Robotic Hand

PERSONAL PROJECT

12/23/2017 | 3,969 words

1. Investigating

    i.   Define a clear goal and global context for the project, based on personal interests

    ii.   Identify prior learning and subject-specific knowledge relevant to the project

    iii.   Demonstrate research skills.

2. Planning

    i.   Develop criteria for the product/outcome

    ii.   Plan and record the development process of the project

    iii.   Demonstrate self-management skills.

3. Taking Action

    i.   Create a product/outcome in response to the goal, global context, and criteria

    ii.   Demonstrate thinking skills

    iii.   Demonstrate communication and social skills.

4. Reflecting

    i.   Evaluate the quality of the product/outcome against their criteria

    ii.   Reflect on how completing the project has extended their knowledge and understanding of the topic and the global context

    iii.   Reflect on their development as IB learners through the project.

5. Bibliography and Appendix

Investigating

DEFINE A CLEAR GOAL AND GLOBAL CONTEXT FOR THE PROJECT, BASED ON PERSONAL INTERESTS

My goal for this personal project is to design and create a prosthetic hand capable of moving its fingers so that it can grab things with the purpose teaching kids how robotics is used in real-life situations and to show them that it is possible for them to create other types of robots. The main global context for this project will is Scientific and technical innovation. I choose scientific and technical innovation as the global context for this project because the reason kids now don't know about robotics is that the teachers and parents in their lives don't know how easy it is to use robotics to solve everyday problems. This is not good because the kids will never end up learning about robotics and all of this is because there has not been enough innovation in certain countries like Spain for robotics to be taught in schools. I based this on my personal interests because I am really into robotics (given that I have won a few competitions in robotics before), because of this I would like to give other people the chance to study robotics as well.

IDENTIFY PRIOR LEARNING AND SUBJECT-SPECIFIC KNOWLEDGE RELEVANT TO THE PROJECT

I think that the only prior learning that I had from school was two things that I learned in digital design. One of the thing that I had learned in digital design was the basics of 3d modeling, I say the basics because the program and the techniques that I used while designing my project were a lot more advanced from what they thought me in digital design. I used 3d modeling to design the parts that would make up the frame of my prosthetic arm. The other thing that I learned from digital design was the very basics of how to program. I say the basics again because the code that they thought was with blocks (like for example scratch), the block code is very basic because it is what you use to teach kids that are around 6 to 7 years old how to program. I used coding in order to program the Arduino so that it picked up an analog signal from the electromagnetic sensor and then if the signal from the sensor was strong enough it would send another signal to the motor for them to move the fingers in the hands. Most of the techniques and skills that I will be using in the making of my project I have learned on my own or through the internet. Without all the prior learning mentioned above, I would not have been able to complete this project because the two things that I have mentioned are the two very basics of robotics (3d design and programming).

DEMONSTRATE RESEARCH SKILLS

Sources

Background reading and research

I visited my school library to do some research on robotics, electronic circuits, and prosthetics. I didn't really find out much about robotics in the school library, the only thing that I found was all about how technology has advanced in that area. But there was really nothing about the making of robots (which is what I was looking for). All the books that I found about electronic circuits were meant for kids and for studying physics, in all of those books the circuits were too basic and I needed something more advanced in order to make my prosthetic arm. And about prosthetics, I found nothing at all. As you can see I didn't find much information for my project in the school library.

Thingiverse.com (Makerbot)

Thingiverse.com is an open source 3d printing website. This means that people from all over the world can upload their 3d model for everyone else see and the try and print for themselves. I visited Thingiverse to get a few ideas on how to make the design of my prosthetic hand. I also learned from Thingiverse that I could use flexible paracord and fishing wire to act as tendons in your arm, before that my plan was to use one motor for each joint on the fingers which would have made the final product a lot more expensive and I would have functioned a lot worse. Here is some link to some of the designs that I found helpful:

- https://www.thingiverse.com/thing:18939
- https://www.thingiverse.com/thing:2269115

Github.com (GitHub)

