4D Media Jacket

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1. INTRODUCTION

1.1 Elevator Pitch:

We will build a 4D Media Jacke for people who want to experience the next thing in video game and sound technology. Our product will provide the user a 4D experience allowing them to feel a gunshot in a video game or feel the beat of the music they are listening to. No one will want to go back, once they wear and use our product. Music and video game technology has not evolved beyond listening and handheld controllers respectfully, and we aim to change that.

1.2 Elaboration:

According to TIME, people are playing video games more than ever. Gaming increased by 75% in the first week of quarantine itself (Don't Feel Bad if Your Kids Are Gaming More Than Ever, 2021). Verizon has stated that each week since the pandemic has hit there has been a 23% increase in gaming. In addition, popular consoles such as a Nintendo Switch are not keeping up with its demand (11/30 Update: Verizon is prepared to serve customers during COVID-19 crisis, 2021). In regards to the movie industry, Netflix gained 16 million subscriptions within the first month of lockdown according to BBC (Netflix gets 16 million new sign-ups thanks to lockdown, 2021). The average weekly Netflix usage rose 72% since the COVID-19 pandemic began (Average Weekly Netflix Usage Rose 72% in the U.S. Since COVID-19 Pandemic Began, 2021). Thus, media has become an integral and pervasive part of the pandemic life.

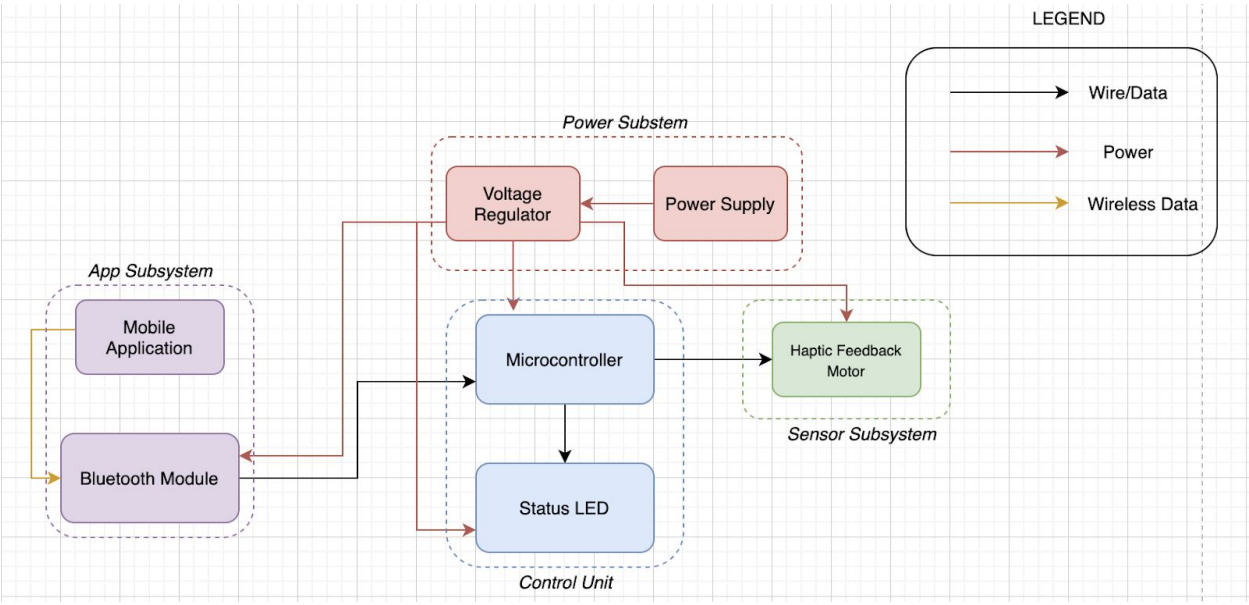
The most important goal for us to reach in this project is to have a functioning jacket that can create physical vibrations based on different media - movies, music, and video games. We want to successfully create a more engaging media experience through this jacket by upgrading from a 2D experience to a 4D experience. We want to make sure that this jacket is inexpensive, so that it can be purchased by more consumers. In movies, the jacket should be able to simulate certain actions from a movie onto the jacket. With music, the jacket should vibrate at the appropriate rate. For video games, consumers should be able to feel a strong vibration in the location where they have been hit.

