Emotiv Epoc+ live metrics quality validation

Neuro-usability, Winter semester 16/17

TU Berlin, Quality and Usability

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Summary

In this study, we test the quality of the live performance metrics data provided by the Emotiv Epoc+ EEG system. The Emotiv headset comes with a convenient Emotiv Control Panel software that processes the signals recorded by the Emotiv Epoc headset in real time. The quality of the live metrics has not yet been studied by third parties, hence we create an application to record the Emotiv live metrics and corresponding data using Affective Slider. We show test participants images for which we ask them to rate their pleasure and arousal level while recording their EEG with the Emotiv headset. Finally we compare the data from the Affective Slider and Emotiv headset to find out if they correlate.

We use Processing coupled with the Emotiv Xavier SDK to create the interface of our test as well as capturing the data for the analysis. The analysis will be done in the second phase of the project after running the tests.

Motivation

Research of Brain-Computer Interfaces have traditionally been done in lab environment due to the expensive and inconvenient equipment needed. Low cost alternatives to the laboratory level equipment have come to the market that enable the use of EEG in out-of-the-lab applications. [1] Emotiv Epoc+ is one of these low cost EEG sensors that are easy to use and provide EEG data analysis out of the box. This real time analysis of the EEG signal allows detection of for example valence and engagement. Due to the easy tracking of the user's emotion the out of the box emotion tracking provides great opportunities for application developers and studies.

The quality of the raw data provided by the Emotiv Epoc+ has been studied in several studies [1] [2] [3]. However, the quality of the real time analysis provided by the Emotiv Xavier SDK has not been validated yet. As the convenient sensor provides a lot of opportunities for applications, it would be beneficial to know how well the real time analysis corresponds to what the user is feeling. Therefore it would be beneficial to study the quality of the real time emotion tracking provided by the Emotiv Xavier SDK.

Related literature

The raw data provided by the Emotiv has been studied and compared with laboratory level devices [1] [2] [3]. Duvinage et. at (2013) conclude that the Emotiv headset does not perform as well as a medical device and that the relative operational and maintenance costs are higher than those of the medical-grade competitors [1]. Badcock et. al (2013) state that Emotiv may prove a valid alternative to medical grade systems when recording late auditory ERPs. They also state that the system may also be useful in the future for measuring less reliable ERPs, if their detection can be made as reliable as of the auditory ERPs. [2] Stytsenko et. al (2011) suggest that the data between the Emotiv headset and a G-TEC

device are alike in general, but a G-TEC device has a cleaner and stronger signal. In addition, they evidenced a drift in the recording speed of the headset. [3]

To summarize, there is a clear difference between the quality of the raw data provided by the Emotiv Epoc+ headset and laboratory level EEG measurement tools. Still, the headset has been used in several studies, but not in for example medical context, in which data quality is highly important [8].

Solution

In order to find out how accurate the performance metrics provided by Emotiv Xavier SDK are, we compare the data with subjective survey results collected from test participants using the Affective Slider. By comparing the live data provided by Emotiv with the data from the Affective Slider, we are able to determine how well they correlate with each other and thus how accurate the data provided by the Emotiv sensor is.

We create an interface that shows the test participants images from the International Affective Picture System [6]. For each image, we ask the participant to rate their pleasure and arousal level with the use of the Affective Slider [4]. The pleasure level and arousal levels captured by the Affective Slider should correspond to valence level and excitement captured by the Emotiv headset. To be more precise, the excitement level should correspond to the arousal level, since Emotiv states that: "*In general, the greater the increase in physiological arousal the greater the output score for the detection [instantaneous excitement]*" [5].

We hypothesize that the valence and excitement levels captured by the Emotiv headset correlate with the pleasure and arousal level provided by the affective Slider. To check the validity of our hypothesis, we compare the headset signal data with the subjective data using statistical tools.

Methods

We use the Java version of the Emotiv Xavier SDK and Processing to create the application that shows users images from the International Affective Picture System and queries the users about their feelings for each picture with the Affective Slider, and finally saves the data from the Emotiv headset and Affective Slider for later analysis.

Each user is shown 20 pictures to get enough data points, but to keep the test short enough. The user gets to change the image themselves after they have set their answer in the affective slider. We aim for 10 test participants. For each image we take the peak and average values for valence and excitement that the Emotiv headset measures. We then compare these number with the scores of the Affective Slider using Spearman's Rank-Order Correlation.

References

[1] Duvinage M, Castermans T, Petieau M, Hoellinger T, Cheron G and Dutoit T (2003) "*Performance of the Emotiv Epoc headset for P300-based applications*". BioMedical Engineering OnLine 2013 12:56
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[2] Badcock NA, Mousikou P, Mahajan Y, de Lissa P, Thie J and McArthur G (2013) "V*alidation of the Emotiv EPOC® EEG gaming system for measuring research quality auditory ERPs*". PeerJ 1:e38 https://doi.org/10.7717/peerj.38

[3] Stytsenko K, Evaldas J and Cosima P (2011) "*Evaluation of consumer EEG device Emotiv EPOC*" MEi: CogSci Conference 2011, Ljubljana. 2011.

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[5] Knowledge Base. (2016). *Understanding the Performance Metrics Detection Suite*. [online] Available at: https://emotiv.zendesk.com/hc/en-us/articles/201444095-Understanding-the-Performance-Metrics-Detection-Suite [Accessed 6 Dec. 2016].

[6] Csea.phhp.ufl.edu. (2016). *The Center for the Study of Emotion and Attention*. [online] Available at: http://csea.phhp.ufl.edu/media/iapsmessage.html [Accessed 6 Dec. 2016].

[8] Emotiv. (2016). *Independent Studies Archives - Emotiv*. [online] Available at: https://www.emotiv.com/category/independent-studies/ [Accessed 6 Dec. 2016].

Work packets

We decided to set responsible persons for each key tasks, even though each task will be carried out with the whole group.

TASK	**RESPONSIBLE**
Prototyping	
Interface of the experiment	Mikko
Sensor integration	Stephane
User testing	
Pilot test	Yuan
Recruiting	Stephane
Running tests	Mikko

Mid-term presentation	All
Data-analysis	
Writing results and conclusions	Yuan
Project ending	
Preparing presentation (dl: 8.2.2017)	All
Writing report (dl: 18.2.2017)	All

Time schedule

	1st week	2nd week	3rd week	4th week	5th week
Nov.2016					Project Plan Changing
			16th, Nov Expose	EEG&Other sensors testing	
Dec.2016	Project Plan Changing			Christmas Break	
	Prototype Implementation		14th, Dec Mid-term		
Jan.2017	Recruiting			Result Analysis	
	Pilot test	User Test			
Feb.2017		8th, Feb Final presentatio	18th, Feb Final Report		
	Conclusion&Prepare Presentation		Report Writing		