ARAtronics Research Center for
Opto-Mechatronics Engineering

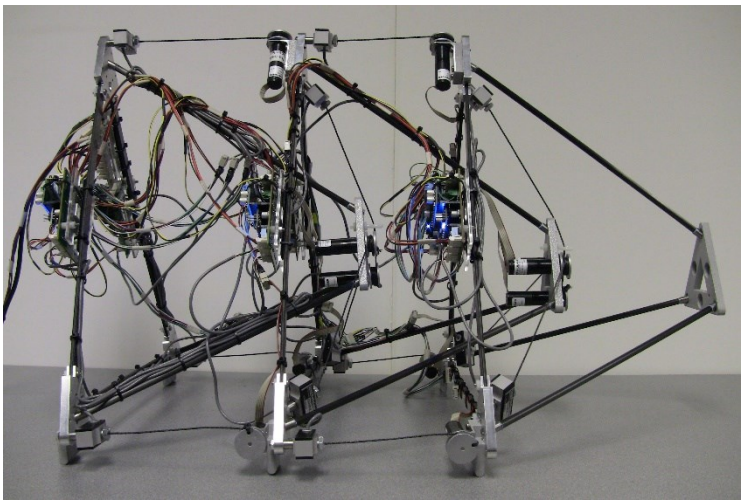
ARAtronics Research Center,
Mechatronics Engineering Department,
Faculty of Engineering and Material Sciences (EMS),
The German University in Cairo (GUC)

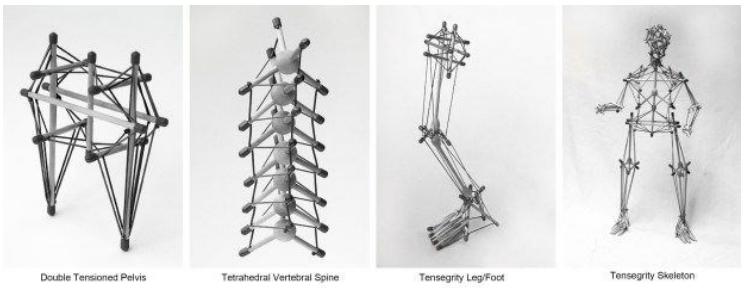
Bachelor's Thesis, Term Project

Design and Control of Modular Spine-Like Tensegrity Structures for Humanoid Robots

Supervisor (s): (**Assist. Prof. Dr. Eng.** Amir Roushdy)

This project presents a study on form-finding of four-stage class one self-equilibrated spine biotensegrity models. Advantageous features such as slenderness and natural curvature of the human spine, as well as the stabilizing network that consists of the spinal column and muscles, we will model and incorporate in the mathematical formulation of the spine biotensegrity models. Form-finding analysis, which involved determination of independent self-equilibrium stress modes using generalized inverse and their linear combination, was carried out. Form-finding strategy for searching the self-equilibrated models was studied through two approaches: application of various combinations of (1) twist angles and (2) nodal coordinates. **There is a Master's student from Mechatronics engineering Department and the Lab Engineer from ARAtronics, guiding and directing the student with Assist. Prof. Dr. Eng. Amir Roushdy.**





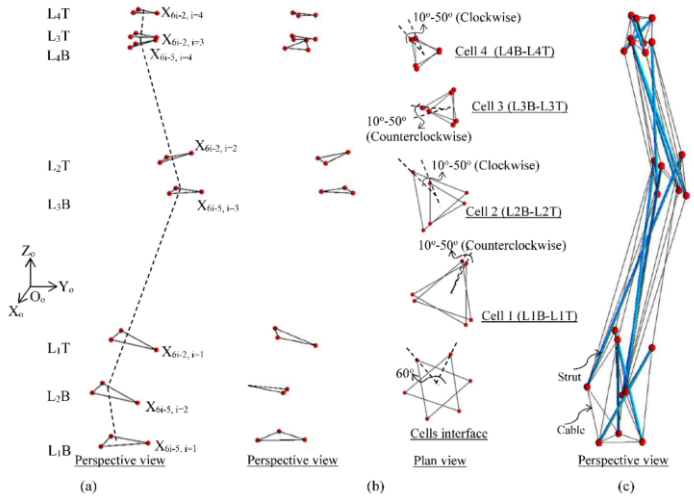


Fig.: Assemblage of a spine biotensegrity model (a) fitting of triangular surfaces perpendicular to the established curvature line, (b) twisting of cells shown in elevation and plan view, (c) incorporation of struts and cables according to the element connectivity pattern.

For more details please contact:
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Project description and objective:

A total of three configurations of the spine biotensegrity models with different sizes of triangular cell will be investigated for the first time in this project. All members in the spine biotensegrity models satisfied the assumption of linear elastic material behavior. With the established spine biotensegrity model, the advantageous characteristics of flexibility and versatility of movement can be further studied for potential application in deployable structures and flexible arm in the robotic industry.

Research focus of this project:

- Literature review on the project should be studied properly.
- Not only, creating a software control system for the project but also the hardware.
- Experiments using the gadget and control system should be built properly.
- The outcomes must be documented.

Requirements:

- Passionate to learn more about 3D Printing design, Robotics and control.
- Prior mechatronic design expertise is desired like "SolidWork and Arduino".
- Enthusiasm for completing actual practical work with 3D printing staff (design fabrication and construction).
- A method of working that is both structured and self-contained.

General tasks of the project:

- The complete methodology is already available in the ARAtronics Lab, so we will discuss it from the first day to start the automation process for it
- Fabricate the machine/system using 3D printer/CNC machine (small parts).
- Assembly all parts of the Robot.
- Changing the working variables and see the effect on the locomotion of the robot.

Other notes:

- A weekly meeting with the advisors will be required for this project, as well as weekly progress updates (***The meeting could be more than once during the week based on your progress and based on your achievements***).
- You should to be in the Lab two days per week (***It could be more than two days based on your progress and based on your achievements***).
- All reports must be prepared in the style of a research paper.
- The outcome of this research will be published in one of the coming international Conferences and , or Journal

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