form of feedback to the patient is visual feedback provided through a screen, which may be insufficient.

Clinical trials involving brain-computer interface (BCI) based robotic rehabilitation are currently ongoing and some advantages over standard robotic rehabilitation include robotic assistance to the patient only if motor intent is detected and detection of motor intent being calibrated to patient-specific motor imagery electroencephalogram (EEG).

Embodiments of the present invention seek to improve on current brain-computer interface systems.

**SUMMARY**

According to a first aspect of the present invention, there is provided a method for brain-computer interface (BCI) based interaction, the method comprising the steps of: acquiring a person's EEG signal; processing the EEG signal to determine a motor imagery of the person; detecting a movement of the person using a detection device; and providing feedback to the person based on the motor imagery, the movement, or both; wherein providing the feedback comprises activating a stimulation element of the detection device for providing a stimulus to the person. The processing of the EEG signal comprises using a trained classification algorithm. The training the classification algorithm comprises dividing the EEG signal into a plurality of time segments; for each time segment, dividing a corresponding EEG signal portion into a plurality of frequency bands; for each frequency band, computing a spatial filtering projection matrix based on a CSP algorithm and a corresponding feature, and computing mutual information of each corresponding feature with respect to one or more motor imagery classes; for each segment, summing the mutual information of all the corresponding with respect to the respective classes; and selecting the corresponding features of the segment with a maximum sum of mutual information for one class for training classifiers of the classification algorithm.

The method may comprise processing the EEG signal to determine whether a specific motor imagery is performed by the person and activating the stimulation element if the specific motor imagery is performed.

The feedback may further comprise a separate visual feedback to the person if the specific motor imagery is performed.

The method may comprise determining whether a specific movement is performed by the person and activating the stimulation element if the specific movement is performed.

The feedback may further comprise a separate visual feedback to the person if the specific movement is performed.

The determining whether the specific movement is performed by the person may occur over a period of time.

The processing of the EEG signal may comprise using a trained classification algorithm.

The t~~T~~raining the classification algorithm ~~may~~ comprises: dividing the EEG signal into a plurality of time segments; for each time segment, dividing a corresponding EEG signal portion into a plurality of frequency bands, for each frequency band; computing a spatial filtering projection matrix based on a CSP algorithm and a corresponding feature, and computing mutual information of each corresponding feature with respect to one or more motor imagery classes; for each segment, summing the mutual information of all the corresponding with respect to the respective classes; and selecting the corresponding features of the segment with a maximum sum of mutual information for one class for training classifiers of the classification algorithm.

The method may further comprise training classifiers of the classification algorithm using the selected corresponding features.

Training the classifiers may comprise non-linear regression using the selected corresponding features and non-linear post-processing regression using an output from the non linear regression.

Computing the spatial filtering projection matrix based on the CSP algorithm may comprise using a multi-modal multi-time segment for each frequency band.

The multi-modal multi-time segment for each frequency band may comprise a multi-modal representation of an idle state.

According to a second aspect of the present invention, there is provided a brain-computer interface system comprising: means for acquiring a person's EEG signal; means for processing the EEG signal to determine a motor imagery of the person; means for detecting a movement of the person using a detection device; and means for providing feedback to the person based on the motor imagery, the movement, or both; wherein the means for providing the feedback comprises a stimulation element of the detection device for providing a stimulus to the person. The means for processing the EEG signal is operable to use a trained classification algorithm. The system further comprises means for training the classification algorithm. The means for training being operable to divide the EEG signal into a plurality of time segments; for each time segment, divide a corresponding EEG signal portion into a plurality of frequency bands; for each frequency band, compute a spatial filtering projection matrix based on a CSP algorithm and a corresponding feature, and compute mutual information of each corresponding feature with respect to one or more motor imagery classes; for each time segment, sum the mutual information of all the corresponding features with respect to the respective classes; and select the corresponding features of the time segment with a maximum sum of mutual information for one class for training classifiers of the classification algorithm.

The stimulation element may comprise a tactile actuator.

The system may further comprise a screen for providing visual feedback to the person based on the motor imagery, the movement, or both.

According to a third aspect of the present invention, there is provided a method of training a classification algorithm for a BCI, the method comprising the steps of: dividing a EEG signal into a plurality of time segments, for each time segment, dividing a corresponding EEG signal portion into a plurality of frequency bands; for each frequency band, computing a spatial filtering projection matrix based on a CSP algorithm and a corresponding feature, and computing mutual information of each corresponding feature with respect to one or more motor imagery classes; for each time segment, summing the mutual information of all the corresponding features with respect to the respective classes; and selecting the corresponding features of the time segment with a maximum sum of mutual information for one class for training classifiers of the classification algorithm.

Training the classifiers may comprise non-linear regression using the selected corresponding features and non-linear post-processing regression using an output from the non linear regression.

Computing the spatial filtering projection matrix based on the CSP algorithm may comprise using a multi-modal multi-time segment for each frequency band.

The multi-modal multi-time segment for each frequency band may comprise a multi-modal representation of an idle state.

## BRIEF DESCRIPTION OF THE DRAWINGS

Example embodiments of the invention will be better understood and readily apparent to one of ordinary skill in the art from the following written description, by way of example only, and in conjunction with the drawings, in which:

Figure 1 is a schematic drawing illustrating a system architecture of a non-invasive electroencephalogram (EEG) based brain-computer interface (BCI) for stroke rehabilitation, according to an example embodiment of the present invention.