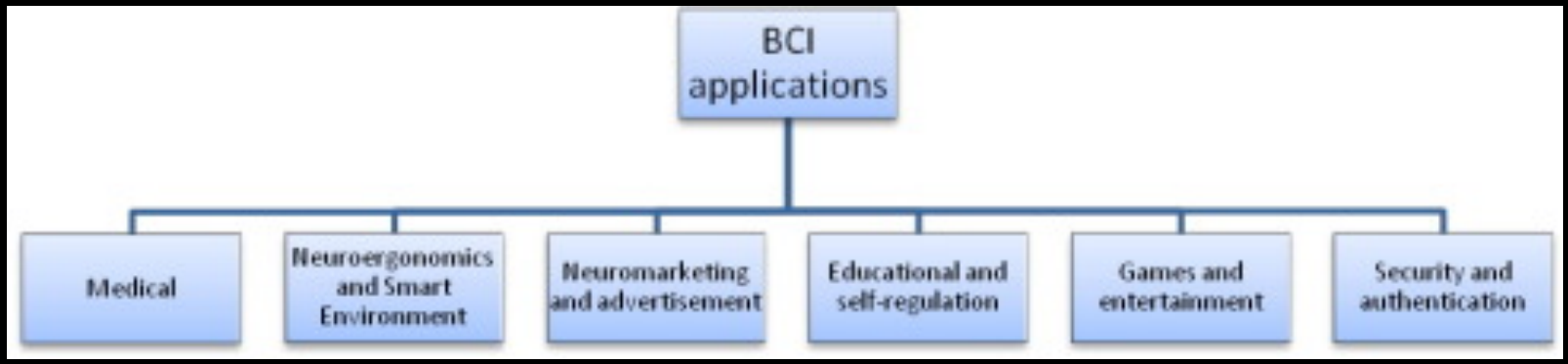
BCI - OPPORTUNITIES AND CHALLENGES IN VR APPLICATION

