Team A8: Sensor Suit

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Use-Case / Use-Case Requirements

Goal: Improve game interactivity by incorporating more sophisticated tactile feedback that supports *The Last Spartan* desktop game.

- Initialization of haptic response (vibration of a motor) such that the feedback is indistinguishable from actions on screen
- Feedback points in front, back, and side of torso
- Keyboard-free experience
- 4+ hours of game time with the system
- Wearable system that is customizable to guarantee comfort
- Improved game experience

Design Requirements

- Map a unique haptic response to **4 different events** in the game
  - low health, getting hit (small), getting hit (large), forceful jump
- Latency between in-game action and haptic response **less than 100 ms**
- Adjustable wearable system that can **extend/contract up to 4 inches**
- Wireless wearable system operates within a **range of around 6 feet**
- Motor vibration frequency **above 3000 RPM**
- RGB light intensity between **300-500 lux**

Solution Approach - The System

Our solution

Adjustable vest which covers the torso and is embedded with 20 vibrational motors which respond uniquely to various in-game events

Input

Wireless Controller

Output

Vibration motors that run at 640 to 3200 RPM, creating 0.15 to 7 Newtons of force

20 motors on vest (8 on front, 8 on back, 2 on each side) + RGB lights

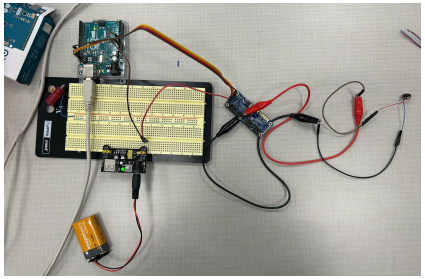
Considerations

Careful wiring to allow for movement / adjustability while limiting excess wires

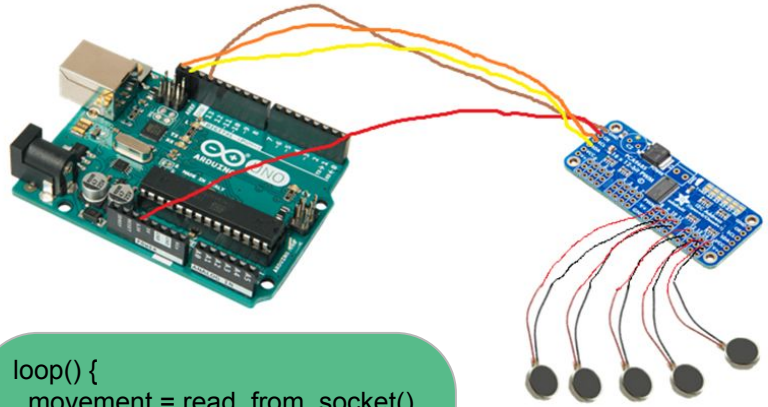
Comfortability and size-ability of suit.

Cost of suit < $200

Solution Approach - The Hardware



- **Adafruit 16-channel servo driver**
  - Controls 16 front-torso and back-torso vibration motors
- **Arduino Uno WiFi Rev 2**
  - Controls 4 side-torso vibration motors
  - 12 sets of RGB lights
  - Computing capabilities to activate motors in unique patterns
  - Cost effective, simple, rediably available
- **Rainbow ribbon cables**
  - Compact wiring and color coded cabling

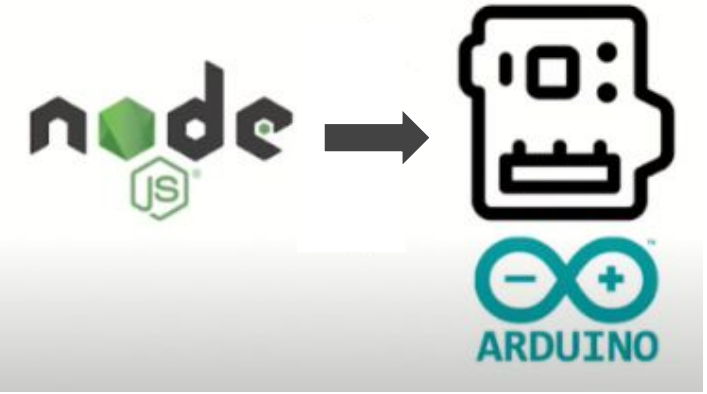


```
loop() {
  movement = read_from_socket()
  if (movement == “largeHit”) {
    activate_hit()
  }
  elif (movement == “lowHealth”) {
    activate_lowHealth()
  }
  ….
}
```

