BabyBot: Rehab Device for Infants with Cerebral Palsy

Project Sponsor: Susko and Hawkes Labs

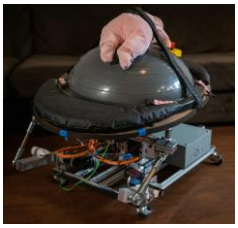
Broadly defined as a brain injury occurring before the age of 2, Cerebral Palsy (CP) is a disorder caused by a static brain injury occurring before the age of 24 months that affects 1 in every 300 children in the U.S. Often the only way to repair the damaged brain is rehabilitation. The objective of this project is to create the first ever in-home rehabilitation robot for infants with established risk for movement abnormalities (most of which will be diagnosed with Cerebral Palsy). With the progression of Covid-19, the need for rehabilitation robots have only become more apparent but with it comes some additional benefits: the volume of training can be an order of magnitude higher, new and precise kinematic and kinetic diagnostics can be quickly recorded, and the generation of big data can predict rehabilitation treatment response.

Over the last 4 years, 4 Capstone teams have developed 4 entirely different designs for the BabyBot, each improving on the performance of the previous designs while also addressing key issues that were identified. All iterations were highly successful, with awards won nearly every year since its conception and hopefully more to come this year!

BabyBot Year 1

BabyBot Year 2

BabyBot Year 3



BabyBot Year 4

The Year 1 system used around 30 independent motors to create a shape-shifting crib surface to create an environment that fosters movement for infants (see figure). Year 2 of this project saw a shift in the paradigm for delivering therapy to infants, attempting to recreate ball therapy done in the clinic by placing the child in a nest and tilting the platform. This version of the machine was tested with a live infant and was highly regarded by local pediatric physical therapists. However it was far too large to put in the clinic. Year 3 saught to miniturize the system, which was accomplished using a race car simulator. The project was impressive but not usable due to COVID shutting down the machine shop and campus. Year 4 (last year) sought to improve electronics and control and also to add a bouncing function. This was

accomplished quite nicely but the machine is not finished to the level at which therapists can put live babies on the device. The user interface, software and hardware all need one more iteration. So, year 5 is it! Your project will benefit greatly from the work done before you. This project will be exciting because it is 1) multidisciplinary, 2) you have a really good direction and prototype to start with 3) You will get to redesign the whole thing 4) you will get to witness live therapy with infants and 5) we will hopefully find a live infant to test with by the end of the year and 6) I expect this device to be used in a clinical trial going forward, it may directly make a huge difference in the lives of disabled youth! 7) It's a robot!

- Designing a data analytics system - As mentioned before, one of the biggest benefits of automated therapy is the ability to collect and analyze data. Requires creativity to decide what data could be beneficial and what hardware will be implemented to collect and analyze this data. Knowledge/skills in embedded systems (including PCB design), data science, controls systems, and signal processing are all desirable.

- Achieve robustness and safe operation - Last year's design was clever and integrated a bounce feature. However, the final concept is made of 3D printed plastic (durability will be suspect) and it may not be the best way of doing the bouncing. The device should look like something off a store shelf and it should look fun!

- Preparing the device for patient testing and use - The ultimate goal for this year is to make Babybot ready for patient testing. Not only does this mean meeting the size, weight, and electrical specifications, but it also means creating a system that will keep the patient involved in the machine in the form of gamification of therapy for the infants.

Skills and interests for this project include:

- Machine Design
- Mechatronics and Robotics
- Control Systems
- Mobile Embedded Systems
- PCB Design
- Product Design