

## Developing an Educational Robotic Platform

Jacob Knaup

11/22/2017

### **Introduction**

The proposed research project will continue my work in Dr. Aukes' lab over the past two semesters with the goal of demonstrating that a robot can be designed and built by and for undergraduate and high school students as an educational tool. Dr. Aukes' IDEALab utilizes laminate construction to build foldable robots from cheap materials, allowing robots—such as the one I will develop through this research—to be constructed from scratch in a matter of hours by students using readily-available equipment. The resulting platform and the methods used to make it will be publicly available and designed for use by instructors in teaching robotic concepts to students.

### **Curiosity**

Traditional robots are complex and their manufacture requires advanced machining tools, largely limiting their use to military and industrial applications. This research employs curiosity to ask the question of whether robots could be simple enough to be designed and built by undergraduate and high school students. With STEM education on the rise, many educators are looking to introduce engineering and technology at younger ages. If a system for designing and building low-cost robots could be developed, then students could use this system to design and build robots of their own from scratch, and to use that experience as a teaching tool rather than relying on a kit.

### **Connections**

One solution to the problem of making robots cheap and simple enough for students to build is laminate construction. Foldable robots are constructed from cheap planar materials that are laser-cut into a desired shape and then laminated together into the finished device. I have been working in Dr. Aukes' lab building foldable laminate robots for the past two semesters, developing force-sensing and simulation solutions for foldable robots. My research will bring together this prior work as well as the mentorship of Dr. Aukes to develop an educational robot using laminate materials. The outcome will directly connect with students and educators through the class EGR 598 Foldable Robotics being taught at ASU next semester. In this class, students will be constructing their own robots in a semester-long project while going through the same process of design, modeling, simulation, and experimentation that I am going through. By sharing my modeling and simulation files with the class, they can be used as examples as the students develop their own robots, connecting my research to a real-life educational outcome.

Furthermore, I am currently working towards publishing a conference paper about my research for the spring semester. By publishing my work in an international conference, it will be seen by a variety of educators who can then utilize these techniques in their own classes. Moreover, the model and design files accompanying the paper can be directly used as examples from which students can build their own robots.

### **Creating Value**

Throughout the process, emphasis will be placed on developing not just the robot itself, but also tools and methods that can be utilized by others to build robots of their own. For example, in order to simulate a robot leg design, the game engine Unity was used in prior work in favor of more expensive and specialized software. By taking advantage of more accessible options and developing them beyond their intended use, methods can be developed that are more accessible for students and educators. This work will result in a demonstration of how laminate techniques can be used to build educational robots. These same techniques can then be used by students to build their own robots and optimize them with unique constraints and objectives. Therefore, my work will create value not just for ASU students in foldable robotics, but also for students and educators around the world in other universities. If the paper is used as a framework in college classrooms, it would only be a short step for it to be adapted into a high school curriculum. This usage would be further aided by making a series of tutorial videos walking through the process used to design, simulate, construct, and test my robots for the paper. Therefore, my research will create value by resulting in published results and tools to be adopted by educators and used in classes.