THE UNIVERSITY OF RHODE ISLAND

Towards Neural-controlled Artificial Legs using High-Performance Embedded Computers

PI: He (Helen) Huang; Co-PI: Yan Sun, Qing Yang
Department of Electrical, Computer, and Biomedical Engineering, University of Rhode Island

THINK BIG WE DO

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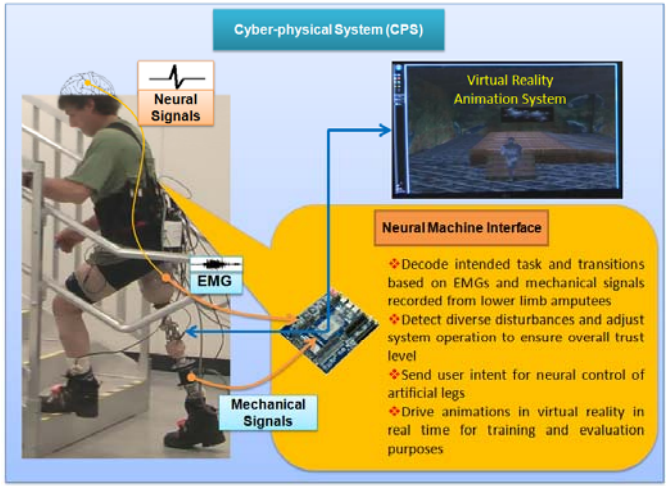
Neural-Machine Interface for Artificial Legs

- There are over *1.7 million* amputees in the US, around 75% of which are lower limb amputees.
- The population of lower limb amputees is still growing as the incidence of dysvascular disease increases.
- The function of current prosthetic legs is limited due to the lack of neural control.
- Neural-controlled artificial legs will improve the quality of life of leg amputees.

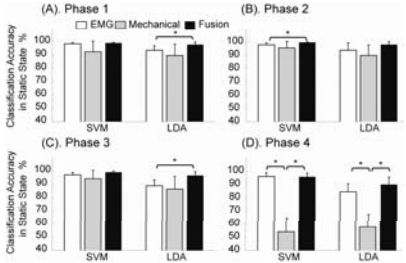
Objective

To develop a ***robust*** and ***high-performance neural-machine interface*** (NMI) that accurately deciphers the user's intended movements in real-time for artificial legs.



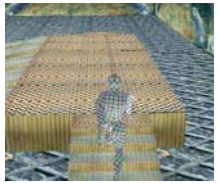
Research Progress

Decoding User Intent Based on Neuromuscular-Mechanical Fusion



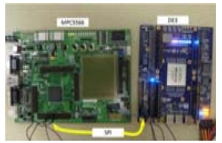
The fusion-based algorithm outperforms the decoding algorithm based on only EMG signals or mechanical signals.

Virtual Reality System



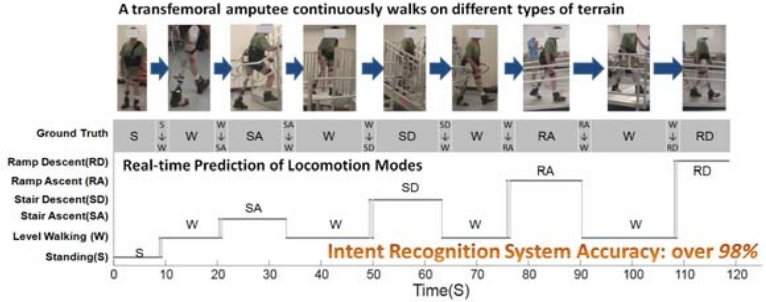
- The virtual animation correlates with the user's locomotion mode in real-time.
- The skeletal key frame (SKF)-based animation technique is employed in our motion reconstruction system.

Embedded System Implementation

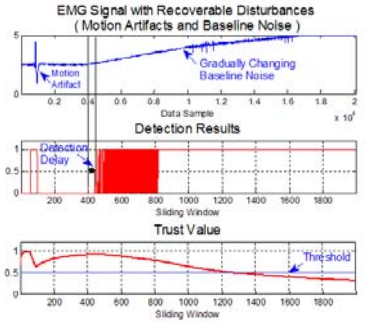


Our parallel pattern recognition algorithm implementation on FPGA (Altera Stratix III) indicates a 38X speedup vs. the software implementation on a PC with Intel i3 3.2 GHz processor

Real-time Intent Recognition



Trust Management Module



- Abnormal detector can detect motion artifacts and gradual baseline noise
- Trust value dynamically drops and recovers according to the presence and absence of the disturbances

Future Work

- integrate the trust module in the real-time NMI;
- Improve the virtual reality system with accurate position mapping;
- Real-time integration on embedded systems.

Selected Publications

Huang H et al. "Design of a Robust EMG Sensing Interface for Pattern Classification", *Journal of Neural Engineering*, vol. 7(5), pp 0565, 2010

Zhang F et al. "Towards design of a stumble detector for artificial legs". *IEEE Trans Neural Syst Rehabil Eng*, 2011 (In Press)

Huang H et al. "Continuous Locomotion Mode Identification for Prosthetic Legs based on Neuromuscular-Mechanical Fusion", *IEEE Trans Biomed Eng*, 2011 (In Press)

Zhang, X. et al. "On design and implementation of neural-machine interface for artificial legs", *IEEE Transactions on Industrial Informatics*, 2011 (Minor revision)

Zhang F et al. "A Novel CPS System for Evaluating a Neural-Machine Interface for Artificial Legs" *ICCPS*, 2011

Huang et al. "Integrating neuromuscular and cyber systems for neural control of artificial legs", *ICCPS*, 2010