Jessica Lai

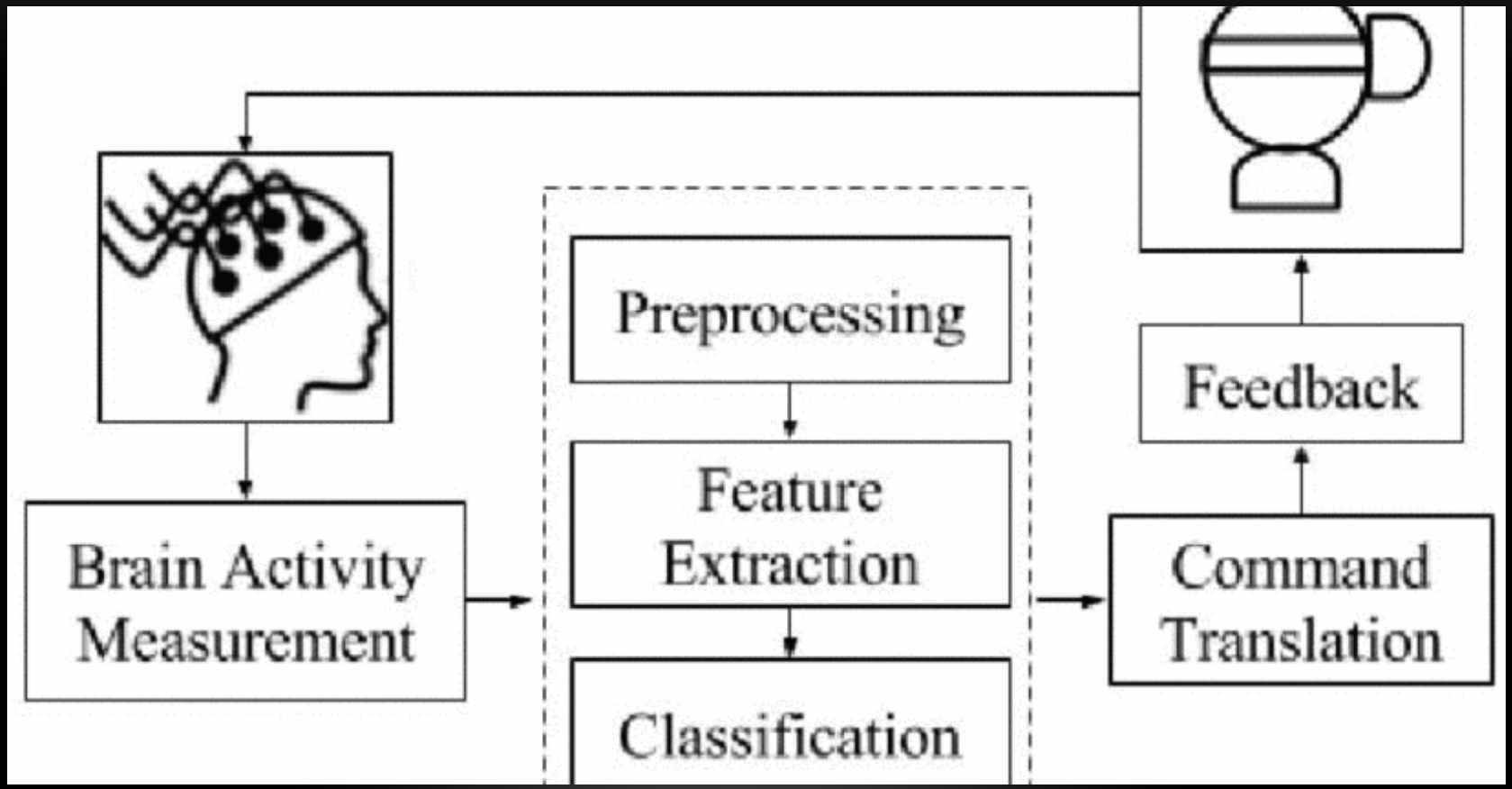
BRAIN COMPUTER INTERFACE

- Communication pathway between users and systems
