Get Active Gaming System
1 Introduction

1.1 Objective
In this age of technology, electronic devices surround us. Both adults and kids alike are glued to these devices. In any spare time we have, we pick them up reflectively, either to check social media or play games. It’s also easy for tired parents to hand their kids an electronic device to entertain them. All of this screen time is dangerous, and there are consequences of using so much interactive technology at such a young age. Researchers have found that children are starting to get attached more to objects instead of their parents. When using screen devices, their surrounding environment gets blocked out, resulting in kids not learning social skills and conversational manners [1]. Using devices so much also takes away time from being active, which can cause many problems in the future. It’s getting harder to motivate kids to exercise and be active because of technology. With the use of electronic devices, there’s no need to move around in order for kids to tire themselves out in order to entertain themselves. It’s much easier to sit in one spot and stare at a screen. Also for adults, the increased use of electronic devices in this age has taken time away from getting active. Between checking emails, and keeping tabs on people, it’s important for adults to put down their phones once in a while.

Our goal is to provide entertainment that doesn’t involve screen devices and motivates people to get active. We will create a small box that allows people to be active right in their homes. It will feel like a video game, but eliminates the use of a screen. The box will be small and lightweight, so the users can set it up in a variety of places such as in a home, office, or retirement center. There will be three functionalities, consisting of two games and a heart rate monitor. The first game works similar to whack-a-mole, where four devices using pressure sensors will be placed around the user’s environment and light up to prompt the user to press it. The next game is a get active test, where accelerometers will be placed in arms bands and put on the user and then they have to keep moving for a certain amount of time. The heart rate monitor keeps track of the users heart rate during these games.

1.2 Background
There have been other devices that try to promote activity outside of screen devices. Video game devices like Microsoft Kinect or Wii incorporate physical activities into their games, but a TV screen is still used. Kinect uses RGB, a depth sensor, and a microphone in order to detect the user’s motions, and Wii uses a controller as the interface [2][3]. Our game would incorporate all of the fun and physical activity these other technologies use, but it would also have the addition of no screen, helping people to cut down on screen time. With no screen needed, there is more mobility and flexibility in the placement of the box and locations it can be played.

1.3 High Level Requirements
- Box Functionality: The main control box is able to start and stop two games based on user input, record the high scores, and display important game information like the high score, current game score, and the user’s heart rate on an LED panel.
- Sensor accuracy: Signal latency of less than 1 second between peripheral module (heart rate monitor, accelerometer, and pressure sensors) and central hub.
- Game mobility: The game is designed to be set up in a room no larger than 25’x25’.
2 Design

2.1 Block Diagram
The block diagram clearly lays out the four components of the Get Active Gaming System and how they all fit together. The central hub will contain the majority of the Get Active Gaming System’s functionality and logic. This will be important for selecting the game a user would like to play, monitoring the heart rate of the player, and recording and displaying relevant information from the game. The use of many IR transceivers for each component of the Get Active Gaming System will allow for clear communication between the components and should maintain signal integrity. The block diagram also outlines the important components of the Whack-a-Mole game, the Get Moving Test game, and the heart rate monitor.

![Block Diagram](image)

Figure 1. Block Diagram

2.2 Physical Design
The Get Active Gaming System would look similar to the diagram below. The central hub would be a small box plugged into the wall power outlet. The IR remote will interact with the central hub to allow the player to change the game they are playing. The Whack-a-Mole modules would be spread around the room with some on or along the walls and others on the floor. The player would need to put on the accelerometer wristband for the Get Moving Test game. The player would also put the IR heart rate monitor on one of their fingers any time they are using the Get Active Gaming system.
2.3 Block Design
2.3.1 Central Hub
The central hub will contain the major electrical components and logic for the Get Active Gaming System. Players will be able to select which game they would like to play, see their game score, and monitor their heart rate. The central hub will be the central unit that all of the wireless devices connect to and will provide instructions to the devices.
AC Outlet

The AC wall outlet will supply power for the pieces inside of the central hub (IR receiver, IR LED, microcontroller, and LCD panel). It should supply the necessary power without overloading the system.

Power Supply

The power supply will convert the AC current from the wall outlet into DC current for use by all the elements within the central hub (IR receiver, IR LED, microcontroller, and LCD panel). The power supply is a voltage regulator, so the output should be regulated to 4.5-5.5V [4].

Central Hub IR Receiver

Must detect signal from the other core IR elements of the gaming system (the whack-a-mole modules, the get moving test module, and the heart rate monitor) within a 25 foot range (small room size) and within 1 second transmission time. The IR Receiver needs to accurately (within 20% error) sense the IR patterns being sent to it in order for the different modules to be handled differently by the microcontroller later.

