MODIFYING AN ISOPERIMETRIC COMPLIANT ROBOT FOR CHILD CARETAKING AND PLAYMATE

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ABSTRACT

An untethered, isoperimetric, compliant-truss robot developed in Stanford University is a swarm network of individual robots forming an octahedron with triangular faces. The individual robot roller modules bend tubes into the triangular shape which allow the entire structure to deformation. The deformation allows it to move and manipulate its environment. This is a promising design for a variety of applications where a soft touch is necessary. Meanwhile, social robots (SR) for pediatric care use innovations in artificial intelligence and human interface for hospital, daycare, and domestic use. Our research explores the potential of soft robot design for child healthcare and as a robotic playmate, by modifying the structure of the compliant-truss robot and optimizing its motion.

Keywords: truss-robot, swarm robotics

METHODOLOGY

This paper is the start of a series of studies meant to modify the as a child-care unit and robotic playmate. The following modifications are explored:

HANDS & FEET: the modules can be improved with passive grippers, acting as mounting brackets for end effectors or even high traction pads for feet. The new structure greatly alters the axis of rotation for each DoF.

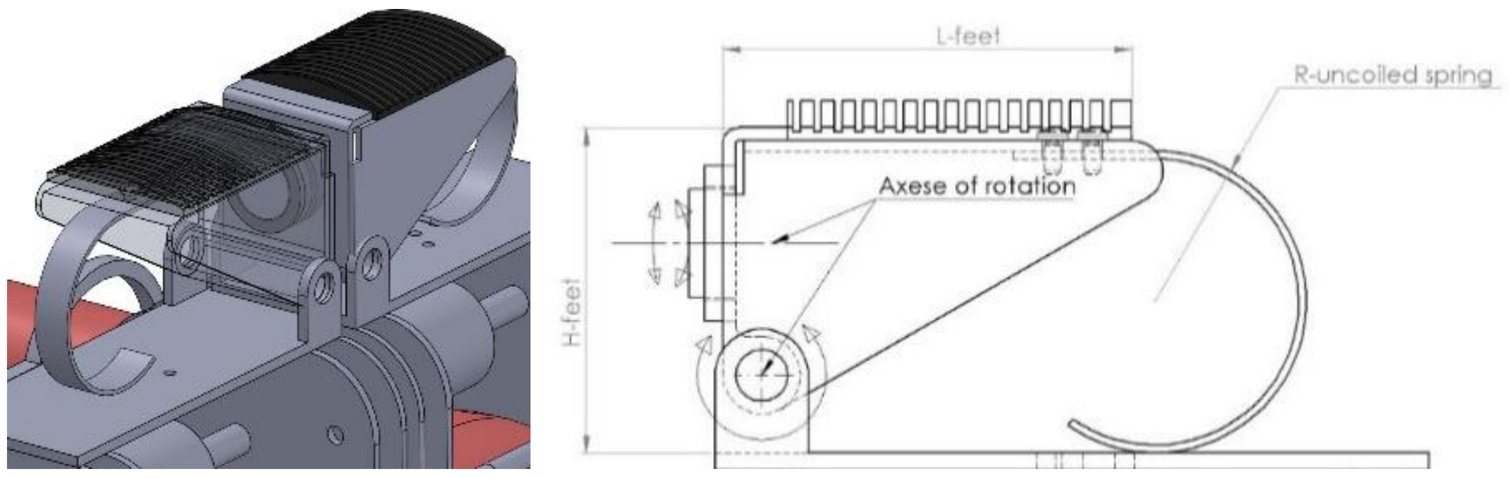

Fig. 2. Gripper attached to 3-dof universal joint between two modules and variable dimensions

TRUSS LEGS REDESIGN: a compliant, semi-rigid tube can be molded from a single compliant material, with the ridges to induce spring-stiffness. The individual roller modules would be relocated to the mid-point of each leg and a pully system would be used instead to compress the structure.