Currently there are a few similar concept jackets in the market. The problem with these jackets, however, is that they are only built and supported by VR based video games. They do not have the ability to utilize haptic feedback for other forms of media such as music and movies. In addition, these jackets are expensive as well.

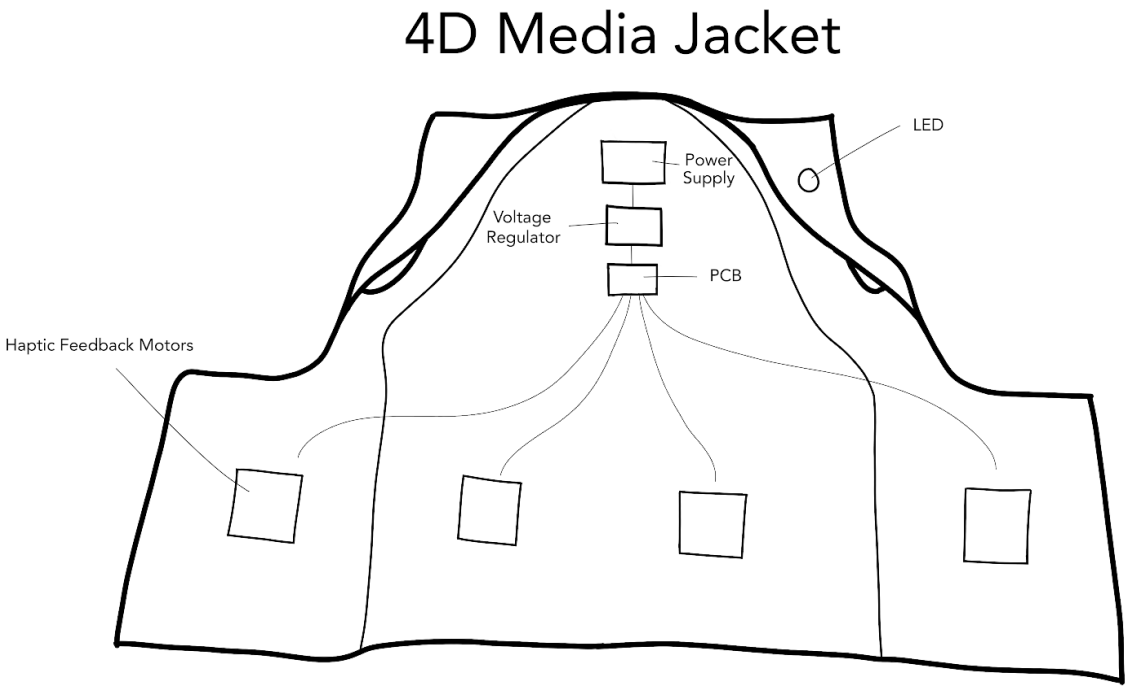
2.1 High Level Requirements:

- ➢ Jacket must be able to create different patterns of haptic feedback based on inputs from the microcontroller over Bluetooth
- ➢ Jacket must be able to last over 4 hours of use on a single charge.
- ➢ The app interface should be able to activate the jacket and simulate haptic feedback patterns.
- ➢ The Bluetooth module attached to the microcontroller must have a maximum latency of ~70ms.

3.1 Block Diagram:



4.1 Physical Design:

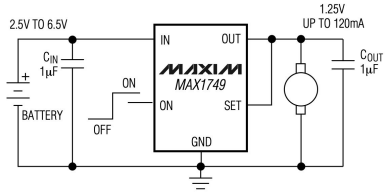


5.1 Requirement and Verification Tables:

The main risks for this project are latency and power. The bluetooth module we have chosen is not the fastest way of communication, but it is more energy efficient than a wifi module. Thus, latency will play a major factor in user experience. The second risk is power. We need a pretty small and relatively lightweight power supply, but the haptic feedback motors have significant energy consumption in large numbers. Thus, we need to balance the power consumption of the feedback motors against their effectiveness.