- Developed with biomedical field in mind
- Contribute to various fields



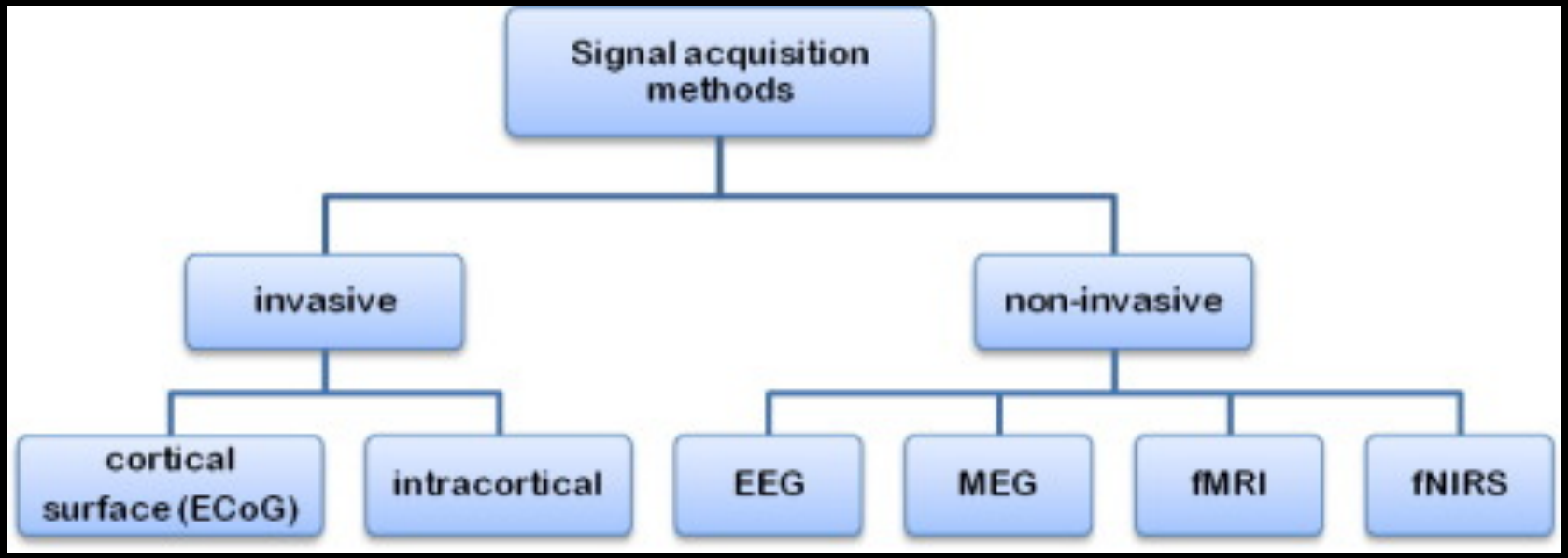
- https://www.youtube.com/watch?v=w6QEGeIKHw0

