Senior Project – Electrical Engineering and Computer Science – 2014

UNION COLLEGE

Designing a Wireless Tensegrity

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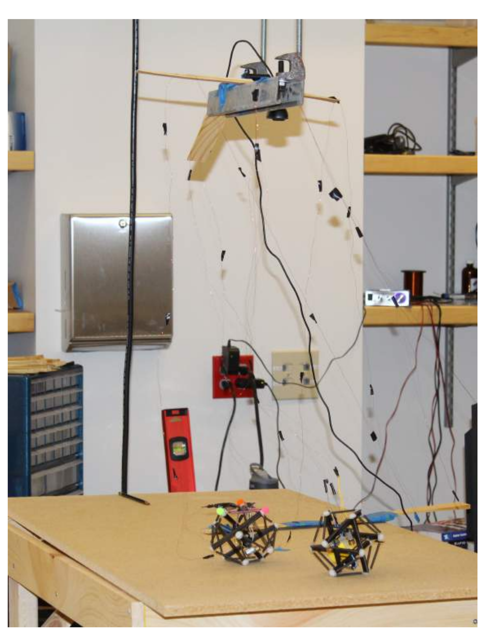
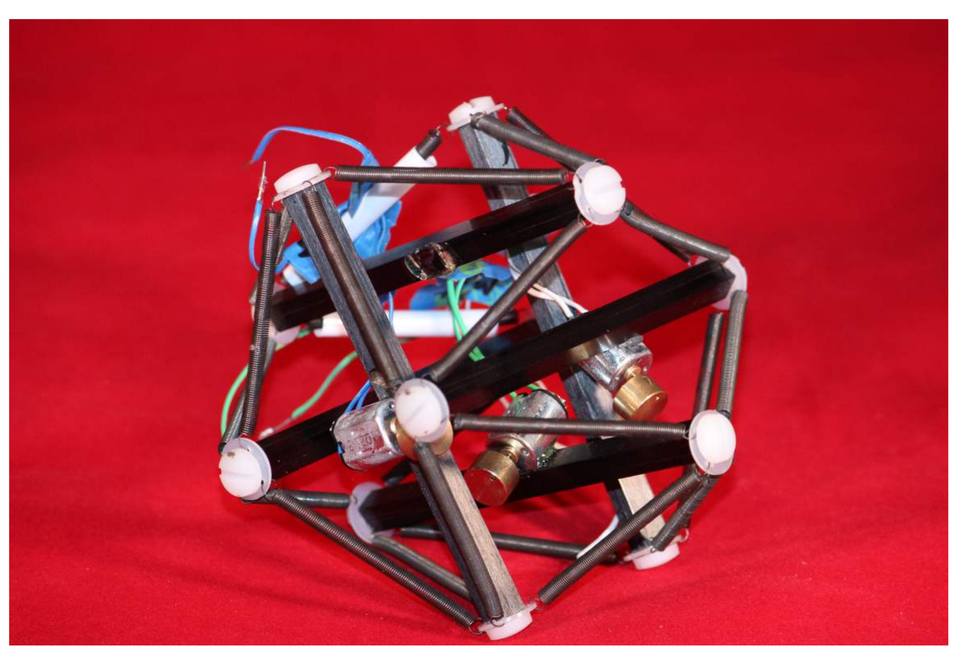
Abstract

A tensegrity is a deformable robot made from struts and springs held together in a stable pre-stress form. We are doing research at Union to learn how to make the robot move by vibration. While successful, this research is limited by the current wired design of the robot. For example the current robot VALTR has a tether that tangles and has to be reset if it turns too much or moves too much. My research was to design and construct a new, wireless tensegrity robot controlled by a spiking neural network. This new robot allows us to conduct research without the inhibition of the tether. With it we can better control the frequencies of the vibrations by using an inertial measurement unit and motor encoders as inputs into a spiking neural network. This new robot will further allow us to continue research in using tensegrities to get a better understanding of how complex living systems move.





Pictured above is the current tensegrity robot and arena. The tether can be seen on the left extending from the robot to the camera above.