![Figure 4. IR Receiver test circuit using 4 AA 1.3 V batteries [5]](image)

![Figure 5. IR Receiver digital test circuit using microcontroller [6]](image)

Central Hub IR LED

The IR LED should be able to transmit signal within a range of at least 25 feet (the size of a small room). The LED should have a wavelength of around 850 nm +/- 100 nm to ensure it matches up with the IR Receiver. The LED should have a max power dissipation of 150 mW to ensure it can link with the microcontroller and doesn’t draw too much power, causing it to have a shorter lifetime.
Microcontroller

Must be able to keep track of current score, heart rate, and number of active minutes. Must also receive the signals from the IR receivers and be able to transmit signals to the external modules. Must control the logic needed to run the games and control the output shown on the LCD panel [9].

LCD Panel

Must accurately display the game score(s) and the player’s current heart rate. We plan to use a 16x02 display, 32 characters, which we can program to display the user information and flash between game modes so the user knows what they’re selecting.

Remote

The remote must be able to send a signal at least 25 feet (size of small room) in order to connect with the transceiver within the central hub so when the user presses buttons on the remote, the game mode is changed. The IR remote should have at least 3 different IR pattern options (one per button) so we can send three different signals to the microcontroller to dictate the three games/settings and at most 10 (in case we add additional features) but not enough to overwhelm the user with unnecessary button options. The power usage should be such that it will run for at least 50 hours using a standard coin cell battery.

2.3.2 Whack-a-Mole

There will be four of these Whack-a-Mole modules in the final design. The modules can be placed around a room and will be able to communicate with the central hub. When the user decides they would like to play the Whack-a-Mole game and have selected it on the central hub, the four modules will light up at various times. The player will then need to run around the room to quickly hit the module before the time is up. The central hub will communicate with the modules and the modules will light up in a random manner. The modules will then communicate back with the central hub in order to keep an accurate game score and signal the need for a new module to light up.
Coin Cell Batteries

The batteries must be able to power the two transceivers and fit into the circuit alongside the pressure sensor. If the signals are too noisy, the batteries must also be able to power a filter in the circuit (active or passive). The battery needs to supply between 1.5-3V to the system [10].

IR Receiver

Must detect signal from the central hub within a 25 foot range (small room size) and within 1 second transmission time. The IR Receiver needs to accurately (within 20% error) sense the IR patterns being sent to it in order to distinguish if it should tell the LED to light up or if a different signal is being sent and should be ignored.

IR LED

This LED is responsible for communicating to the user whether they should press the pressure sensor associated with it so it’s important that it also has a range of at least 25 feet. The LED should have a wavelength of around 850 nm +/- 100 nm to ensure it matches up with the IR Receiver on the Central Hub. The LED should have a max power dissipation of 150 mW to ensure it can link with the microcontroller and doesn’t draw too much power, causing it to have a shorter lifetime.

Microcontroller

The microcontroller must be able to receive data from pressure sensors, and pressure sensors IR transceivers. The microcontroller must control all functionalities of the whack-a-mole module.

Pressure Sensors

Must be able to detect an applied force of 0-10.5 kg and change resistance depending on the amount of pressure being applied. The resistance of the sensor when no pressure is applied should be above 1 MOhm and below 2 kOhm when maximum pressure is applied (10 kg +/- 0.5 kg).

LEDs

The LEDs must be visible to the user up to 25 feet so the user knows which whack-a-mole module to press.
2.3.3 Get Moving Test
The get moving test will monitor how active the player is during a given amount of time. Accelerometers will be attached on the player’s arms and then they will be free to move (do jumping jacks, jog in place, etc.) and the accelerometer modules will communicate back to the central box in order to increase the overall game score. The more a player moves, the higher their end score.

Fig 8. Get Moving Test Schematic

Coin Cell Batteries

Batteries must be able to deliver power to the transceivers and accelerometer, along with fitting in the arm band. The battery needs to supply between 1.5-3V to the system.

Accelerometer IR Receiver

Must detect signal from the central hub within a 25 foot range (small room size) and within 1 second transmission time. The IR Receiver needs to accurately (within 20% error) sense the IR patterns being sent to it in order to distinguish if the module is being told to run or standby.

Accelerometer IR LED

This LED is responsible for communicating the Get Moving Test results and accelerometer data to the central hub so it’s important that it also has a range of at least 25 feet. The LED should have a wavelength of around 850 nm +/- 100 nm to ensure it matches up with the IR Receiver on the Central Hub. The LED
should have a max power dissipation of 150 mW to ensure it can link with the microcontroller and doesn’t draw too much power, causing it to have a shorter lifetime.

