silicON

A Wearable Exoskeleton for Upper Limb Stroke Rehabilitation

Every year, **more than 795,000** people in the United States have stroke. About **%87** of all strokes are ischemic. **Current rehabilitation** only begins at the earliest of **one month after** hospital treatment. Recent studies show that **immediate rehabilitation** of ischemic stroke victims helps **significantly** to recover brain plasticity and to improve their muscle functions. A **repetitive exercise routine** within the first month of stroke **prevents** spasticities and muscle deformation.

silicON is a soft robotic silicone-based sleeve targeted for rehabilitation of a stroke patient's tricep and bicep muscles. The soft robotic sleeve uses the flow of pressurized air into and out of channels within the sleeve. **silicON** offers a full range of motion for a user's arm while providing repetitive assistive training. **silicON** uses pneumatic actuators and silicone-based materials making the product more affordable, lightweight and more compact. We are currently working on our prototype 2 adding more aesthetics and a better control system to our prototype 1.

We are aiming for immediate treatment of ischemic stroke patients within one month of their hospitalization along with their drug therapy. **%87** of strokes are **ischemic**. In 2014, around **580,000** people had ischemic stroke. American Heart Association projects additional **3.4 million** will have had stroke by 2030. On average, **every 40 seconds**, someone in the US has a stroke.

Current solution of immediate treatment is a rehabilitation practitioner. The cost of whole treatment is **~$140,000** with a rehab practitioner for three months of rehab. This is primarily due to spasticities or muscle deformations developed in the patients.

Although there are robotic solutions of **~$100,000** like InMotion Arm aiming for post-hospitalization treatment, **silicON** is unique in aiming for in-hospitalization period of rehabilitation with the addition of affordability.

silicON is currently being developed as a MEAM Senior Design Project. The final version will be ready by **April 20th**. We have already built a prototype 1 that is able to perform semi-autonomous assistive training. We are working on prototype 2 incorporating a more advanced control system allowing a fully autonomous training, and on manufacturing an aesthetically beautiful and comfortable sleeve.

Including the spendings of Prototype 1, Prototype 2 and the expected cost of Final Prototype, all parts required for manufacturing, building, and testing cost around **$900.** The estimated cost per unit covers silicone cures ($6 per unit), 3D printed molds ($2 per unit which can be used multiple times), tubing ($2 per unit), sensors ($40 per unit), Arduino UNO ($25), air supplier ($40) - a **total cost of $115** which could be less than $100 by using custom sensor and microcontroller boards, and custom air supplier.

silicON is being developed by

Ashlee Anderson
Experienced in manufacturing, rapid prototyping and strength of materials. Will be responsible for material science research, as well as design and manufacturing of silicone molds and sleeves.

Sahan Ayvaz
Experienced in software programming; familiar with mechatronics. Will produce the electro-mechanical valve control architecture and program Arduino/Raspberry Pi to optimize the feedback loop and provide semi-autonomous motion.

Theodore A. Brochu
Experienced in 3D modeling, air-flow load calculation in HVAC applications, and project estimating. Will assist in pump sizing, structural design, and material analysis.

Thomas Tallerico
Experienced in design of mechanical systems and pumps. Will design valve system and assist with software integration.

Ana de la Vega-Hazas
Experienced in 3D modeling with Autodesk Inventor and materials science. Will assist with material science research, prototyping and integration of electronics.