PROCESS


Brain Activity Measurement
Preprocessing
Feature Extraction
Classification
Command Translation
Feedback

SIGNAL ACQUISITION

- Electroencephalography (EEG) most used for VR

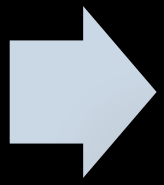


EEG

- Record electrical activity along scalp
- Easy to use
- Portable
- Cheaper

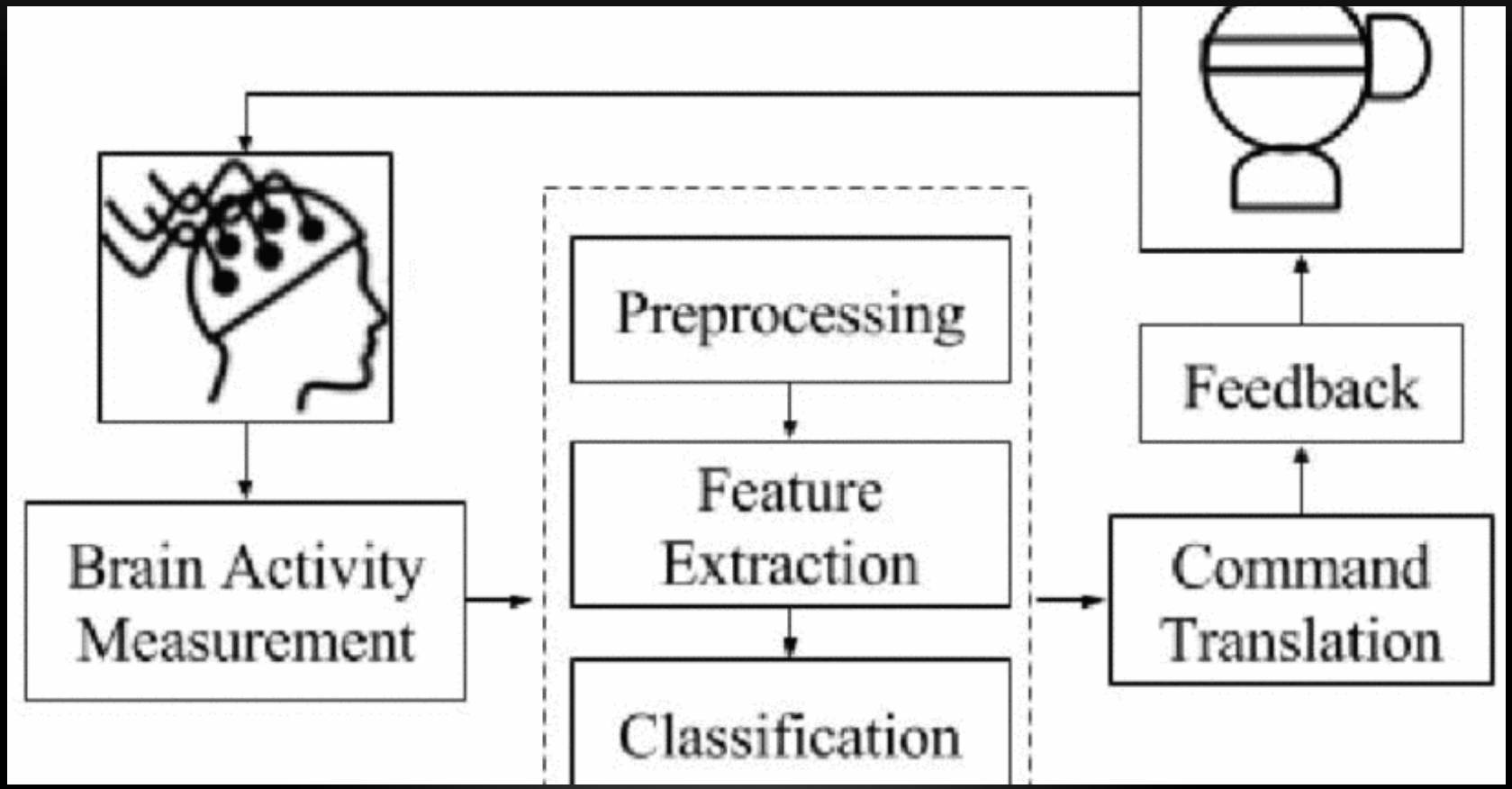
PREPARATIONS

Personal training to control signals