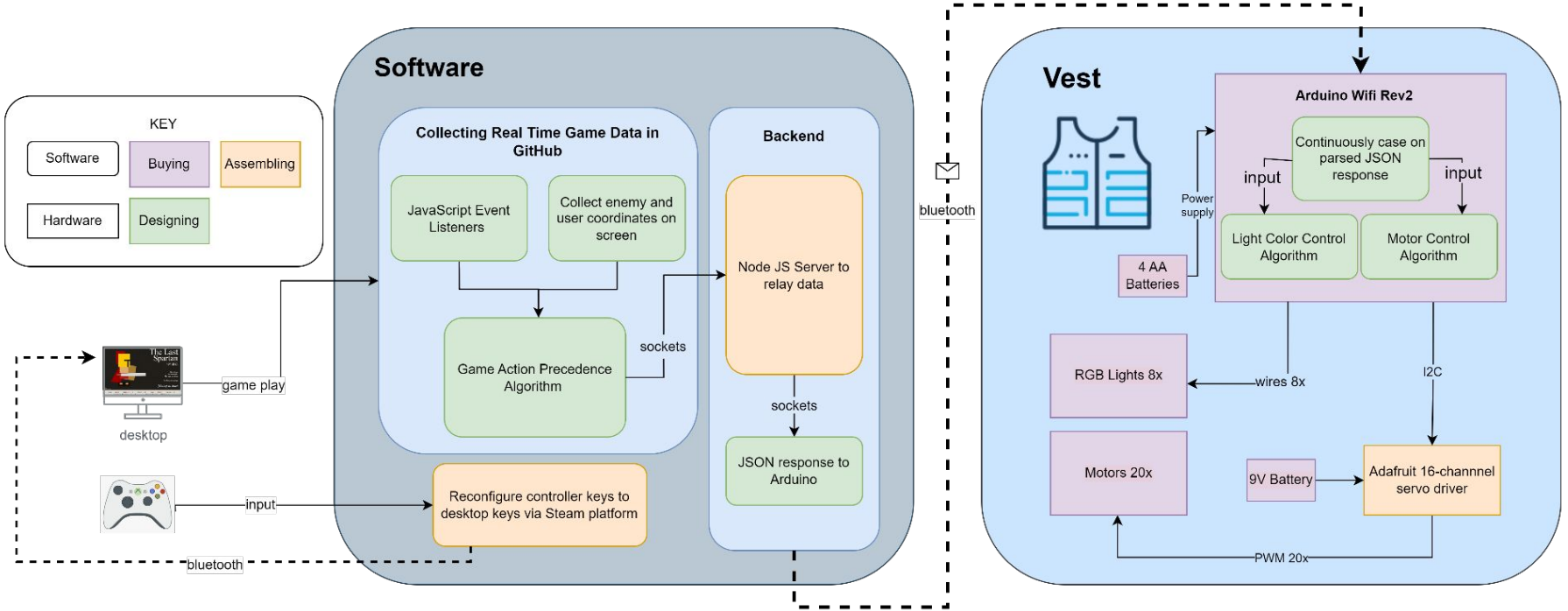
Solution Approach - The Software

- **Web Application**
  - Hosting our web application game on Node JS
  - JS to collect real-time game data
  - Incorporate event listeners into game code
  - Easily pass on data to Node JS server

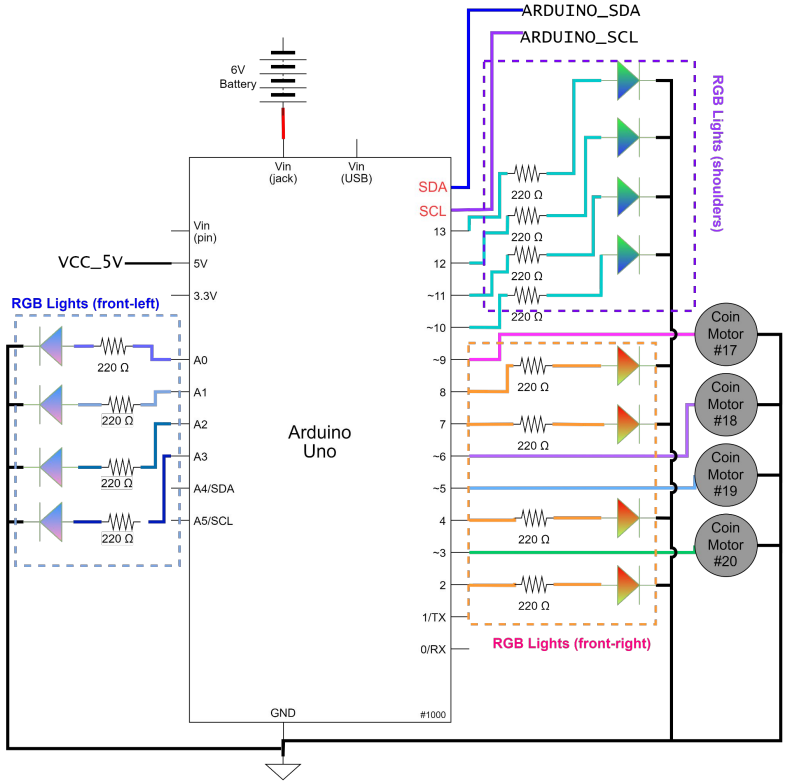
- **Server Architecture**
  - Node JS server to relay data
  - Standard http library and socket.io which creates a response to be sent to the Arduino IDE
  - Haptic algorithm cases on parsed JSON response

