The Design and Construction of a Novel Variable-Geometry Snake-like Input Device

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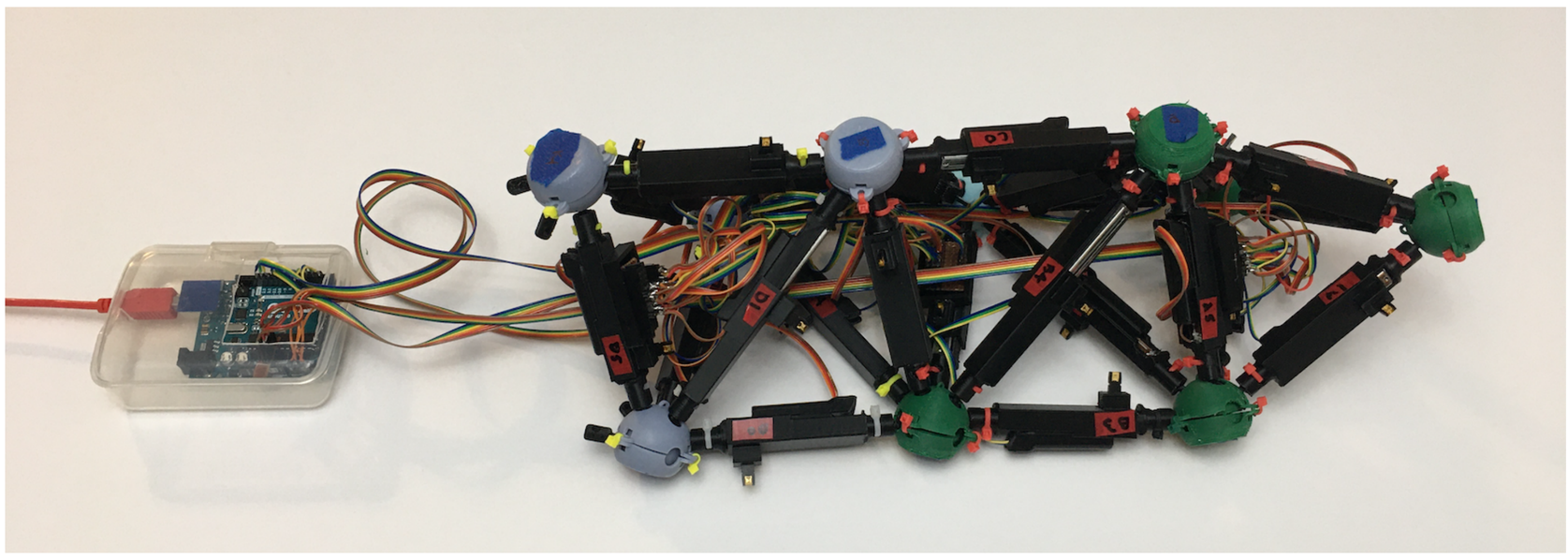
Abstract

Humans are skillful. By building a bio-inspired manipulable snake-like controller that can be molded into a wide variety of shapes, we allow a human controller to telepresently specify complex shapes and shape changes. We constructed a tetrahelix consisting of seven tetrahedron made of adjustable-length members connected via 3D printed Song-Kwon-Kim joints which allow manual changes to the shape of the controller. These changes in length are digitized and organized via an Arduino and transmitted to more powerful computers where they may specify a shape to be animated or control a robot of similar shape, or simply specify relative positions in Cartesian space. Although this research is basic, we hope it will eventually amplify human control of *in vivo* mechanical devices such as endoscopes, search-and-rescue robots weaseling into tight spaces, or general purpose tetrobots used for planetary space exploration as suggested by Prof. Sanderson and his students 20 years ago.

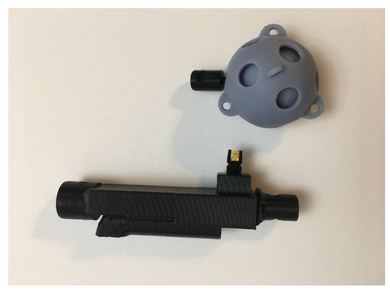
Overall Design

The TetroCon is isomorphic to a Boerdijk-Coxeter helix, which is composed only of tetrahedra. It is therefore inherently rigid. By allowing the edges to detectably change length, the TetroCon shape can be reconstructed in a computer to control a basically tubular or snake-like virtual or physical robot.



