The Mottier Innovation Challenge in Systems Engineering

Submission 1

1. Project Title
Soft pneumatic climbing/crawling robot

2. Please list team members, denoting department and undergraduate/graduate student
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4. What are you trying to do? Articulate your objectives using absolutely no jargon.
We are trying to design and fabricate a robot that is soft, flexible, and compliant and uses these features to climb trees, pipes, and any cylindrical object. The robot can be used for a variety of applications including pipe inspection, fruit picking, etc. The soft nature and pneumatic actuation allows the robot to be lightweight and safe for human-robot interaction.

5. How is it done today, and what are the limits of current practice?
Current robots that are used for similar applications are rigid, heavy, and expensive. They are also not suitable for human interaction due to rigid parts and heavy components.

6. What's new in your approach and why do you think it will be successful?
Our approach uses soft pneumatic actuators that are flexible, compliant and lightweight. They are very inexpensive to fabricate and use low pressure actuation. They are suitable for climbing or crawling application due to their flexibility and their ability to wrap around objects of varying dimensions. Our robot would use multiple such actuators that can bend in an arc to grasp any cylindrical object similar to an octopus's arm or a snake. A series of contracting and extending actuators are then used to propel the robot forward or backward.

7. Who cares? If you're successful, what difference will it make? What are the risks and the payoffs?
Oil and natural gas, nuclear, water supply industries have extensive pipe networks that require regular maintenance and checkups. Current robots are heavy, expensive, and are limited on the pipe dimensions they can operate on. Also, the current robots also require skilled personnel to operate. Whereas our soft robots are inexpensive, light and very human friendly and easier on their operation. The robot can also be used for fruit picking application by attaching a soft gripper to the robot. Our robot being soft and compliant would avoid any damage to the fruit while picking. This can pave the way for automating the fruit picking process and would be of interest to agriculture and farming industries. One of the challenges with these robots is due to their complex dynamics, it's hard to predict the pressure required to grasp a particular pipe.

8. How much will it cost? How long will it take? What are the midterm and final "exams" to check for success?
The robot would cost less than $100 for materials and fabrication. It would take around four-five months to come up with a functioning prototype of the robot. Midterm exam would be designing the actuators, connections, and have a working prototype with open-loop control. The final exam check would be to have a fully functioning soft robot with closed loop control that can climb/crawl any cylindrical object.