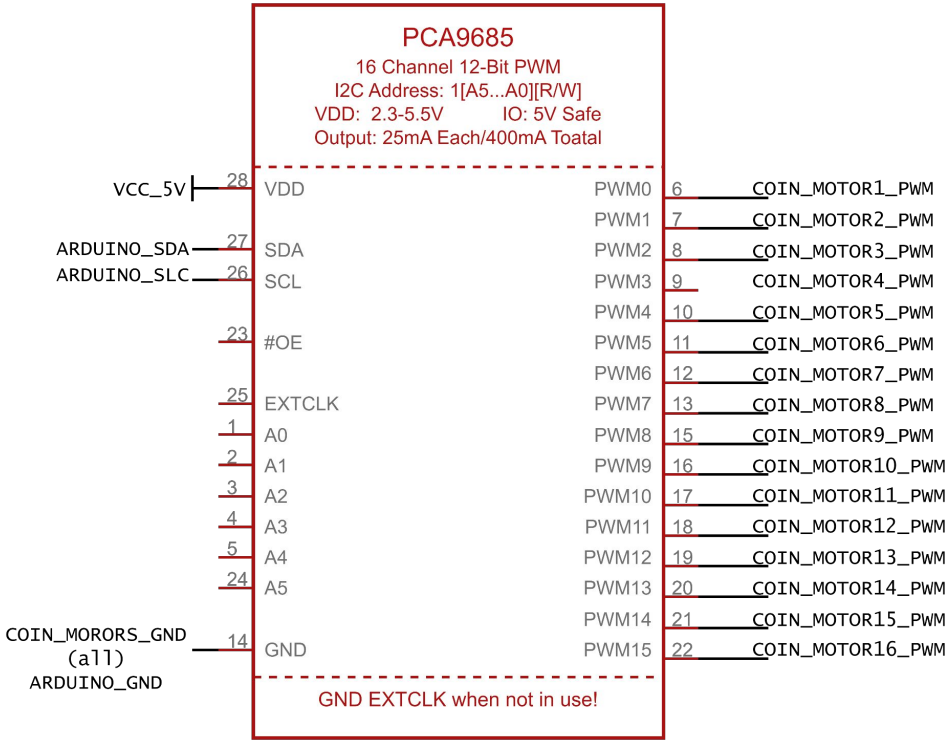


Implementation Plan



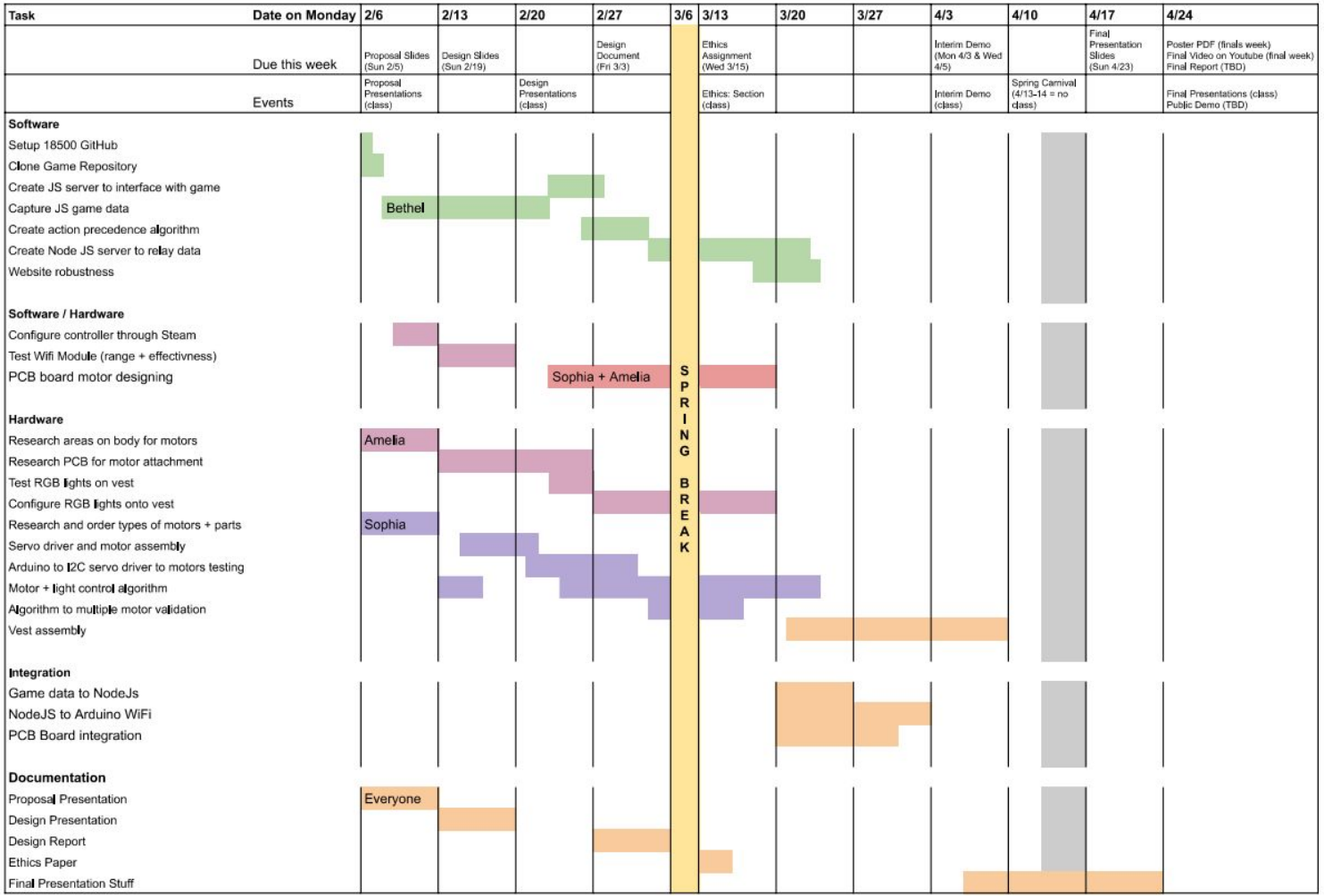
System Specification





Testing, Validation, and Metrics (hardware/software)		Goal	How to Measure
1	Arduino IDE Receives JSON Response	100% of data is received	Print JSON response on serial monitor
2	Correctly Parse Game Data	4 unique haptic responses	Check configuration of active motors against game event
3	Motor Sensation	Have a failure rate less than 15%	User rates scale of sensation from 1-5
4	Minimal Motor Relocation Vest	< .5” radially	In the vest, record motor location before/after playing game

Testing, Validation, and Metrics (entire feedback system)		Goal	How to Measure
1	Wireless Range	6 ft	Record distance at which the user can still play
2	Latency	<100ms	Record time between game action and response using Arduino
3	Battery Life	4+ Hours	Divide the battery capacity by the average device current consumption over time
4	Improve Game Experience	Positive feedback	Survey feedback from users
5	Cost	< $200	Sum parts list


Task
Date on Monday
2/6
2/13
2/20
2/27
3/6
3/13
3/20
3/27
4/3
4/10
4/17
4/24
Due this week
Proposal Slides (Sun 2/5)
Design Slides (Sun 2/19)
Design Document (Fri 3/3)
Ethics Assignment (Wed 3/15)
Interim Demo (Mon 4/3 & Wed 4/5)
Final Presentation Slides (Sun 4/23)
Poster PDF (finals week)
Final Video on Youtube (final week)
Final Report (TBD)
Events
Proposal Presentations (class)
Design Presentations (class)
Ethics: Section (class)