Github.com is an open scoured website for everything to do with computer science, robotics, Linux plugins, and programming, there are even a few full-sized operating systems on GitHub. I visited GitHub so that I could get a few ideas on how to structure the code that I need to make the Arduino circuit work. While looking through GitHub I found two different designs that stood out to me a lot. One of them was an arm that mimicked the movements captured by a movement sensor, this means that the robotic hand would mimic the hand movements of an actual arm. There are two problems with this, one of them is that it would be expensive to buy one motor for each finger and I am trying to make a prosthetic so there won't be an arm to mimic. The second design used a myoware muscle sensor to move the arm. I liked this one more because you could use it as a prosthetic. Here are the two links:

- https://github.com/tt-anderson
- https://github.com/tt-anderson/robotic-arm-software

Interview with doctor (Bueno)

Since my project had a lot to do with medicine (being a prosthetic and using microcurrents) I decided that I would be a good idea to interview a doctor. The doctor that I interviewed is called Dr. Elena Bueno. She told me that microcurrents were very small amounts of electricity that flowed through your nerves system and muscles and she also told me that when you tense your muscles the microcurrents in your body increase and when you relax your muscles the microcurrents decrease. This later fits into my design because I would use microcurrents in order to control the movement of the arm.

Planning

DEVELOP CRITERIA FOR THE PRODUCT/OUTCOME

Criteria

- Aesthetics
    - o The prosthetic arm that I will make as a teaching tool for the classes I will be presenting to will have to shape of a regular hand given that that's what I want to create, to show kids how detailed a 3D printer can be.
    - o The texture of the arm will be a bit rough on the outside but will be nice and smooth where the amputee will put his arm
    - o The total weight of the arm will not go over 500g
    - o The class will be no longer than 40 minutes
- Cost
    - o I want to show the kids that the price of a typical prosthetic hand is around 200 dollars and I doesn't even move and a hand that does move costs around 1500 dollars. I want them to know that with basic robotics it will cost me around 150 euros to make a working prosthetic hand instead of 1500.
        - ▪ Servo = 11,83 * 2 = 23.66
        - ▪ Arduino Nano + shield = 11,11
        - ▪ 6v battery = 10,99
        - ▪ Nylon paracord = 7,89
        - ▪ Myoware Sensor = 39.99
- Customer
    - o My prosthetic arm is meant to teach kids from grades 6 to 10 how robotics can be used to solve everyday problems
- Environment
    - o Since the plastic that I am using to make this hand is PLA it can be recycled
    - o All the electrical components can be removed and reused
- Size
    - o The size of my product will be the size of a normal arm
- Safety
    - o All the electric components will be stowed away so there is no risk of electric shock
- Function
    - o My products role is to function as a prosthetic arm for amputees
    - o And to teach kids on how robotics is used every day
    - o I will use my arm to teach kids because it will not pass the regulations for it to be used as a prosthetic
- Material

- o My product will be mostly made of PLA plastic
- o I used PLA because it is cheap and easy to use
- o It would be better if the was made from cast plastic because it would be stronger
- o All the plastic pieces were 3D printed

How I changed my design

The first design that I made used 5 motors to move the hand, four of the motors would be stored in the forearm while one of the motors will be stored in the hand. The motor that I will store in the hand will be used to move only the thumb. The four other motors will be used to move the other four motors to move the other four fingers on the hand. I will control the hand by using the myoware muscle sensor. This sensor detects the micro current flowing throw your nervous system. There is one main problem with this design is that the price would be too high because of the motors, the total price of this project would be around 200 euros. Here is a link to the pictures of this design:
https://goo.gl/ev04UB

The second and final design that I came up with used 2 servo motors to move the fingers on the hand. One of the motors will control 3 fingers and the other motor will control the other 2 fingers. I will control the fingers by using the myoware muscle sensor. The sensor reads the micro current flowing throw your nerves system. The only problem that I see is that the fingers don't have independent movements, but this is because I wanted to save money on this project. The total price of the full project would be around 130 to 150 euros.

How are the criteria challenging?

The criteria that I chose are challenging mainly because of its main function. The main function in the criteria is to use a working prosthetic arm as a teaching tool. This I hard mainly because the kids that I will be teaching to don't even understand the basics of robotics. This is challenging because I must explain my project in detail to them while still trying to keep their interest as well as having to basically simplify my presentation so that it is easier for them to understand what I am trying to say.