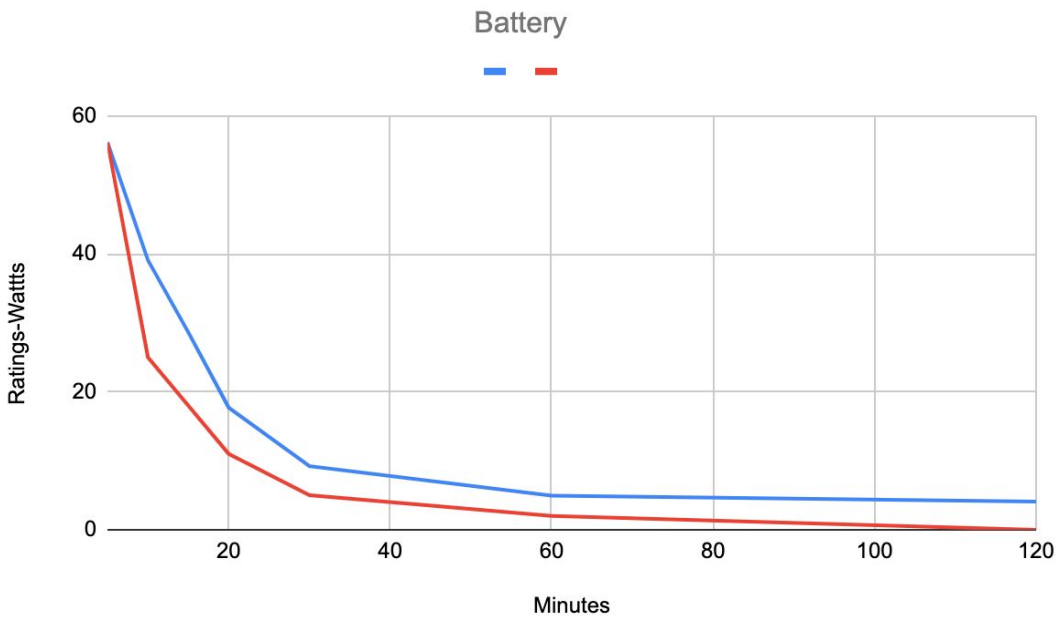
Li-Ion Battery

Requirement	Verification
1) Must store more than 6Ah in charge	A) Connect a fully charged battery (6V) Li-ion battery with positive terminal at Vdd and negative terminal at GND. B) Discharge at a rate of 350mA for 20 hours. C) Connect a voltmeter in parallel to the battery and ensure the voltage is greater than 5.25 V



Requirement	Verification
1) Vibration produced by haptic feedback motor must not be uncomfortable	A) Connect power source to MAX1749EUK+T with capacitors and NFP-7C-FS0725 haptic feedback motor as shown in diagram B) Put the motor in close proximity to a body, held down in place (e.g in a pocket). If the vibration is too strong or causes discomfort, discontinue use of this motor and reduce amplitude of feedback.

6.1 Plots

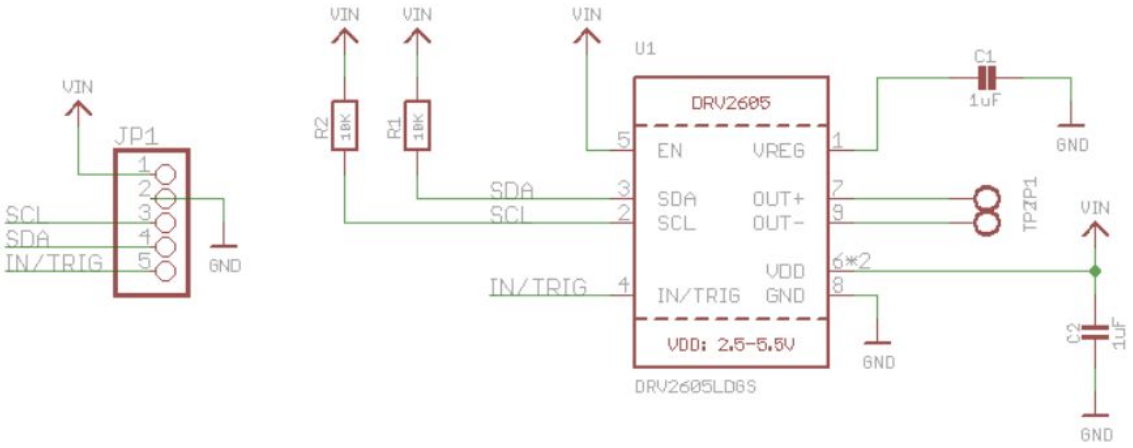


Red: Coin Motor
Blue: 7G NFP-E1015

**Chart made with assumption of 10 motors*

7.1 Schematics

Haptic Motor Driver (built on adafruit design)



