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, Fabrication and Control for Animatronics Robots Based on Kinetic Wires

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

Elastically deforming wire structures are lightweight, durable, and can be bent within minutes using CNC bending machines. We will work on design of kinetic wire characters, tailored for fabrication on consumer-grade hardware. Our technique will takes as input a network of curves or a skeletal animation, then estimates a cable-driven, compliant wire structure which matches user-selected targets or key frames as closely as possible. To enable large localized deformations, we will shape wire into functional spring-like entities at a discrete set of locations. We first detect regions where changes to local stiffness properties are needed, then insert bendable entities of varying shape and size. To avoid a discrete optimization, we first optimize stiffness properties of generic, non-fabricable entities which capture well the behavior of our bendable designs. To co-optimize stiffness properties and cable forces, we will formulate an equilibrium-constrained minimization problem, safeguarding against inelastic deformations. We will demonstrate our method on six fabricated examples, showcasing rich behavior including large deformations and complex, spatial motion. **There is a Lab Engineer from the ARAtronics Laboratory, guiding and directing the student with Assist. Prof. Dr. Eng. Amir Roushdy.**

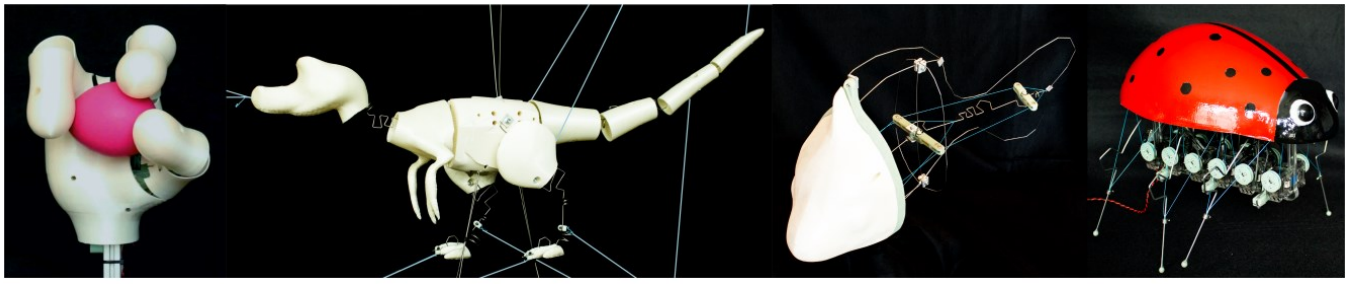

**Fig.:** Animatronics Robots Based on Kinetic Wires

### Project description and objective:

We will have our approach to design and fabricate a kinetic animatronic dinosaur, a stably walking robotic insect with 6 compliant wire legs, a soft robotic alien hand, a posable magnetic climber, compliant lamp designs and an animatronic fish with coupled wire contours. These demonstrations show the rich global behavior we can achieve by locally shaping the wire into spring-like entities of desired stiffness, size, and visual appeal, and furthermore validate our approach on input with large deformations and complex spatial motion.

### 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.

For more details please contact:
Assist. Prof. Dr. Eng. Amir Roushdy, Room: C7.108, E-mail: amir.ali@guc.edu.eg, Web site: www.aratronics.com

- 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".
- 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 project will be publish into one of the coming international conferences/journals.

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