Motor System

The tensegrity robot is designed to have two motors that both can vibrate independently of each other. The vibrations from the motors make the tensegrity move by exploiting it's natural resonances. The Qik 2s9v1 dual serial motor controller was selected to drive two 10:1 high power micro gear motors.

Microcontroller

The microcontroller component is responsible for linking all of the other systems together. It had to be small and very energy efficient. The biggest challenge was to ensure that there were enough ports to allow for all of the components to be interfaced. The Arduino Micro board met all of these requirements.

Communication System

To communicate with the robot a wireless system needed to be established. The system that was chosen was bluetooth. The BlueSMiRF module is small and low powered, allowing for communication without sacrificing other goals.

Project Goals

Wireless: Create a tensegrity robot that is controlled without a tether and contains an on-board power source.

Size: Use the smallest possible components so that the size of the final design is minimized.

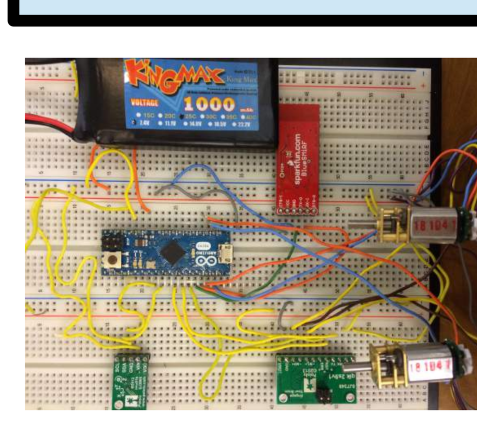
Run-time: Have a battery that would allow for over an hour of operation on one charge.

Modular: Be designed so that it is easy and inexpensive to multiply, so that larger tensegrities can be created in the future.

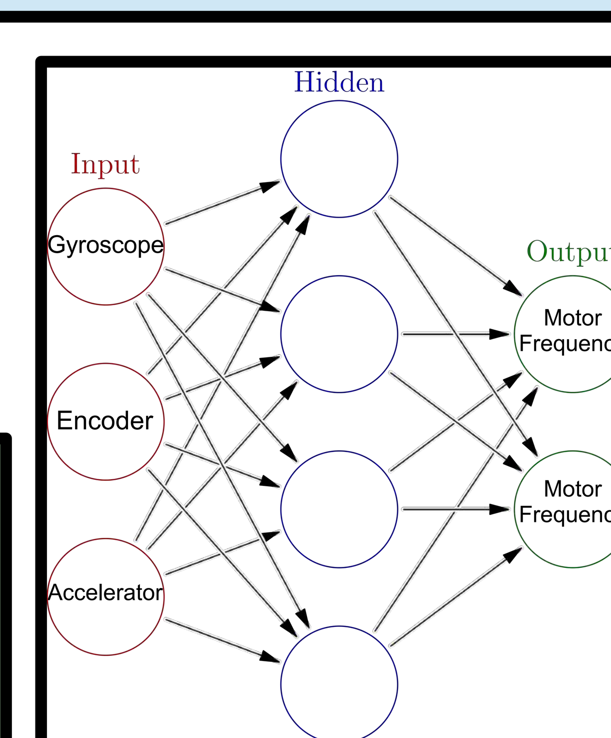
Closed Loop Control: The motor frequency will controlled with a feedback system to allow for more accurate control.

Feedback System

The feedback system allows for the motor vibration frequency to be better controlled by using a spiking neural network (SNN). A SNN functions by collecting input until a threshold has been met and then triggering the output. This network takes inertial measurement data and shaft encoder data as inputs, uses weights, and produces an output motor voltage. The Pololu MinIMU-9 v2 and Optical Encoder were chosen for their size, cost and power consumption.



Left: A picture of all the different components connected together.
Right: A picture of an artificial neural network showing the different inputs and outputs.



Results and Future Work

All of the components currently are interfaced together and can run wirelessly. The spiking neural network uses the inputs and assigned weights to output a frequency. Next steps will be to search for a smaller, lighter battery and 3D print a strut design so that all the components can be mounted onto an actual robot.

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