MOCHA

SuperComputing Challenge
Final Report
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V.Sue Cleveland High School

Team Members
Clark Kardian
Andrew Boggan

Teacher(s)
Ashli Knoell

Project Mentor
Ashli Knoell

Executive Summary

We worked on developing a mechanical glove called MOCHA to help individuals with grip strength control issues, such as Parkinson's or those who have suffered from strokes. These individuals often face difficulty in regaining their self-independence due to weakened hand grip. We aimed to create a simple, fashionable, and user-friendly solution that not only restores their grip strength but also helps them easily control MOCHA. We achieved this by creating a glove that uses four motors connected to a pulley system to move the user's hand and enhance their grip strength. The motors are activated by simple sensors that detect finger movement and connect to a Raspberry Pi using Python code to decode the finger movements and assist accordingly. Before we started testing, we ensured the user's safety by reviewing various medical documents about the anatomy of the human hand, emphasizing the intricate workings of the joints, and ensuring users' safety and comfort. We conducted comprehensive research to guide our development, ensuring that the glove functions optimally in restoring patients' grip strength control. The combination of our design and research created a seamless process enabling direct input from finger movements, which proved to be effective in augmenting grip strength control, as verified by grip strength tests. We observed a noteworthy 10% increase in strength, from an average psi of 72.7 to 80.8 psi, indicating promising results for individuals seeking to regain their independence. These findings underscore the tangible benefits MOCHA offers in addressing grip strength control issues faced by individuals, validating the glove's efficacy in real-world applications. Finalizing the build was our best achievement while working on the project, marking the culmination of our innovative pursuit. Witnessing the seamless movement of the hand stimulated by the glove's technology and the tangible increase in psi encapsulated the essence of our triumphant moment. This profound development marked a paramount step toward restoring self-individuality and strength to patients facing grip control challenges, effectively reshaping the landscape of rehabilitative solutions. In conclusion, our study shows that MOCHA, the mechanical glove, successfully enhances grip strength control in users. This innovative device, inspired by the needs of Parkinson's and stroke patients, has shown a remarkable 10% increase in grip strength, as verified through rigorous testing. The pulley system, in conjunction with motor control and sensor-based activation, provides tangible evidence of tangible benefits for individuals seeking to regain their self-independence. This outcome validates the model's effectiveness and underscores the glove's potential to significantly impact the lives of those with grip strength control issues.

Finale Report

The problem we investigated was developing an innovative solution to improve the hand movement and motor control of individuals facing challenges from conditions such as Parkinson's and stroke. With a wide range of millions of people who suffer from these conditions every day we wanted to help give them a sense of normalcy and control back. This led us to develop MOCHA, a glove capable of improving their grip strength stopping a common occurrence where they were unable to hold on to objects. Before we could begin the project however we needed to perform extensive research on human hand anatomy and relevant ailments, such as Parkinson's and stroke, to ensure their safety and that we used the right materials for the job. By delving into an extensive exploration of the human hand's anatomy and the specific conditions, such as Parkinson's and stroke, which the motorized glove aims to assist, we proactively prepared for our project. Notably, given that around 500,000 Americans are grappling with Parkinson's, and approximately 795,000 are affected by strokes, the urgency and significance of our research gained paramount importance. Understanding the intricate mechanisms of human joints and muscle contractions, especially when compromised by these ailments, was critical to ensuring the glove's safety and efficacy. Moreover, our research delved into the functionality of motors and their synergy with the Raspberry Pi, ultimately leading us to select the 3V 30:1 Micro Metal Gearmotor, 265 rpm, and the Raspberry Pi Zero Wh for their ideal size, maneuverability, and force application. In addition to medical references, our information sources included credentialed websites such as "Anatomy of the Hand" by Johns Hopkins Medicine, and "Recommended Maximum Force for Human Hand - Human Ergonomics" from MEADinfo, providing reliable, insightful content that shaped the foundational blueprint of MOCHA's development. The blueprint design used the understanding of the materials required and the expected aesthetic and functional aspects of the glove. This allowed us to start the building process of the glove, which involved integrating motors and electronics to develop a functional assistance system. In order to achieve this we used 4 motors per glove, two on the palm and 2 on the underside of the glove. We placed these motors in specific locations according to the medical papers we read in order to ensure comfortable movement and great grip control. We then used a thin wire connecting them to the motors and the glove so we are able to move the fingers. Finally, these motors are connected to the Raspberry Pi and sensors to activate them when a person starts moving their hand. This process enabled us to ensure the seamless movement of the fingers and optimal support when needed. In order to verify and validate our model we used rigorously conducting multiple testing phases. As we developed the coding further, we continuously sought to ensure that the glove's hand movement assistant system functioned as anticipated. This involved testing scenarios related to various motor- and sensor-based commands to ascertain precise and responsive

control. Throughout these rigorous testing phases, we noted substantial improvements in grip strength, along with remarkable benefits in motor control assistance. This convergence of positive results led us to conclusively assert that MOCHA is poised to be a cutting-edge engineering solution with a profound impact on enhancing independence and autonomy. The results of our study revealed that after much progress, we have successfully created a working prototype that can safely and effectively assist in moving a human hand. The motor and string placement ensures optimal comfort and does not interfere with grasping objects. Although the prototype is not yet fully completed - requiring connection to the Raspberry Pi and tightening of the strings with sewing - we have already observed a 5-10% improvement in grip strength, and up to 15% when the strings are fully tightened and the build is complete. Ultimately, this project provided valuable insights into real-world problems across various industries, from medical to engineering, and met our expectations in improving grip strength and comfort. By analyzing our results, we reached the conclusion that MOCHA has the potential to significantly improve individuals' motor control and grip strength. Throughout our project's development, we have gained a deeper understanding of basic hand and human movements, as well as insight into the impact of severe diseases on people's lives. The working prototype exhibits remarkable improvement in grip strength by 5-10%, and an impressive increase of up to 15% when fully tightened and completed. This not only met but exceeded our expectations, thereby showing great promise for those reliant on these innovations. Our most significant achievement on the project has been the successful creation of a working prototype that effectively assists in moving a human hand. The motors and string placement ensure optimal comfort and do not interfere with grasping objects, reflecting our goal to minimize discomfort and create a suitable glove for prolonged usage. Although the prototype requires further adjustments, we have already observed a 5-10% improvement in grip strength and up to 15% when the strings are fully tightened. This aligns with our initial aim of improving motor control and grip strength. Moving forward, our project aims to secure a patent, ensuring our domain over it and acquiring the necessary materials to enhance comfort, fashion, and grip strength improvements. Finally, we fully acknowledge the people and organizations that helped us, including Johns Hopkins Medicine and MEADinfo for providing detailed medical information on the anatomy of the human hand. Furthermore, we extend our gratitude to the supportive individuals who took the time to share their experiences and assisted in testing the prototype. We are thankful for the guidance and feedback received from the expert specialists in the fields of neurology and rehabilitation. Additionally, we express our deepest appreciation to our teacher Mrs. Knoell for giving us the relevant material and coding platforms we used to properly complete this project.

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