Brain Machine Interface to control a wheelchair

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Project Summary: To help about 15% of the world's population, who have some form of disability and are unable to perform their activities of daily living independently or without the aid of human help. A virtual wheelchair will be modelled to mimic the dynamic behaviour of a real wheelchair. When the user focuses on a particular visual stimulus, steady-state evoked potentials(SSVEP), at the same frequency as the stimulus, are generated in the visual cortex. The associated frequency, and hence the user intent, can be determined by performing an FFT analysis of the filtered EEG signal. Experimental studies will be conducted to compare two different modes of providing this visual stimulus.

Specific problem being addressed: Brain computer interfaces (BCI) measure the electrical activity in the brain to interpret user intent, and command external devices to execute a task accordingly without the need from the human to move any muscles. BCI driving a robotic system can be very helpful in this context by enabling disabled patients to carry out their daily activities. The main objectives of this project are:

- **Development of the experimental test bed**
  The experimental test-bed comprises the EEG acquisition setup, software for real-time processing and interpretation of the EEG signals, the virtual environment simulation, and the interface between the EEG system and the virtual environment simulations.
- **SSVEP-BCI based wheelchair navigation**
  The virtual wheelchair will be modelled to mimic the dynamic behaviour of a real wheelchair. Experimental studies will be conducted to determine the efficacy of different approaches. We would also like to use this time to investigate feasibility of SSSEP based navigation using already available hardware.
- **Testing, validation, and tuning of the BCI paradigm using healthy subjects**
  The integrated system with navigation control modality will be tested using healthy subjects and stroke survivors (if possible). Subjects will be asked to navigate in typical indoor or outdoor virtual environments. Overall, effectiveness of the system will be determined based upon a user survey, as well as through measurement of cognitive workload.

Impact of this innovation: According to WHO, over a billion people, about 15% of the world's population, have some form of disability and are unable to perform their activities of daily living independently or without the aid of a human help. Furthermore, the rates of disability are increasing significantly due to ageing populations and an increase in chronic health conditions. In many paralytic cases or cases with brainstem stroke, the subject becomes unable to move any muscle in the body. Non-invasive BCI technology has application in wheelchair navigation, and in commanding wheel-chair mounted robotic arm. One important application of EEG-based BCIs is wheelchair control, which can improve the quality of life and increase the independence of a disabled user. The present research proposal aims at to use SSVEP for virtual wheel chair control. Further, we would like to use this set up to investigate the feasibility of SSSEP based paradigm. However, the same BCI paradigm can be used for real wheelchair.