Data training – recongization and classification

EEG BASED BCI MODEL



CLASSIFICATION AND MACHINE LEARNING

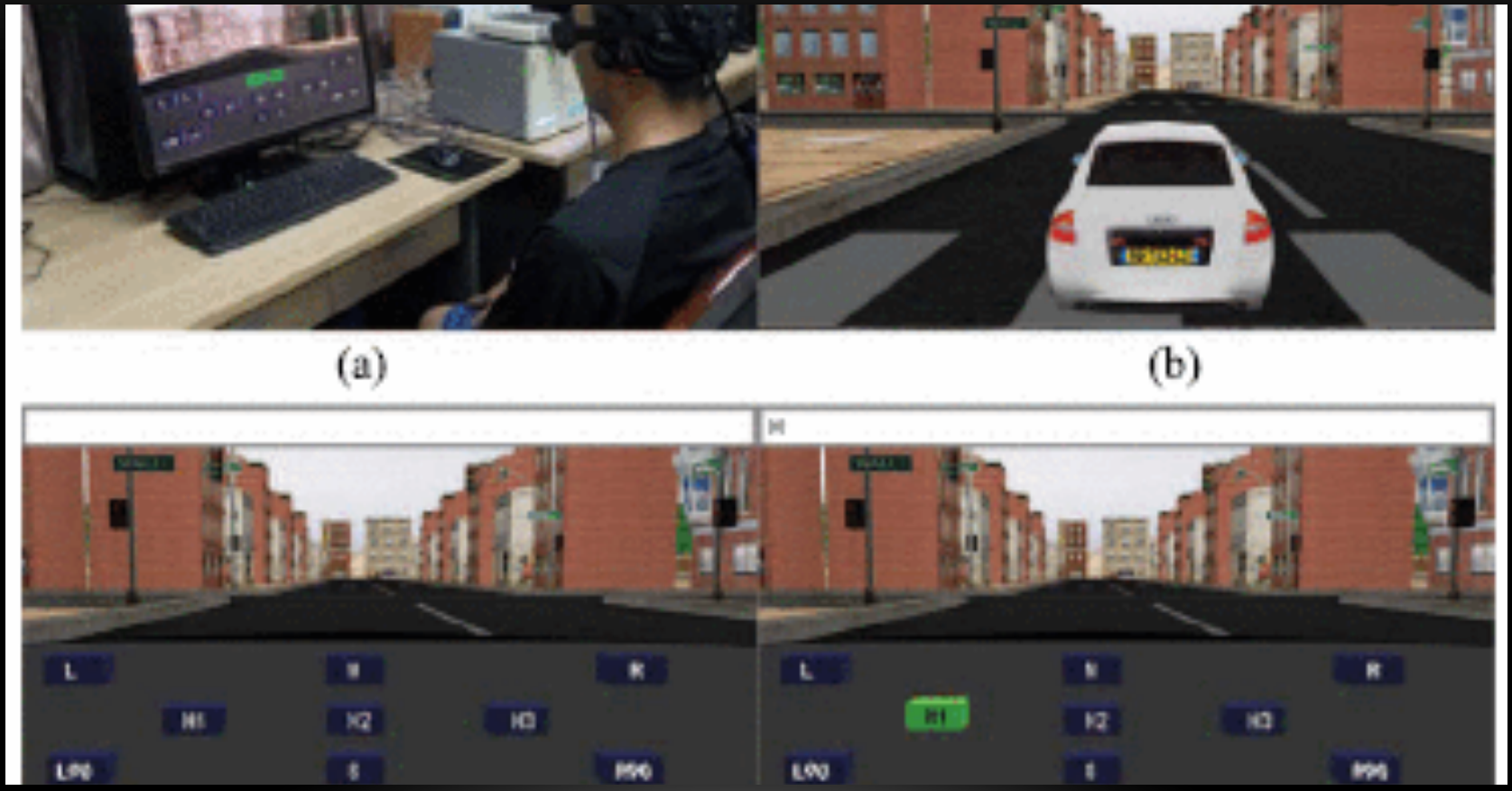
- Speed is key

- Linear Classifiers
  - Linear Discriminant Analysis (LDA)
  - Support Vector Machine (SVM)
- Non-liner Classifiers
  - Support Vector Machine (SVM)
  - K – nearest neighbors (KNN)
  - Neural Networks