I decided to teach people about robotics because it is something that I do as a fun hobby and I am starting to get into it professionally. I think that the main reason people today don't really think about robotics as a hobby because they don't know how accessible and easy to learn it really is, and for this reason I wanted to show people that it is also possible for them to learn and do robotics as a hobby or maybe even professionally.

PLAN AND RECORD THE DEVELOPMENT PROCESS OF THE PROJECT

How has my plan developed?

One of the main this that hindered my project was me leaving for Miami. The reason for me leaving for Miami was that I needed to renovate my reentry permit, which is a

document that I need to keep my citizenship. Other than me going to Miami there were no other changes to my plan.

The biggest obstacle that I had to overcome, was choosing the product. This was a problem for me because I had so many ideas flowing through my mind that it was impossible for me only focused on one, finally after around 3 weeks of thinking I came up with the idea of making a prosthetic limb that function like a real one. But this cause another problem and that was that I didn't know anyone that is missing an arm in order to help me test my arm, so after talking to my supervisor we decided that my project would be to teach kids about robotics using my robotic arm as a teaching tool.

DEMONSTRATE SELF-MANAGEMENT SKILLS

I think that I am around average when it comes to self-management. When it comes to my strengths I am good at planning ahead on what I am going to be doing, both in short and long-term periods of time. My limitations when it comes to self-management are mostly when it comes to doing the work, this is mostly because I get off topic or something else comes up that I give more importance to. I think that two main effective skills that I practiced throughout the project were self-motivation and emotional management. I practiced self-motivation because during the making and presenting of my project there were a lot of setbacks, during the making of the project the main setback was that I kept forgetting the materials that I needed in my other house and because of this I kept needing to go back and forth from each house. During the presenting of the project, the main setback that I had was that I went to Miami during the time that I was supposed to be presenting and sometimes the teachers that I was going to be presenting to rescheduled so I couldn't present that day. I practiced emotional management mostly because I am the type of person that tends to procrastinate a lot, because of this I used emotional management to deal with anxiety. What I mainly did to stop procrastinating and worrying about how my project would turn out was calmly take a nice deep breath, and if I was still stressed after that I took a little 5-minute break.

I would say that I am quite an organized person even though I tend to run into a few hiccups. I think that for this project I have managed my time quite well using both time graphics (a website for making timelines) and google calendar to set myself long and short-term goals. In the appendix, you will find a screenshot of the timeline I flowed while working on my project.

I think that all of my presentations went really well, for all of the classes that I presented to. I started all of my presentations by explaining to my audience what a robot is and what a prosthetic is. Then I started to explain what an Arduino is and how it works by explaining each individual part of the Arduino. When I finished explaining about the Arduino I started to explain to them how the circuit inside the hand worked and finally I let 2 or 3 of them try to control the hand. I recorded my presentations by asking the teacher of the class to record me or take pictures of me presenting. Sometimes I showed a

time-lapse video of my building my robotic hand to the kids while I was fixing the arm onto a kid so that he could try it out.

Taking action

CREATE A PRODUCT/OUTCOME IN RESPONSE TO THE GOAL, GLOBAL CONTEXT AND CRITERIA

To measure the success of my outcome I gave each class I went to a survey. Given the results in the chart below, I would say that my presentation was a complete success given that 32 of the students that I presented to, rated my presentation excellent and another 10 students rated my presentation as good. There are still 2 students that gave my presentation an awful rating. I think that my project has completely met all the criteria that I had set for it, except for one that I set in the aesthetics section which was "Its texture will be a bit rough on the outside but will be nice and smooth where the amputee will put his arm" I didn't for fill these criteria because I was not actually going to put this on to a person's arm, so I didn't need to do that in order to give the presentation.

