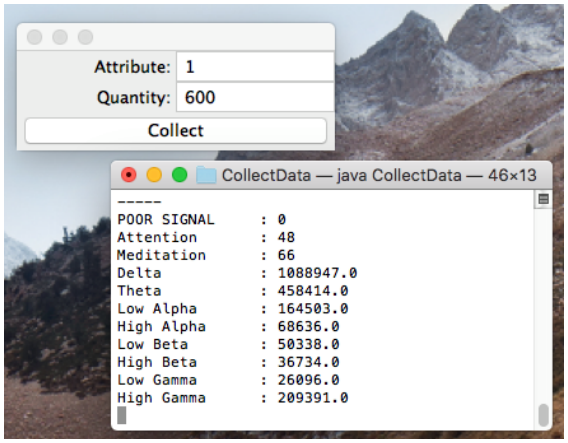

Fig. 2 (software window)

At the beginning we should make sure the mindset is connected properly with working PC as shown in fig. 2 and then we will be ready to collect the data. Collecting data is done by using java command line program and we set the time we need for each seat currently we set the time for 10 minute for each seat plus 1 minute for each so the total is 11 minutes. The 10 minutes is used for data train by SVM meanwhile the 1 minutes data for predict by SVM as well.

SVM[2] (Support Vector Machine) is a pattern recognition technique based on super vised learning. It has heightened generalization capability, and a "kernel trick "allows it to apply in cases where liner classification is impossible.

After collecting all the data, we need, it's time for using the SVM to train the data, merging the seats and check the accuracy.

We have two type of kernel the 0 (linear) and 1 (polynomial) and the difference between them that linear requires less time in training meanwhile the polynomial kernel looks not only at the given features of input samples to determine their similarity, but also combinations of these. Sometimes they get the same accuracy depends on the data sets.

4. Result

First were going to start with the result in merging 2 data (double merge) in Table 1. Then we will show the result of merging 3 data (triple merging) in Table 2. And then we do the 4 times merge in Table 3, And finally 5 times merge is shown in Table 4.

After seeing the results, we notice that double merge has the highest accuracy and the more set we add to the margining the less the accuracy it becomes. If we look at double merging, we will see that gaming with watching movies (1-5) has the higher rate in the gaming set (1). Meanwhile the (reading book) group (2) has also a high rate, in general its better than gaming set.

On the other hand, the highest rate in the experiment is "doing nothing set (3)" specially when it merges with music (3-4) and movies (3-5).

"Doing nothing (3)" when it combined with almost any activity has the highest rate and from that we see that the best useable data is 1-5, 2-3, 3-4, 3-5.

5. Conclusions

I have learned how hard it is to use the brain wave data to analyze it and make it to good use and I have learned that SVM is the best pattern to use to train the data and predict the accuracy.

Table 1 Results of double merge

Sets	kernel 0	kernel 1
1-2	35.8%	39.1%
1-3	39.16%	42.5%
1-4	42.5%	65.0%
1-5	55.8%	67.5%
2-3	76.6%	25.8%
2-4	54.16%	48.3%
2-5	48.3%	44.16%
3-4	74.16%	74.16%
3-5	86.6%	64.16%
4-5	37.5%	49.16%
Average	55.06%	51.98%

Table 2 Results of triple merge

Sets	kernel 0	kernel 1
1-2-3	36.1%	21.1%
1-2-4	25.0%	31.6%
1-2-5	27.7%	39.4%
1-3-4	40.0%	48.8%
1-3-5	48.3%	46.1%
1-4-5	23.8%	44.4%
2-3-4	53.3%	35.5%
2-3-5	52.7%	35.0%
2-4-5	31.6%	34.4%
3-4-5	44.4%	47.2%
Average	38.29%	38.35%

Table 3 Results of 4 times merge

Sets	kernel 0	kernel 1
1-2-3-4	29.58%	18.75%
1-3-4-5	33.33%	35.83%
2-3-4-5	38.75%	29.16%
Average	33.89%	27.91%

Table 4 Results of 5 times merge

Sets	kernel 0	kernel 1
1-2-3-4-5	28.3%	27.6%

6. References

1) Hironori Hiraishi, "Qualitative Analysis of Concentration Level in Throwing Using Simple Brain-Wave Sensor", International Journal of Cognitive Informatics and Natural Intelligence, Vol.11, No.3, pp.17-30, 2017.9
2) Hironori Hiraishi, "Designing a robot controller by using a simple brain-wave sensor and a machine learning technique", Artificial Life and Robotic, Vol.20, No.3, pp.217-221, 2015.10.