Hiding The Squid! - Camouflage Patterns in Artificial Cephalopod Skin

About The Project

This project proposes systems for generating dynamic patterns in threads of soft artificial muscle made from dielectric elastomer (DE) material. Our system mimics the camouflage approaches used by cephalopods, whose network of chromatophore cells allow them to generate a wide range of patterns. This is approached by imposing simple rules that allow our artificial chromatophores to 'sense' their surroundings for use of control of their actuation. In particular, it is demonstrated that our systems are capable of mimicking the Passing Cloud display of the cuttlefish using the viscoelastic continuum model presented. Future work will focus on applications, for instance embedding polarising light filters with varying direction to display complex reflections of light, useful for search and rescue operations.

Dielectric Elastomers as Artificial Muscles

- We have modelled Dielectric Elastomers (DEs) as the material for our artificial cephalopod skin threads.
- They are, flexible, lightweight and strong and can stretch beyond 500% of their natural length.
- When coated with a compliant electrode they actuate under application of voltage, expanding the DE in the planar directions.
- By embedding sensors into the DE we can create smart materials, which can respond to changes in the material’s environment.

The Model

Threads of DE are modelled by splitting it up into a number of block elements joined together along a direction and placing fixed boundary conditions on the ends. Each block is discretised using two nodes constrained to move only in direction 1 and are joined through the sharing of their nodes. Using a viscoelastic model, the stress projected onto blocks is calculated and therefore the accelerations of the nodes. This forms an ODE, which is numerically integrated to estimate the motion of the material.

Pattern Generation

There are two types of cells; self-sensing and manual cells. The self-sensing cells act as agents that decide when to expand and contract their cell. Agents are able to detect the deformation of its surroundings and use it to estimate how many of its neighbours have expanded. The agent makes its decision using a rule-base, consisting of an activation and deactivation rule. The manual cells can be controlled by any external stimuli, e.g. a user toggling a switch, and serve as triggers that prompt self-sensing cells to switch between different patterns.

Supervisors:
Dr. Jonathan Rossiter
Dr. Martin Homer

Researchers by:
Aaron Fishman

Dielectric Elastomers as Artificial Muscles

- We have modelled Dielectric Elastomers (DEs) as the material for our artificial cephalopod skin threads.
- They are, flexible, lightweight and strong and can stretch beyond 500% of their natural length.
- When coated with a compliant electrode they actuate under application of voltage, expanding the DE in the planar directions.
- By embedding sensors into the DE we can create smart materials, which can respond to changes in the material’s environment.

Pattern Generation

There are two types of cells; self-sensing and manual cells. The self-sensing cells act as agents that decide when to expand and contract their cell. Agents are able to detect the deformation of its surroundings and use it to estimate how many of its neighbours have expanded. The agent makes its decision using a rule-base, consisting of an activation and deactivation rule. The manual cells can be controlled by any external stimuli, e.g. a user toggling a switch, and serve as triggers that prompt self-sensing cells to switch between different patterns.

1. Model of dissipative dielectric elastomers: J. Appl. Phys. 111, 034102 (2012); Choon Chiang Foo, Shengqiang Cai, Soo Jin Adrian Koh, Siegfried Bauer, and Zhigang Suo