BRAIN-COMPUTER INTERFACE FOR THOUGHT CONTROLLED MOBILITY

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INTRODUCTION: Brain-Computer Interfaces (BCI) is a developing area of technology which aims to provide a method of controlling external devices using human thoughts. Such technology has many potential uses across a wide range of industries. A possible application in the health sector is aiding the rehabilitation of patients with various neuro-muscular disabilities. Our BCI system uses an Emotiv EPOC headset to acquire EEG data through 14 electrode channels. Data is acquired in 2-second epochs with a 1-second overlap. The sampling rate of the headset is 128 Hz, giving 256 samples for each channel per epoch. Our final solution employs a band-pass filter to remove parts of the signal spectrum not used in the feature extraction process. The filter was designed with a pass-band from 8 to 40 Hz.

METHODS: Our proposed method uses band-powers as signal features for classification. A windowed Fast Fourier Transform (FFT) algorithm is applied, and the result is used to calculate the power spectral density (PSD) of the epoch. Our proposed solution uses 5 frequency bands commonly seen in neuroscience literature, the delta (2-4 Hz), theta (4-8 Hz), alpha (8-13 Hz), beta (13-25 Hz), and gamma (25+ Hz) bands. With 14 EEG channels and 5 frequency bands, a total of 70 band-powers are calculated per epoch. To improve the signal to noise ratio, statistical tests were performed with the aim of finding optimal sets of features for discriminating between each possible pair of thought-commands. A feed-forward neural network classifier was developed to classify the extracted feature vectors. A separate classifier is included for pairs of thought-commands, where each decides on an associated thought-command that best matches the input signal. The classifiers vote on the result and the most common result is chosen as the final classification. Figure 1 below shows a block diagram of our system.

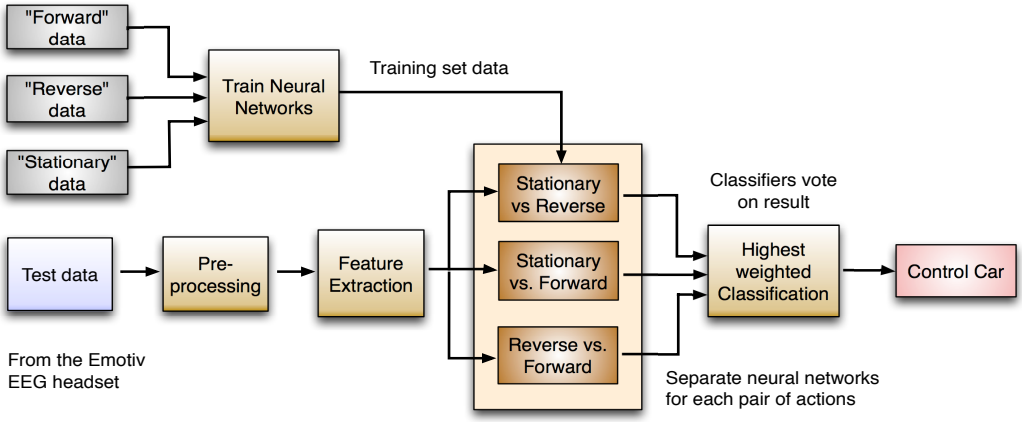

Figure 1: Proposed Brain-Computer Interface.

RESULTS: The final classification result is used to control a remote controlled vehicle; currently, there are three actions possible: forward, reverse and stop. The final system was tested on two subjects. It operates in real-time and can correctly classify three separate action pairs with up to 94% accuracy for subject 1, and 87.5% accuracy for subject 2.

DISCUSSION & CONCLUSIONS: Our system was a good starting point for research in classification of thoughts at University of Canterbury, with results comparable with other BCIs in the literature [1].

REFERENCES:

[1] K. LaFleur, et al. (2013) "Quadcopter control in 3D space using a noninvasive motor imagery-based brain-computer interface", Journal of Neural Engineering.