8.1 TOLERANCE ANALYSIS:

One important tolerance we must maintain is determining how much vibrational frequency we need for the desired amount of haptic feedback we want to incorporate in our jacket. Since our jacket will be a wearable device, we need to study where human skin is most sensitive to the mechanical pressure that will emit from haptic feedback.

There are four different sensory receptors in our skin that respond to mechanical pressure. These four types include Merkel's Cells, Ruffini Ending, Meissner's Corpuscle, and Pacinian Corpuscle. The former two are best at sensing slower movements and the latter two are best at sensing faster movements such as vibrations. The frequency range for these different sensory receptors vary. Upon research, we have found that most devices that utilize haptic feedback motors aim to be sensed by the Pacinian Corpuscle receptors in our skin due to both its effectiveness and safety (What Vibration Frequency Is Best For Haptic Feedback, 2021).

The Pacinian Corpuscle sensory receptors operate at a frequency range of 125 Hz to 300 Hz, peaking at about 250 Hz. Thus, we had to find a haptic feedback motor that stays within this range. Ideally, we wanted to find a motor that is as close to the 250 peak as possible.

Upon further research, we found the NFP-7C-FS0725 haptic feedback motor which has a rated speed of about 14,000 ± 15%rpm.

$$1 \text{ rad/s} = \frac{1}{2\pi} \text{ Hz} = \frac{60}{2\pi} \text{ rpm}$$

Using the equation above we see that this rated speed converts to 233.33 Hz, which is very close to the peak frequency for Pacinian Corpuscle sensory receptors. This is the mathematical reasoning for why we have decided to use the NFP-7C-FS0725 haptic feedback motor.

9.1 Safety and Ethics:

For our power supply unit we will be using lithium-ion batteries. We will be using a 7Ah battery to keep all 15 haptic feedback motors running for a period of 4 hours. The problem with these batteries is that they can easily overheat. This can happen either by overcharging the battery, overusing the battery, or bringing the batteries to extreme temperatures. This is especially risky in our project because the batteries will be inside of the jacket which will actually be worn by a person. To mitigate this, we will make sure to not overcharge, overuse, and bring the jacket/battery to extreme temperatures. In addition, we will replace the batteries every couple weeks to make sure that the batteries are not being overused.

Another possible concern for this project is that the haptic feedback for certain video games (particularly those where we will be simulating gunshot hits) may be too strong for certain people, especially those

with pre existing heart conditions. In order to resolve this, we will conduct a lot of research regarding how much stimulation is safe over the parts of the body that the jacket covers, and pay close attention to the rules and regulations of other high stimulation activities such as roller coasters to ensure that the ride is safe for everyone. This aligns with the IEEE Code of Ethics, #9, which states that technologies should not injure people (IEEE Code of Ethics, 2021).

It is evident that the media plays a large role in our society today. It is responsible for not only the learning but also mental well being of many young people. Status quo is that there is concern that violence from video games make young people more prone to violence in real life. Our group can see how questions can rise regarding whether enhancing the video game experience from 2D to 4D will make matters worse. The fact of the matter is that although these concerns exist, there is no scientific evidence correlating video games to someone becoming more violence prone. Facts are based on quantitative methods and scientific calculations, and not opinions or anecdotes. This aligns with IEEE Code of Ethics, #5. In order to be "honest" and "realistic" in stating claims and concerns, we have to look at the available evidence - which explicitly does not correlate playing video games and increased violence (IEEE Code of Ethics, 2021). Thus, since there is no actual evidence linking the two together, we believe that enhancing the video game experience through our project does not provoke any ethical risk.

10.1 References:

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