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

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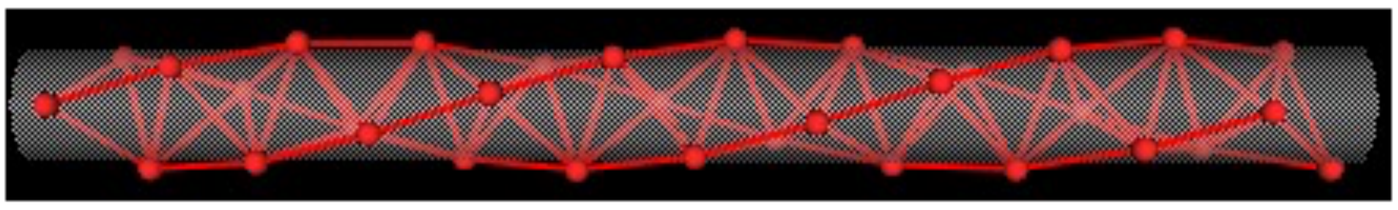
Abstract

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 power 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.

The device structure resembles that of a Boerdijk-Coxeter (BC) helix, which, by virtue of its inherently chiral nature, imparts an ability to adopt a more cylindrical presence, than that of otherwise arranged counterparts [see figure 2]. This fact enables a mimicry of naturally occurring systems in an otherwise synthetic, rigid robotic system, that is highly favorable in applications of human-robot interaction.



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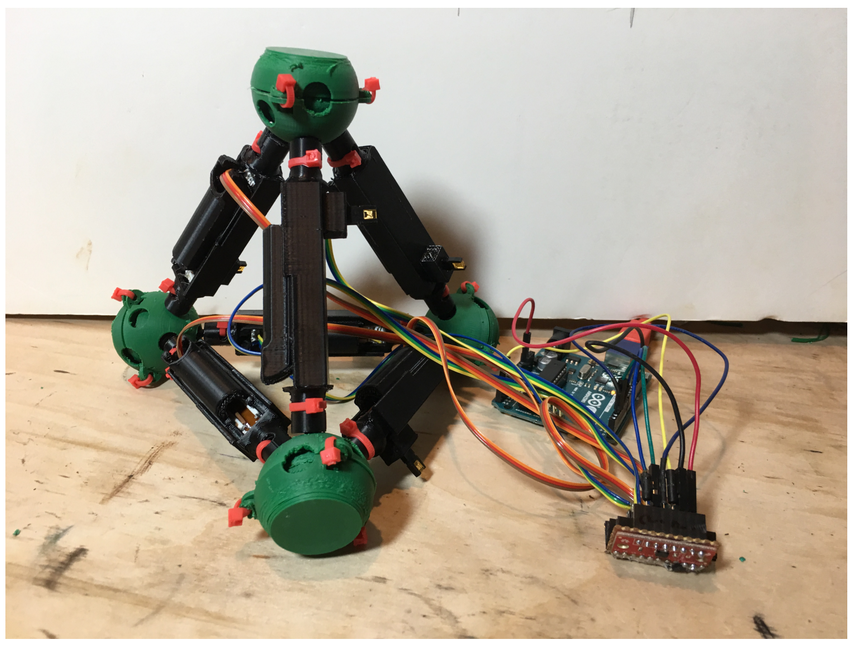
http://www.rwgrayprojects.com/rbfnotes/helix/helix01.html



Each segment of the BC helix consists of a resisitance-based linear potentiometer encased in a 3D printed sliding sleeve. The segments of the device terminate at a novel spherical joint designed by Song, Kwon and Kim[cite SKK joint], which enables a defined extent of 3D translation as illustrated in figure 3.

Groupings of 6 sliding potentiometers, associated with individual tetrahedron in the larger structure, were wired to on-board, mounted multiplexers via soldered electrical joints. Male header pins at the terminating ends of each wire allow for ease of removal of worn out or damaged sensors, or damaged printed components

The modular structure of the device further facilitates reproduceability and ease of access for 'trouble shooting'; every major component of the device can be simply removed or replaced, without affecting the stability or integrity of the rest of the device.