Graph of results

■ Exelent   ■ Good   ■ Marginal   ■ Bad   ■ Very bad   ■ Awful
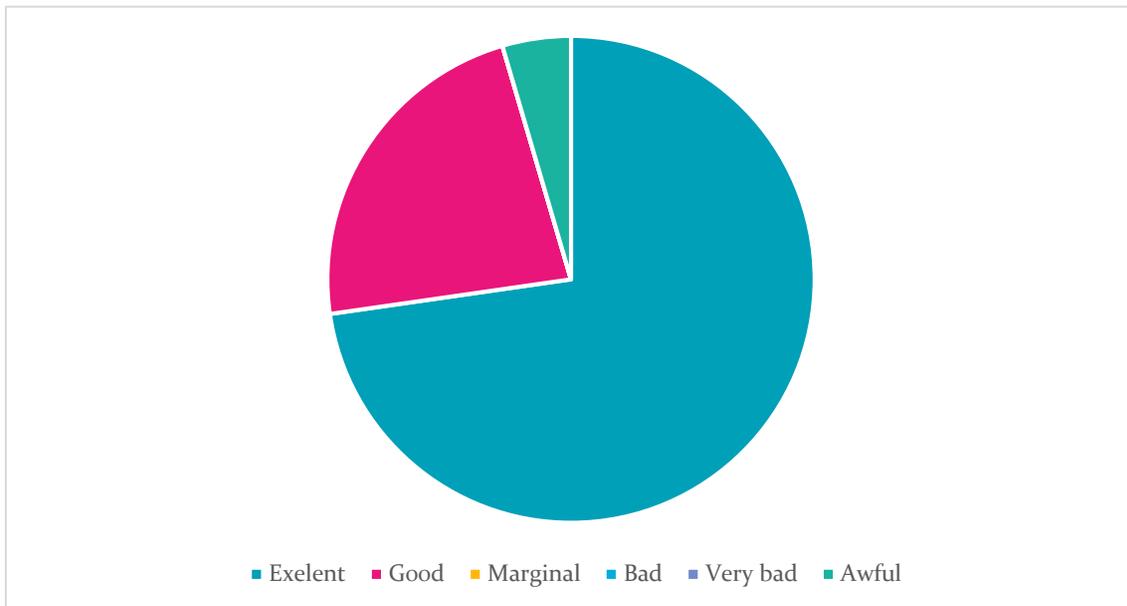
DEMONSTRATE THINKING SKILLS

I think that with this project I have been very creative. I think that I have been created mostly because of the large number of design ideas that I have had and because of the number of ideas that I have had for the project in general. I have had around 3 different

design ideas for this project, even though they were all a bit similar they were hard to come up with mostly because of the different parts that I had was planning to use. I had a lot of creativity when it came to deciding what I was gone do with my project because at the beginning I had around 50 different ideas from a submarine to a full robotic arm.

The research that I had done changed the outcome of my project a lot. The main reason for this is because my initial intention was to make each joint in each finger have a dedicated motor. The problem with that is not only that it would look extremely ugly but that the total price of the project would be around 500 euros. The research that I did change my design because instead of using one motor for each joint on the fingers I would recreate the tendons that pass through the finger and pull on them with a motor, this way I could use one motor for up to 2 fingers, this would not just make the design look better, but I would also make it cheaper.

DEMONSTRATES COMMUNICATION AND SOCIAL SKILLS

For this project, I have only met with two people to help me. The first person that I meet with for my project was my assigned supervisor. I meet with him around 4 times to plan out my timetable and to check that I have everything up to date. The second person that I have met with is Dr. Elena Bueno. I meet with her once and it was to interview her about microcurrent which is flowing through the body, given the I am going to be using microcurrent to control my arm.

Reflecting

EVALUATE THE QUALITY OF THE PRODUCT / OUTCOME AGAINST THEIR CRITERIA

As I said before my project has met most of the criteria that I had set it. The only part of the criteria that I haven't done is inside the aesthetics area and it says, "Its texture will be a bit rough on the outside but will be nice and smooth where the amputee will put his arm". As I said before in the "Taking Action" section, the reason why I didn't do this part of the criteria is because I was not actually planning on putting this on a person's arm, this is because I hadn't designed them for it to fit onto an arm because for me to do that I would have to find a person with one arm and take some measurements.

Given the pie chart that I showed in the "Taking Action" section, I can confidently say that that the feedback that I got for my presentations was overly positive. I think that all of my presentations went really well, there is only one that I think I could have majorly improved on. This was the first class that I had with 6 sixes, I think that my main problem with this class was that I was saying things that were a bit too complicated for them, but next time I had a class with grade 6 again I made sure to simplify the contents a little so it would be a bit easier for them to understand.

