Multi-Jointed Robots Controlled by Specific Bio signals
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Abstract:
This past year, my plan was to build a multi-jointed robot controlled by Electroencephalography, Electrocardiography, and Electromyography. After spending a year designing and developing several different prototype chassis, I plan to continue my project this year by incorporating bio-signals and building a final prototype.

Background:
In the Spring of 2015, I was a part of a robotics class and for my final project, I tried to build a robot that could travel with legs instead of wheels. I decided to continue the project into the fall of my Junior year. Since then, I have studied other methods of control to apply to my project. These methods include: Electromyography (EMG), which is a diagnostic procedure to assess the health of muscles and the nerve cells that control them. (2) Electroencephalography (EEG), is a test that detects electrical activity in your brain. (1) I will also be using Electrocardiography (ECG), which is used to monitor your heart. (3) The robot's speed will correspond with the increasing speed of my heart rate and the data will be collected by the Electrocardiogram. The robot's joint movement and walking motion will be controlled by my nerve and muscle movement and the data will be collected by the Electromyogram. Finally, the direction of the robot will be collected by the Electroencephalogram by tracking the pulse of my brain wave activity.

I spent the entire 2015-2016 academic year designing several prototypes while testing the best method to create tension within each joint. I built my first prototype out of legos. By attaching an elastic band on one side of the joint and a string running the other side which was connected to a fixed point; this established enough joint tension to preform a simple walking function. Yet this method could never fully support the weight of the chassis and the legos would break under tension. This led me to design my second prototype which was a larger chassis built out of VEX parts.

I continued to use the string to create tension in the chassis but the VEX parts were rough and couldn't produce a fluid walk function that also supported the weight of the chassis. I built the front legs but attached wheels to the back to test my walking code yet this also failed due to the front legs inability to pull the weight of the chassis. Yet even though the robot couldn't preform the full walking motion, it gave me a brief insight to what the walk would resemble as the front legs tried to pull the chassis forward. It resembled an AT-AT Walker from Star Wars.

Goals:

The original goal of my project was to educate myself and others about ECG, EMG, EEG, and Biomechanics. By working on this project, I planned set up a foundation in my robotic career that can help me have a solid understanding for the projects that I may perform in the future. Now, about to embark on my second year, my goal is to finish what I set out to do. I will build a fully functional final prototype that is controlled by each of the previously stated Bio-Signals.

Essential Question: Can I build a Multi Jointed Robot Controlled by Specific Bio signals and how will this project contribute to my HPA community or to the scientific research in this field?

Implementation & Challenges

Project Planning: By keeping a clear calendar and setting due dates for myself, I plan on finishing each step in a specific amount of time and not spending to much time on one aspect of my project.

How do you plan on achieving your goals?

I plan on achieving my goals by staying on task and dedicated to the time spent in class on my project.

Research and Resources:

Over the course of the past year, I have researched a lot about Boston Dynamics, MIT's Big Dog, Backyard Brains Human to Human Interface, AutoCad and Code Academy. Each of these resources has helped me whether it was inspiration for my project, Big Dog, or applications that taught me how to build my project, Code Academy. My next step is to continue researching online CAD or other design platforms that I can use to professionally design my final prototype.

Challenges:

I expect to encounter more difficulty with the physical building of my final prototype. I will also struggle with never having enough time to finish my days work. I will also struggle with incorporating EEG because I research it more thoroughly. All three of these will be my biggest set backs but these are similar challenges to my previous year and I believe that I will be able to overcome them this time around.

What I will build:

I will build a robot whose joint movement will be controlled by my joint movement with the EMG Spikerbox, speed is controlled by my heart rate with the Arduino Heartbeat sensor, and the direction of the robot will be controlled by my brain activity. I will begin by building four legs with a knee joint. The prototype will be built with legos and controlled by my biosignals through EMG, ECG, EEG technology.

Impact:

The fields of Electroencephalography, Electrocardiography, Electromyography, and Biomechanics are all fields of high importance for the future of the scientific community and the human race. Even small projects that dive into these topics continue to expand our knowledge for bettering the life of people in need. Every small step can make a large impact towards the research for robotic prosthetic limbs and other fields in biomechanics. By studying these fields, I can set a base for future ideas and projects that I want to pursue.

Legacy:

The main importance of this project is that my research will expand beyond my years at Hawaii Preparatory Academy. The legacy of my project will be the research and the data itself. The future of the project will be for the students with an ambitious passion for robotics and a desire to learn about how to help others. I hope that the final draft of my project inspires people to pursue the field of robotics. I also hope that this project inspires my generation to realize the endless opportunities that we are presented with to leave this world better than when we entered it.

Appendix A:

"EEG (electroencephalogram)." *EEG*. Web. 31 Aug. 2015.
"Electromyography (EMG)." - *Mayo Clinic*. Web. 31 Aug. 2015.
"Electrocardiogram (ECG or EKG)." - *Mayo Clinic*. Web. 31 Aug. 2015.

Each of these links taught me the foundations of EMG, ECG, or EEG. This will be useful for my project because I implement all three bio signals this year and a basic understanding for the equipment and medical uses are valuable background information.

Appendix B:
Critical: Arduino, Bread Boards, Batteries, Servos, EMG, ECG, and EEG equipment, Chassis material (VEX but more likely 3D Print Material), Online Design Software

Necessary: Screws, Zip ties, Screwdriver, Duct Tape, Scissors