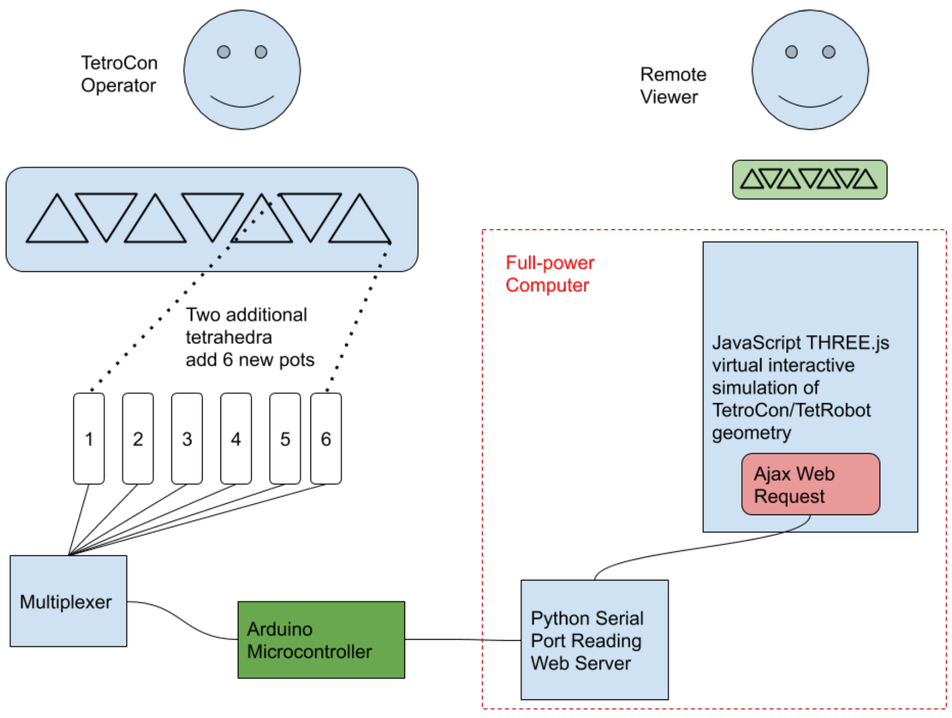
Mechanical Design

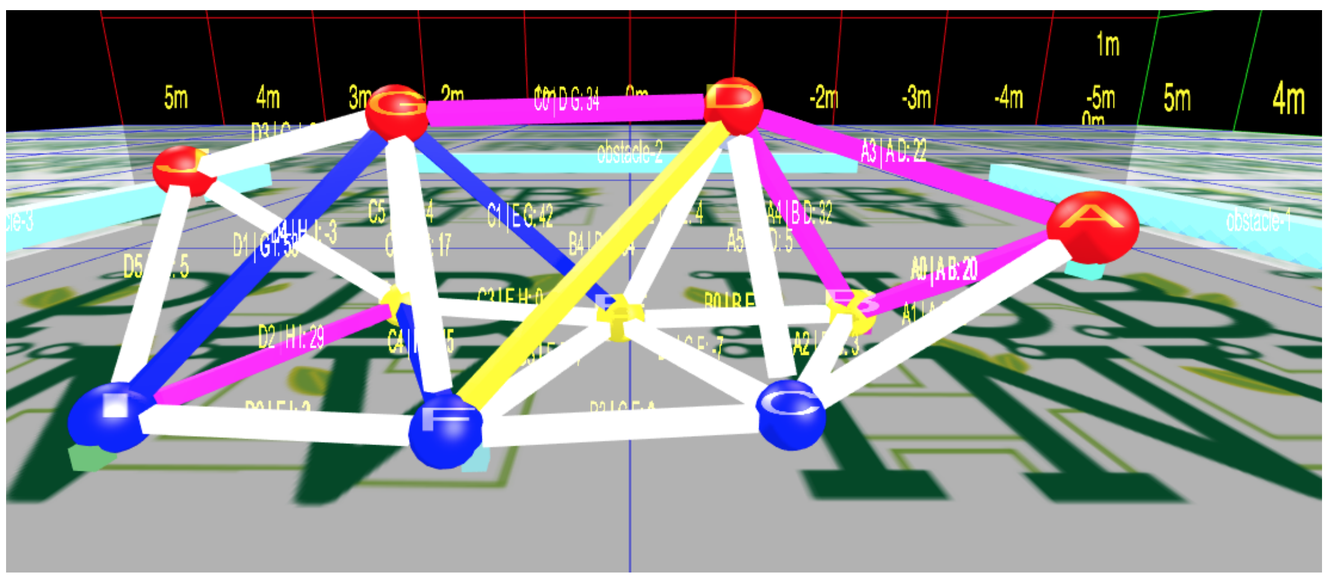
In order to support changes in the shape of the triangles, a joint supporting multiple members and angular changes is required. The Song-Kwon-Kim joint is one such joint. We have designed a universal version of this joint which we 3D print for both the TetroCon and the TetRobot. The members between joints change length by sliding a sleeve along with the wiper of a slide potentiometer.



Electronic Design

Six pots at a time are wired to an 8-channel mux digitally controlled by an Arduino, which digitizes the analog signals to construct a JSON object transmitted over its serial port. The JSON is read by a simple Python web server which makes it available as web request. A Bullet-based simulation of the TetRobot converts this into a virtual model of the tetrahedral system capable of being transmitted to the physical TetRobot.





Screenshot of Live Virtual Model of TetroCon in Web Page