Interim Demo (class)
Spring Carnival (4/13-14 = no class)
Final Presentations (class)
Public Demo (TBD)
Software
Setup 18500 GitHub
Clone Game Repository
Create JS server to interface with game
Capture JS game data
Bethel
Create action precedence algorithm
Create Node JS server to relay data
Website robustness
Software / Hardware
Configure controller through Steam
Test Wifi Module (range + effectivness)
PCB board motor designing
Sophia + Amelia
SPRING BREAK
Hardware
Research areas on body for motors
Amelia
Research PCB for motor attachment
Test RGB lights on vest
Configure RGB lights onto vest
Research and order types of motors + parts
Sophia
Servo driver and motor assembly
Arduino to I2C servo driver to motors testing
Motor + light control algorithm
Algorithm to multiple motor validation
Vest assembly
Integration
Game data to NodeJs
NodeJS to Arduino WiFi
PCB Board integration
Documentation
Proposal Presentation
Everyone
Design Presentation
Design Report
Ethics Paper
Final Presentation Stuff

Conclusion

Build a wireless haptic vest that connects to the desktop game *The Last Spartan* and improves game immersion through a vibrotactile feedback system

Product:

- Desktop game that has a Node JS backend collecting data
- Haptic vest with Arduino WiFi controlling vibrating motors and RGB lights

Metrics:

- Provide a cost-effective solution which increases user immersion in *The Last Spartan*
- User can distinguish unique haptic-response for each in-game action