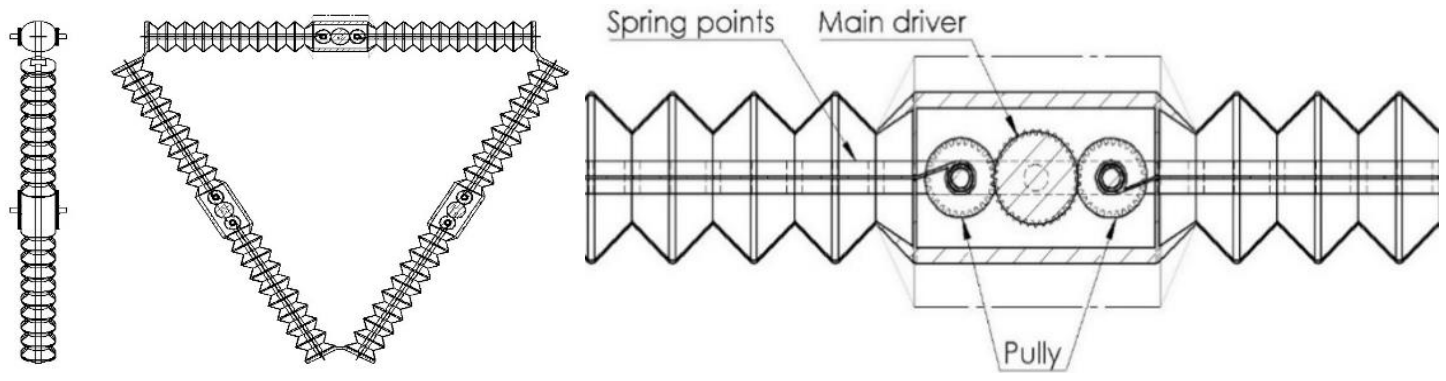

Fig. 3. Profile of the flat triangular face of the robot, composed of one compliant material; and the individual module relocated into the edge.

CONCLUSIONS

Modifications are explored to improve the interactive safety of the robot for the purpose described. A base for feet and tools would increase the robot's functionality and movement. A new compliant structure could be created to increase versatility. Additional research will focus on refining these measurements, modifications, and using advanced genetic algorithms to teach the robot optimized motions

INTRODUCTION

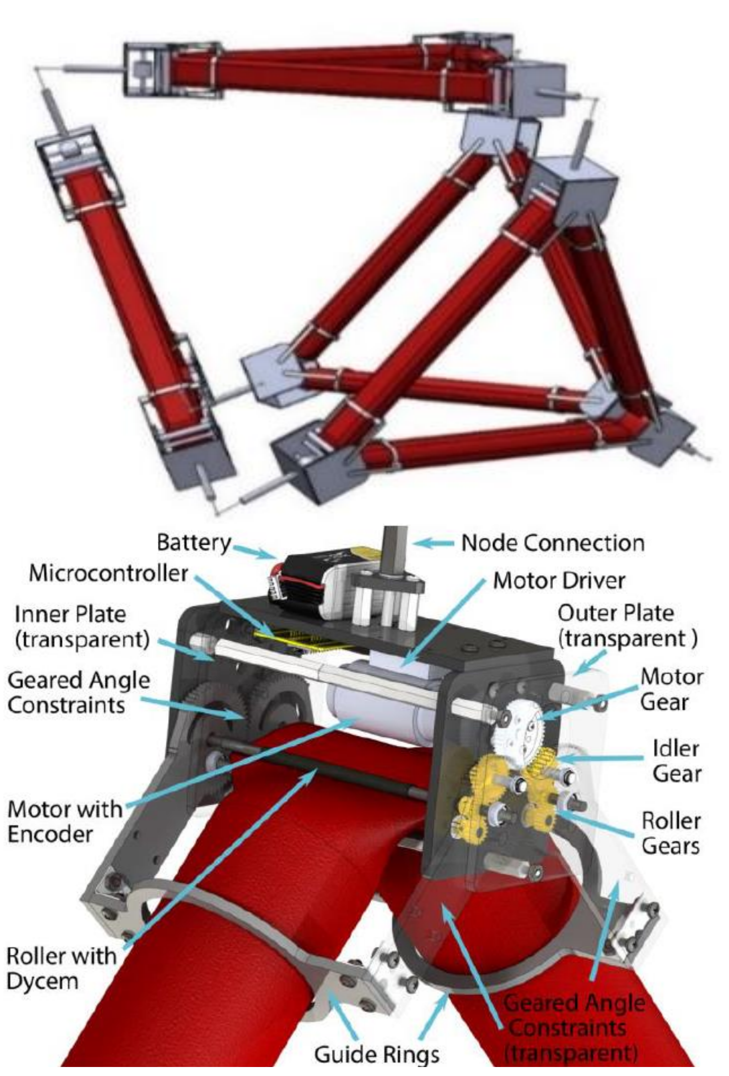

Fig. 1. Structure of the standing 3-D robot and roller module of Usevitch et al. (2020)

