Prosthetic Hand Using Microcomputers and Sensors

JERON OSGUTHORPE, SUU SUCCESS ACADEMY, CEDAR CITY, UTAH USA

FAIR/PROJECT ID: ETSD062

Introduction

Engineering Goal: Create an affordable prosthetic hand that can run many of the same functions as other prosthetic hands

For those with disabilities, specifically those who require prosthetic hands, the prosthetics can be hard to afford. In fact, just for a cosmetic prosthetic, they cost at least $5,000 going up to even $20,000.

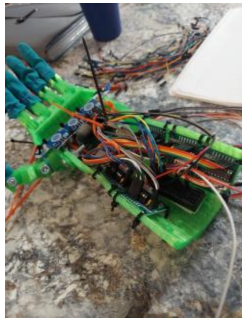
For a prosthetic that has a hook for functionality, they can range up to even $40,000. And the latest technology that has a lot of functionality, they can reach up to even $100,000.

For someone with a disability, this is a major problem. Not only do those with disabilities make on average 13% less than those without a disability (in America), but they also often must pay for their own prosthetics.

Now there has however been some work on this problem. Many organizations and institutions have resorted to 3D printing as an option for creating cheaper prosthetics. However, they are still wildly expensive with the lowest costing official 3D printed prosthetic costs around $2,000.

With this being a continuation from my last years studies, I found that 3D printing was definitely the way to go when it comes to the production o the hand itself, however, this year, I decided to use the 3D printing to create a much more realistic prosthetic that with using multiple sensors and more motors, can complete many of the same functions as other prosthetics.

Photos (pictures taken by Jeron Osguthorpe (me)):



Methods

With the help from other organizations and designs, I was able to find a design that for my project, could be 3D printed and follow the same concept as my project from last year.

With my project, I decide to use string/line, motors, and sensors. The 3D hand that I ended up using was a design that used a tensioner and line to open and close the hand. However, instead of using a tensioner, I used microcomputers, sensors and motors to move each individual fingers based off the sensors.

I originally printed out the 3D hand and used screws to put the hand together. I then mounted each of the motors and sensors by drilling holes and securing the driver boards with zip ties. Afterwards, I connected all the motors and sensors with connection wires (totaling around 64 wires) and started the programming.

For the microcomputer controller I used a Raspberry Pi (model 3B+) as well as python programming to control the motors and receive data from the sensors. For the sensors I used a Micro:Bit (v1.0) and simple touch sensors to receive data. By taking serial data received by the Micro:Bit, I then used Python if/then statements to have the hand complete certain functions based off the combinations of sensors received by the Micro:Bit.

The role of the touch sensors was to stop the motors from moving when the hand gripped onto an item/when the touch sensors detected something. After the prototype was built, I then tested it by running the code and having the hand complete certain tasks such as holding an item, pushing buttons and showing gestures.

* = Struggled but Still worked, ** = Worked but not sure it worked correctly (no way to see)

Results

The tests consisted of many tasks including tasks for the physical hand to complete as well as tasks for the code to complete. Some of the physical tasks consisted of picking up items, pushing buttons and showing gestures. Some of the tasks for the code were receiving data and completing if/then statements as well as running each of the motors without overstepping.

Task	Result
Pick up Item	Successful
Hold Pencil	Struggled*
Shake Hand	Successful
Make a Fist	Successful
Push Buttons	Successful
Point	Successful
Show Numbers	Struggled*
Gestures	Struggled*

Display Serial Data From Micro:Bit	Motor Left and Right Resutls:
Sense 1 (B’1’) = True	Motor 1 Left = Successful
Sense 2 (B’2’) = True	Motor 1 Right = Successful
Sense 3 (B’3’) = True	Motor 2 Left = Successful
Sense 4 (B’4’) = True	Motor 2 Right = Successful
Sense 5 (B’5’) = True	Motor 3 Left = Struggled*
Sense 6 (B’6’) = True	Motor 3 Right = Successful
Sense 7 (B’7’) = True	Motor 4 Left = Successful
Sense 8 (B’8) = True	Motor 4 Right = Struggled*
Sense 9 (B’9’) = True	Motor 5 Left = Struggled*
Sense 10 (B’10’) = True	Motor 5 Right = Successful
Sense 11 (B’11’) = True	
Sense 12 (B’12’) = True	
Sense 13 (B’13’) = True	
Sense 14 (B’14’) = Might have Struggled, not Sure **	

Discussion

As stated earlier, many prosthetics are widely expensive and its hard for those with disabilities to afford them. From my results, comparing my results to how much prosthetics cost, one with similar functionality would cost around $24,500. However, for a consumer, my prosthetic hand would cost around $105 to up to $200 depending on parts used, quality of 3D print and shipping. By comparing these prices, we see that my project costs about 0.429% of the cost in comparison.

This means that with the results, my prosthetic hand, with some upgrades could be a much more cost-efficient way of providing prosthetics for those who need them.

With the project being based off Python programming, this also means that over time, the project can even be upgraded just by sending out new software to those who need them. So instead of having to get a whole new prosthetic in order to get more functionality, the hand could even do more functions just by updating itself.

However, some of the problems that I ran into while creating the hand are mostly the printing process and the code. With the printing, it took over 48 hours of printing and multiple tries on almost every single part to get it printed out correctly. With the code, some of the time it would skip some steps, however, after some more refining of the code, I was able to straighten that out by requiring it to complete those steps to continue. With the code, I also had trouble running the motors as they are a unique type of motor. In the end, the only remaining problem were simple things such as some of the time the fingers would struggle to move with the hand.

Conclusions

In the end, my project accomplished many of the goals that I had for it. Even though it may have had struggles and could definitely be improved upon in the future, the overall prototype though accomplished the main goals.

With the hand costing only 0.429% of the cost, this makes it a lot easier on those with disabilities, as they won't have to pay as much for a prosthetic. Because of the 3D design, the hand can also be customized to everyone, as everyone is different (within certain parameters).

The project ended up being a lot more of a success compared to last years prototype, as this prototype was more durable, better functioning, more realistic and only a little bit more expensive overall.

References

Photos Taken By Jeron Osguthorpe (me)

Acknowledgements to Shanae Osguthorpe for help and support of the project, she helped collect photos, run tests and even assemble parts of the hand under my instruction.

Acknowledgements to Eyshia VanIperen for also helping me with both years projects with the 3D printing, photos, running tests and assembling parts under my instruction.

Acknowledgements to Remington Anderson, as well as the open-source code community such as GitHub and Stack Overflow for helping me with the development process of my code.

Open-Source Project Timeline (currently open, might change if copyright registered): https://github.com/jerono-coder/2021-2022-Science-Fair-Project/blob/main/README.md