Ethical and Environmental Analysis

Year: _2018_____ Semester: ___fall_____ Team: __07___
Project:___________Handi_glove_________________
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Assignment Evaluation:

Item	Score (0-5)	Weight	Points	Notes
Assignment-Specific Items				
Environmental Impact	5	x6	30	
Ethical Challenges	4.5	x6	27	
Writing-Specific Items				
Spelling and Grammar	4	x2	8	
Formatting and Citations	5	x1	5	
Figures and Graphs	5	x2	10	
Technical Writing Style	4	x3	12	
Total Score	92			

5: Excellent 4: Good 3: Acceptable 2: Poor 1: Very Poor 0: Not attempted

Comments:
Good work. Please check the comments.

1.0 Environmental Impact Analysis

The Handi_glove contains several major electronic components including the printed circuit boards, the mechanical robot hand, a control glove with the 3D printed exoskeleton, DC motors, linear actuators, and a lot of different electronic sensors. For the PCB, robot hand and the 3D print part, some materials' substantial environmental effects need to be considered during manufacturing and disposal process. For the DC motors and the linear actuators, the high amount of energy compensation can potentially bring environmental side effects. Besides, various other smaller electronic components can lead to environmental hazards if not recycled appropriately.

The Printed Circuit Board plays a significant role in all major electronics. It is an integral part of electronic devices nowadays. The PCB manufacturing process is a tedious one that generates plenty of waste if not done correctly. There are many ways to minimize waste during the production, but it is often a lot more costly and requires much more attention to detail by the manufacturer. PCB manufacturing requires an immaculate environment in order to avoid contamination. This means that there would be a significant amount of water used in the process and thus generating ~~wastewaters~~ wastewater[1].

The solder used to make electrical connections on a Printed Circuit Board used to contain lead. Nowadays, most places ban solder that contains lead due to its extreme toxic effects on the human body. In our project, we use lead-free solders. Under regular use of PCBs, though, there are no significant harms to humans that should be noted.
Since modern technology is continually being developed at an astounding rate, the problem of PCB recycling became apparent. If there are toxic materials used in the manufacturing of PCBs, then when they are recycled, they must be handled carefully in order to avoid mass-polluting the environment. One notable improvement in the recycling process of PCBs is the spray water process, which eliminates the industrial dust and toxic odors released through the process of shredding and smashing old PCBs [3]. The lifecycle of PCBs is not long. When the end-of-life stage of a PCB comes by, there are 3 main parts to recycling it-- thermal processing, chemical processing, and physical processing [4]. In chemical processing, in particular, much wastewater is produced. The chemical processing involves recovering precious metals from PCBs, in doing so, waste acid and various waste metallic ions are produced. Physical processing refers to the actual disassembly of the components. This is where the industrial dust, noxious odor, and noise pollution is produced. The former two types of pollution, however, can be tackled by the earlier mentioned method of spray water.

In addition to the PCB, the electronic components are also threats to the environment. In order to reduce materials that are hazardous to the environment and pollute landfills, and are dangerous in terms of occupational exposure during manufacturing and disposal[5], all the components that are used in this system meet the RoHS compliant standards. However, many electronic components, like high-quality capacitors and IC chips, rely on rare earth metals, tantalum, and indium. These materials are in massive worldwide consumption with limited supply and low EOL recycling rate. Sources have shown that indium can only be extracted for another fourteen years before our natural supply runs out[6].

Tantalum can only be extracted for another fifty years, and its production already caused huge environmental problems like land erosion, pollution, and deforestation in africa[7]. In the design, those materials are limited in use and are replaced with more environmentally friendly materials.

The user-controlled exoskeleton glove is constructed through 3D printing and assembled with common metal screws. 3D printed pieces have significantly less material density compared to injection molded pieces. In addition, the printing process does not generate any significant toxic odors or other effects that would be harmful to humans [8]. There are different 3D printing materials used in the industry. The more traditional option a petroleum-based material, whereas more environmentally-friendly options include biodegradable and renewable plant-based sources. Our project uses biodegradable Polylactic acid. Polylactic acid is a thermoplastic made from cornstarch or sugarcane and is one of the more popular choices in 3D printing materials nowadays [9].
Recycling 3D printed components made from PLA can be difficult-- only because it becomes very brittle and users are hesitant to try it since the properties change after being recycled. Since PLA is entirely biodegradable, instead of being recycled, it can just be degraded, which is a very environmentally friendly option.

2.0 Ethical Challenges

When it comes to ethical challenges, there is no big issue for our product if users follow the user manual and use the glove properly. However, under the extreme condition or illegal operation for the project, it might be damaged, and the inbuilt circuit board or elements cannot work. There are several issues that need to be considered, and we need to mention this problem to protect the users from harm.

In our project, there are a lot of electrical components and children are naturally curious and do not know the dangers of electricity. When the human body comes into direct contact with a source of power, it can cause serious injury. Therefore, we have considerable responsibility to anticipate how the project will be used and take action at the design stage to prevent harm caused through foreseeable misuse. Thus, Children children under three years of age should never allow touching the project be allowed to use this product which is unsuitable for small children. The project exists of a lot of little elements components, and then there is a risk that small children can swallow it. Moreover, for the big child, the best way to prevent electrical injuries is to make sure all wires are properly insulated, tuck wires away from children's reach and it is important to supervise them while using this product to use. Besides, the instructions must observe followed and should warn the user about all the hazards and how to avoid or control them.[10]

Handi_glove provides functionality like 'motion restraint' to simulate the experiment environment so that user can create precise interaction as if he/she is conducting the actual experiment. However, due to the risk of parts breaking, the servo controlling the tension cable may overpull and hurt the user. The ADC value determines the output signal from the servo to control the pulling power from the pressure sensor. However, STM32 microcontroller's ADC conversion function has a vulnerability of generating a wide range of output. In other words, there are two sets of ADC range being generated by random. Therefore we have to either write software to handle two sets of value or dive into the STM built-in function to see how ADC value is read. We will also have to set an appropriate threshold to avoid the servo from overpulling the tension cable. Safety of the user is undoubtedly our priority, and thus we need to test the software exhaustively before launching the product.

Another feature of Handi_glove is the temperature feedback system. The temperature sensor on the robotic hand will detect temperature changes and transmit the data to the Peltier Module which resides on the glove. It is obvious that everyone has a different endurance for heat. Therefore it is hard to determine a maximum temperature that is suitable for every user. Also, the heat generated will affect the air density in airbag which will be utilized to emulate the pressure feedback. However, this can be solved by adjusting the air expansion based on the heat generated, and such logic can be implemented in the software. Besides, we can survey to collect statistics about the heat endurance of the general public to determine a maximum temperature. We could then select the mean value for maximum temperature so the user will not be burnt.

3.0 Sources Cited

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