Robots are programable tools with structures optimized for carrying out a specific, limited sets of tasks. In pediatric care mostly, assistive robots (AR) find applications in aiding the mental development (Lewis et al., 2021). Lopez-Sastre et al. (2021) explores a rigid, low-cost design, with simple manipulators and locomotion, built to help youth with neurological abnormalities. Social robots (SR) are more interactive designs for hospital, daycare, and domestic use (Dawe et al., 2019). The 'robotic playmate' of Abe et al. (2012) is built to interact with children up to 5 years of age. It uses artificial intelligence to read emotions and act independently, engaging children with games, drawing, and a chatbot. Logan et al. (2019) uses a plush-toy teddy bear with a robotic skeleton to interact with hospitalized children between ages 3 and 10. The toy is remotely controlled by nurses, including facial expressions, gestures, and speech. As far as we know, soft robot designs for pediatric care have not been explored. These use compliant materials that allow for bendable bodies, like biological organisms (Majidi, 2014) and dramatically change shape to move and manipulate its environment.

RESULTS AND DISCUSSIONS

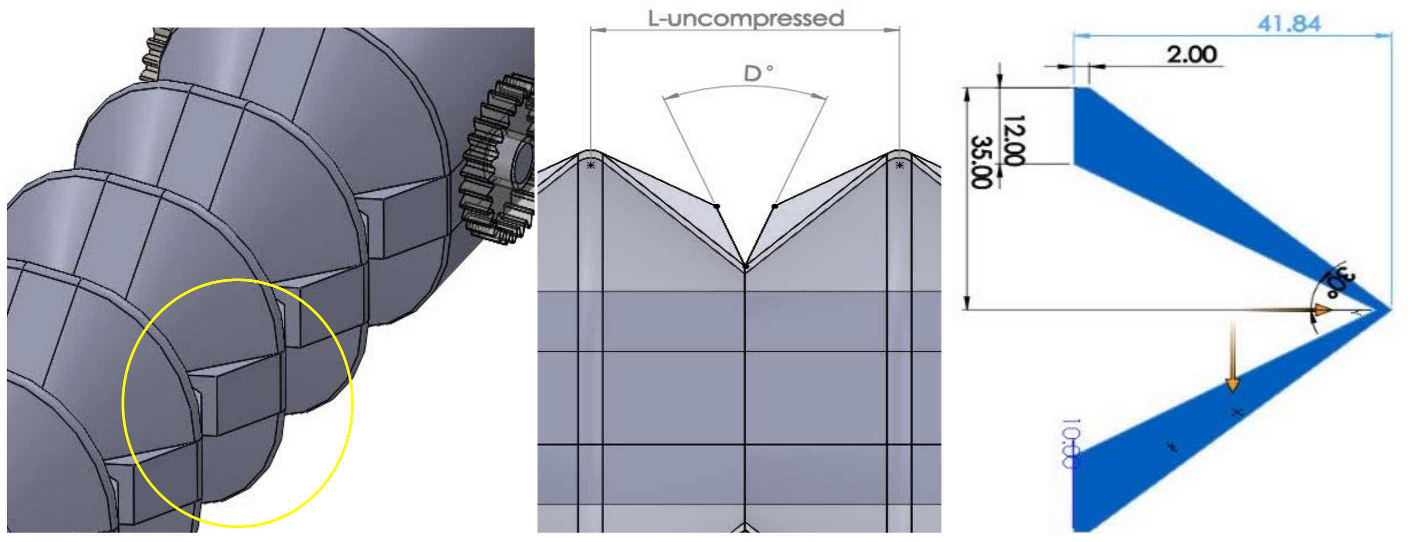

Fig. 4. Profile of the flat triangular face of the robot, composed of one compliant material; and the individual module relocated into the edge.

The truss design was tested on ANSYS by simulating the component that induces spring-stiffness on the tube legs. The polyethylene plastic rigid node is compressed to 35% of its original length. Three initial, uncompressed angles are tested: 30°, 45°, and 60°. The 60° node exerts the greatest resistive force, which is 71 hectobars (0.71 MPa). This computes to 14.2 kilonewtons of resistive force on each node, a stiffness of 316 N/mm per half section of the spring, and, consequently, a stiffness of 10.1 KN/mm on each leg. Post-covid, robots may need to be able to handle children physically, without inducing any pain or damage. We believe the forces shown are enough to retain a stable structure while not physically hurting the end-user.

Fig. 4. from left to right, nodes with 30°, 45°, and 60° uncompressed angles