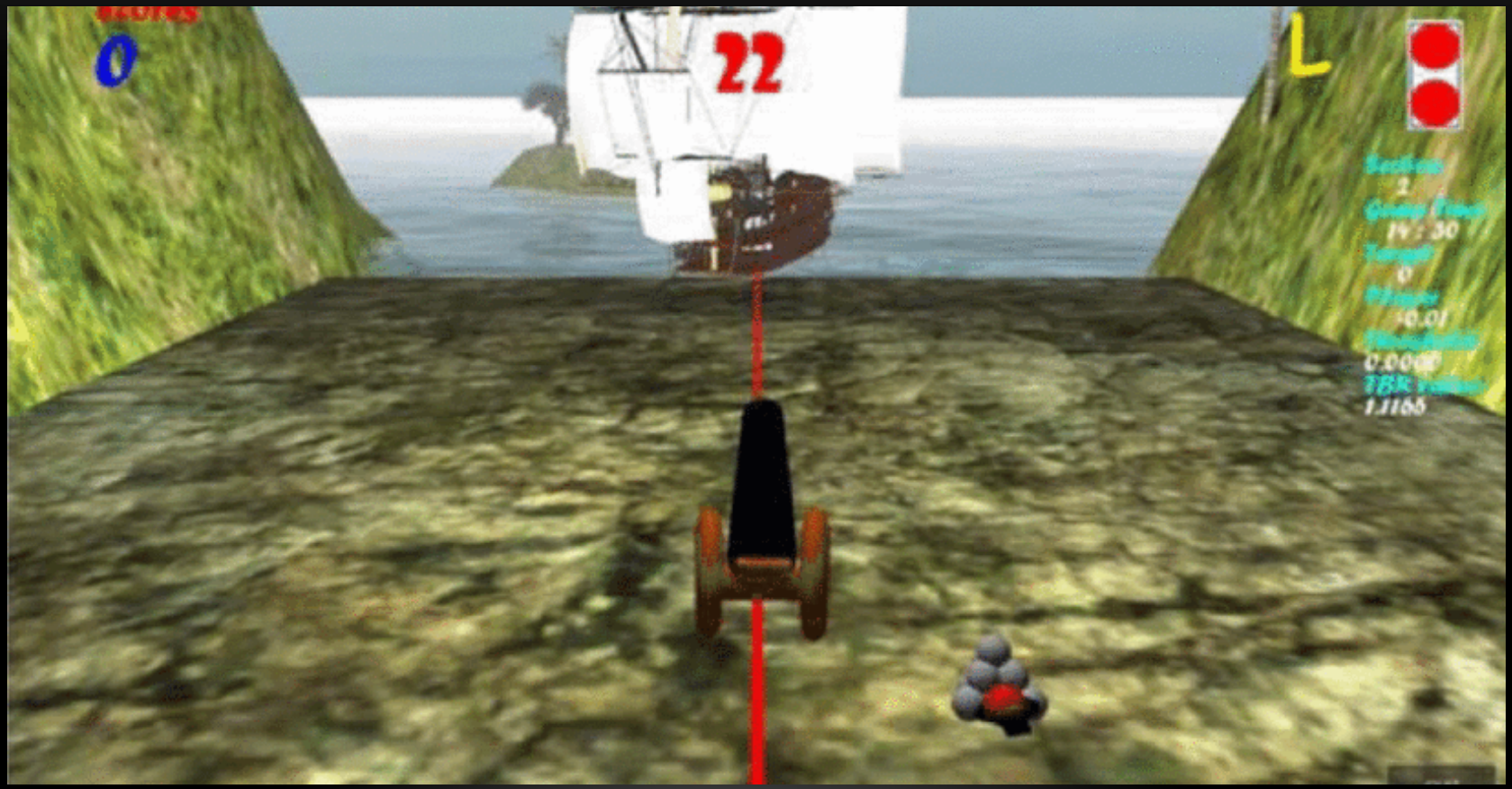
SOFTWARE FRAMEWORKS

- BCI2000
- OpenViBE
- BCILAB
- BioSig

APPLICATIONS



APPLICATIONS



APPLICATIONS

APPLICATIONS

APPLICATIONS

OPPORTUNITIES

- Remove limitation of user input in VR
- Expansion into immersive VR
- User state monitoring

CHALLENGES

- Usability
  - Lack of convenience
  - No common ground for commands
  - Is it really ethical?
- Technical difficulties

REFERENCES

- [1] Sarah N. Abdulkader, Ayman Atia, Mostafa-Sami M. Mostafa, Brain computer interfacing: Applications and challenges, In Egyptian Informatics Journal, Volume 16, Issue 2, 2015, Pages 213-230.
- [2] S. Li, A. Leider, M. Qiu, K. Gai and M. Liu, "Brain-Based Computer Interfaces in Virtual Reality," *2017 IEEE 4th International Conference on Cyber Security and Cloud Computing (CSCloud)*, New York, NY, 2017, pp. 300-305.
- [3] X. Pan, Z. Zhang, J. Qu, C. Zhao and Y. Li, "Enjoy driving from thought in a virtual city," *2017 36th Chinese Control Conference (CCC)*, Dalian, 2017, pp. 11034-11040.
- [4] B. S. Lin, H. C. Hsu, G. E. Jan and J. L. Chen, "An Interactive Upper-Limb Post-Stroke Rehabilitation System Integrating BCI-based Attention Monitoring and Virtual Reality Feedback," *2016 Third International Conference on Computing Measurement Control and Sensor Network (CMCSN)*, Matsue, 2016, pp. 44-47.
- [5] D. Achanccaray, K. Acuña, E. Carranza and J. Andreu-Perez, "A virtual reality and brain computer interface system for upper limb rehabilitation of post stroke patients," *2017 IEEE International Conference on Fuzzy Systems (FUZZ-IEEE)*, Naples, 2017, pp. 1-5.
- [6] J. Fan *et al*., "A Step towards EEG-based brain computer interface for autism intervention," *2015 37th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC)*, Milan, 2015, pp. 3767-3770.
- [7] B. B. Longo, A. B. Benevides, J. Castillo and T. Bastos-Filho, "Using Brain-Computer Interface to control an avatar in a Virtual Reality Environment," *5th ISSNIP-IEEE Biosignals and Biorobotics Conference (2014): Biosignals and Robotics for Better and Safer Living (BRC)*, Salvador, 2014, pp. 1-4.
- [8] J. van Erp, F. Lotte and M. Tangermann, "Brain-Computer Interfaces: Beyond Medical Applications," in *Computer*, vol. 45, no. 4, pp. 26-34, April 2012.