REFLECT ON HOW COMPLETING THE PROJECT HAS EXTENDED THEIR KNOWLEDGE AND UNDERSTANDING OF THE TOPIC AND THE GLOBAL CONTEXT

I started to become more knowledgeable about the global context that I had chosen (Scientific and technical innovation) during the research part of the project. This is because during that period I did some researching about companies that make prosthetics and while looking at these companies I noticed that the prosthetics that they sold 10 years ago and the prosthetics that they sell now are completely different. The reason of this is that because of technological innovation (which is the main part of the global context that I chose) the prosthetic industry has evolved a lot.

REFLECT ON THEIR DEVELOPMENT AS IB LEARNERS THROUGH THE PROJECT

I think that in the learner's profile I have mostly developed: Knowledgeable, Thinkers and Communicators. I chose knowledgeable because during this project because during the research section I learned a lot about prosthetics and medicine which I would not have had any interest in normally. I also selected Thinkers because in the making of my project I encountered a lot of problems that I had to face, so I used a bit of creativity to solve them. Finally, I chose communicators because while presenting my project I would have to communicate my ideas with the kids in the class that I was presenting to.

Bibliography

Bueno, Dr. Elena. *Micro Currents* madrid, 1 january 2018.
    <http://zerosimple.net/Personal_Project/2018-01-01%2021-33-31.mp4>.

GitHub. *GitHub*. n.d. GitHub. 3 october 2017. <https://github.com/>.

Makerbot. *ThingiVerse*. n.d. Makerbot. 30 Septemder 2017.
    <https://www.thingiverse.com/>.

Appendix

PROCESS JOURNAL ENTRIES

Date	Entry
October 21, 2017	I have looked at many robotic hand designs and decided that this one would be a good design. I think this because it can easily fit 4 servos in the arm for the fingers and one in the hand for the thumb. It uses flexible paracord to keep the fingers and thumb upright. I have also created a GitHub repository for all the files that I will be using to create and design this project (My GitHub username is: Simple089)
November 10, 2017	I did some research on where to place the myoware muscle sensor. I decided that the best place for it would be to have one electrode on the triceps and two electrodes on the bicep.
January 1, 2018	I have interviewed a doctor in order to find out more about microcurrents.
October 21, 2017	**Simple086/Robotic Hand** Robotic Hand - A cheap and easy to make robotic hand
November 11, 2017	I started working on a page for this project on my website so that others can find my project really easily. https://goo.gl/HUCihg
December 12, 2017	https://www.youtube.com/watch?v=ubLywoeft-U
December 8, 2017	I have finished the making of my project and I have also scheduled with Mr. Baily so that I can show my project in his class
November 15, 2017	I have bought some shrink wrap tubing in order to make my welds on this project a bit nicer and safer.
November 15, 2017	My goal for the next few days is to try to work on the muscle sensor and to get it set up for use, while I wait for the rest of the parts for the project. I the meeting today we looked at the criteria and considered some adjustments which I will also work on during the next week.

I have also included with this document three more files.

1. This is a link to the recording of my interview with Dr. Elena Bueno: https://mega.nz/#!MHAWjC4b!DbrZ2ILHX8GtBKU_ILC_fyVTtVsIbYX2trx5errXYPQ
2. Here is a link to a recording of one of the presentations that I gave: https://mega.nz/#!5Dh3CZzb!oBUL5O9BpJHCiCPAMt2lt6dmCe7bZoFMVZdNMXJ5KGc
3. Finally, this is a link to an excel file with all the feedback the I got for the presentations that I gave: https://mega.nz/#!gSgz1C4C!1XCFnGXZVu-mvBZTnNidMkd92adPIWXFKK5IYD8RH-0

Other things that I would like to show:

1. This is a link to the GitHub repository that I created for this project: https://github.com/Simple086/Robotic_Hand
2. Here is a link to the time-lapse video of me making my arm: https://www.youtube.com/watch?v=ubLyw0eft-U&t=1s
3. This is a screenshot of the timeline that I followed while working on this project:

   a.