Cervical amplitudes recording with a virtual reality device

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***Abstract*—For our last year at the ENSEEIHT school we leaded a 7 weeks project with the Toulouse Institute of Osteopathy, to develop an application using a Virtual Reality headset. The main goal of this project is to create an application that records the cervical movement of a patient and detects if this patient has cervical disorder or not. In order to do so, we used a framework**

***Index Terms*—Osteopathy; Cervical recording; Oculus Rift; Signal Processing**

I. Introduction

During this projet long, we had to extend one of last year's project, which tried to record cervical movements thanks to an Oculus Rift headset. This project had been motivated by the Toulouse Institute of Osteopathy (ITO), represented by our client Denis Ducommun. The goal was to detect cervical illness by recording the movements dictated to the patient by the osteopath. Denis wanted us to improve the application developed, by placing an animated target inside the headset view. Then, some data analysis could detect whether a patient is ill or healthy. Keen on science and engineering, Denis expressed very well his requirements, and he has been encouraging us since the beginning of the project.

II. Application overview

The application that we developed works as follow : after a client put on the headset, the osteopath can begin the recording through the application. He can specify all the recording parameters, such as the speed and the number of "come and go" of the animated target. Once the recording has begun, the patient must follow the target by moving his head. A message pops in the headset view when the recording is done, and the curves of the recording are plotted in a tab of the application.

Then, the osteopath can import different models, all based on the previously acquired data. He can also select some acquired data to create new models. Thus, the osteopath can compare his patient's recording with the models, which try to detect if the patient has some cervical disease or not.

We chose to develop the headset view with the Unity framework, which is used a lot for 3D design and which matches great the Oculus technology. The graphical interface has been developed in Python, partly because we used the same language for the modelling part.

Special thanks to the ITO for their welcome

III. Data Analysis

Our goal was to develop algorithms that could detect if a patient was ill or healthy, as we can see on the figure 1. To analyse the records received from the Oculus Rift, we decided to use two different approaches. In deed, on one hand we could consider the records as periodic signals, and analyse the frequency and temporal aspects of them. Then, we could differentiate the healthy people from the ill people by comparing the frequency spectrum or the temporal profiles of the records with other data. On the other hand, we could consider the records as a data set, and use it to build a panel. This panel could be used afterwards to classify new records, and then distinguish healthy patients from ill ones.

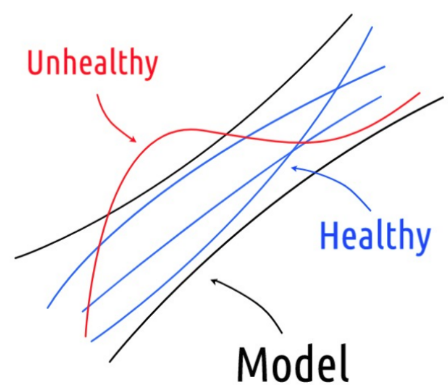

Figure 1. A model detects if a patient's unhealthy or not

Firstly, to analyse the frequency spectrum of a record, we used most common functions used is this domain, such as Fast Fourier Transform (Fft), auto-correlation analysis or even Wavelet transform. Wavelet analysis has the advantage of keeping the link between the temporal profile and the frequency spectrum. We found that it was more relevant to use wavelets in order to detect discriminant factor in unhealthy people's records. By comparing temporal profiles, we also found that most of unhealthy patient's records presented some phase shift between each axes of rotation of the headset. That is why we decided to work in priority on temporal profiles.

Secondly, in order to classify new data, we decided to build a geometry based analysis, by using concave hulls. These mathematical objects allowed us to build a mean hull of the data base profiles. Then, when a new movement is acquired, it is compared with the mean hull. If the new acquisition is way outside the hull (we fixed a threshold), we consider the patient as unhealthy. Two different models came out of this idea, one by using discrete concave hulls, and the other by combining concave hulls with B-splines approximation in order to detect each come and go of the headset.

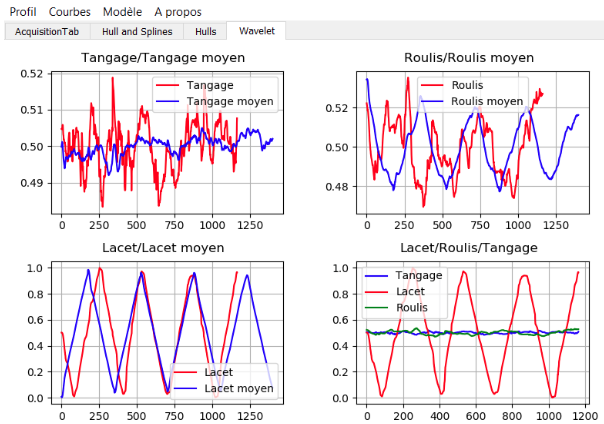

Figure 2. Temporal profile of a healthy patient

IV. Integration & Results

To integrate the modelling part to the application, we decided to create one tab for each model. Then, the osteopath could change from a tab to another. This provides him more information on the patient recording to decide if the models did take the good decision (it would be a shame one unique model missed an unhealthy patient !). We can see the temporal model tab in the figure 2.

V. Conclusion

To conclude, we can say that our models has to be improved. In deed, our data set is not satisfying at all, and need to be increased in order to empowered our model. Furthermore, we validated most of our clients requirements and we were able to develop an efficient application which allows the ITO to take measures of cervical movements. This application is very promising and need to be completed to fulfil our client's needs. This project was very interesting because we never had the opportunity to work with a medical institute. This aspect should not be neglected because of its exigency. It forced us to be precise and rigorous in every one of our analysis.

References

[1] https://github.com/guillaumehottin/CervicalKineRecorder/tree/master/Report