Using Recurrent Neural Networks on the WAY-EEG-GAL dataset

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Abstract

The *WAY-EEG-GAL* dataset is designed to allow testing of techniques to decode sensation, intention and action from scalp EEG recordings in humans who perform a grasp-and-lift task. In this paper we present our methodology to analyze the data and how we tackled the problem of classifying various stages of these tasks by using a RNN on EEG and EMG data. In particular we present particular findings in the EEG data and successes as well as pitfalls concerning the RNN runs.

1 The dataset

In order to allow for critical evaluations of the utility of EEG signals for prosthetic control of object manipulation, the *Wearable interfaces for hAnd function recoverY - EEG - Grisp And Lift (WAY-EEG-GAL)* dataset was created. In particular, it can be used to inter alia examine at what degree it is possible to identify the intention to reach and grasp, hand positions and velocities or that the object's properties have unexpectedly changed. The data was collected during the course of a series of experiments in which twelve right-handed individuals, both male and female, were selected as participants. Each participant was seated at a desk with his hand resting on the table. An LED signaled the person to reach for a small object, grasp it using his index finger and thumb, lift it up a few centimetres, hold it for a brief moment and finally return the object as well as his hand to their intial positions. In this paper, we will from now on refer to this sequence of events and actions as a *trial*.

Each participant then conducted 328 such trials under slight but to the participant unpredictably changing circumstances. That is, the object's weight to be lifted was augmented through an electromagnet, resulting in weights of 165, 330 or 660g. Furthermore, the contact surface changed to be made of sandpaper, suede or silk. Depending on the specific trial, either only the surface, only the object's weight, both or none changed. In order to record kinematics, forces, muscle activations and brain activity, four types of sensors were used during the experiments. In particular, an electroencephalography (EEG) cap, illustrated in figure 1, with 32 electrodes was used to record the brain activity during the trials, sampling at $500Hz$. Furthermore, five electromyography (EMG) sensors, as depicted in figure 2, were placed on the participant's right arm to measure muscle activity at a sample rate of $4kHz$.

The resulting dataset, in the form that we used it, then provides the measurements for each participant and each trial. In this, the EEG and EMG signals are concatenated in matrices respectively with a time stamp decoding the exact record time for each measurement. Moreover, the time of the LED being turned on and off, the trial's start and end time, the type of surface and the object's weight are provided for each trial, as well. [1]
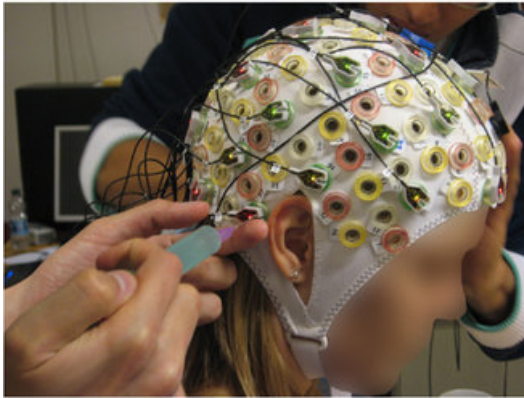
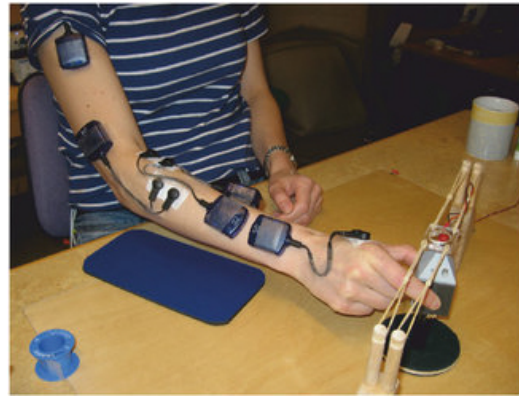Figure 1: An EEG cap measures the participant's brain activity [1]

Figure 2: EMG sensors record the muscle activity of the right arm [1]

References

[1] Luciw, M. D., Jarocka, E., EdinLandsberger, B. B. (2014) Multi-channel EEG recordings during 3,936 grasp and lift trials with varying weight and friction. Retrieved July 20, 2016, from http://www.nature.com/articles/sdata201447.