Microcontroller

Microcontroller must be able to transmit and receive data from the accelerometers and transceivers. The microcontroller needs to control all functions of the Get Moving Test module.

Accelerometers

The accelerometer would need to collect information about how much the person is moving. This accelerometer is an analog device, therefore it outputs an analog voltages. We would then convert this information into a score for the game using the microcontroller.

2.3.4 Heart Rate
The Heart Rate module will monitor the player’s heart rate and send the information to the central hub of the system. The heart rate will then be displayed on the LCD panel within the central hub.

Coin Cell Batteries

The batteries must be able to power the two transceivers and fit into the circuit alongside the IR sensor. If the signals are too noisy, the batteries must also be able to power a filter in the circuit (active or passive). The battery needs to supply between 1.5-3V to the system.
Heart Rate IR Receiver

Must detect signal from the central hub within a 25 foot range (small room size) and within 1 second transmission time. The IR Receiver needs to accurately (within 20% error) sense the IR patterns being sent to it in order to distinguish if it should tell the IR Heart Rate Monitor to begin recording or stay idle.

Heart Rate IR LED

This LED is responsible for communicating the user’s heart rate to the Central Hub so it’s important that it also has a range of at least 25 feet. The LED should have a wavelength of around 850 nm +/- 100 nm to ensure it matches up with the IR Receiver on the Central Hub. The LED should have a max power dissipation of 150 mW to ensure it can link with the microcontroller and doesn’t draw too much power, causing it to have a shorter lifetime.

Microcontroller

Microcontroller must be able to transmit and receive data from the IR Heart Rate monitor and control all the elements in the heart rate monitor block.

IR Heart Rate Monitor

Detect user’s heart rate within a variation of ±10 beats per minute.

Figure 10. IR Pulse Monitor Circuit Schematic [7]
## 2.4 Requirements & Verification Table

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Verification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Power Supply</strong></td>
<td><strong>Verification</strong></td>
</tr>
</tbody>
</table>
| 1. Convert 4.5-5.5V from AC to DC | 1. a. Connect the plugged in power supply to a breadboard  
  b. Measure the voltage across the power supply using the multimeter by placing the red probe on pin with voltage and placing the black probe on ground. |
| **IR Receiver** | 1. a. Build test circuit in figure 1  
  b. Point IR remote at sensor, press button, and observe if LED lights up within 1 second of button presses  
  2. a. Build test circuit in figure 2  
  b. Use test code from Adafruit’s “Using an IR sensor” to display unique IR pattern on microcontroller console and check that the pattern is within 20% of the actual IR remote’s pattern (found online) |
| 1. Detects IR transmissions within 1 second of IR signal being sent from a distance of up to 25 feet.  
  2. Detects unique IR patterns and can display, timing and frequency of pulses (within 20% accuracy) on microcontroller console. |  |
| **IR LED** | 1. a. Using the test circuits in figures 1 and 3, (without the LED branch in figure 1), place the two circuits 25 feet apart.  
  b. Open and short a branch in the figure 3 circuit to cause the LED to turn on and off.  
  c. Observe, using Adafruit code, whether the IR receiver displays different output when the LED is connected and disconnected  
  2. a. Using the digital video mode on a cell phone, record the LED |
| 1. Transmission range > 25 feet.  
  2. 850 nm +/- 100 nm wavelength (low IR range).  
  3. Operates at less than 100 mA of continuous forward current.  
  4. Forward voltage between less than 1.7 V.  
  5. Power dissipation at or below 150 mW. |  |
<table>
<thead>
<tr>
<th>Microcontroller</th>
<th>LCD Panel</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Run off of 1.8-5.5V.</td>
<td>1. Must have dimensions less than 100mm x 100mm to make user friendly.</td>
</tr>
<tr>
<td>2. Delivers signals through the IR LED and IR receiver faster than 1 second.</td>
<td>2. Power supplied around 4.5-5.5V.</td>
</tr>
<tr>
<td>3. Use a multimeter to measure the voltage by placing one probe on the VCC pin and the other probe on the ground pin of the microcontroller chip.</td>
<td>3. Must be able to transmit data at a speed of less than 1 second.</td>
</tr>
</tbody>
</table>

1. Use a multimeter to measure the voltage by placing one probe on the VCC pin and the other probe on the ground pin of the microcontroller chip.

2. 
   a. Set up the microcontroller to light up an LED that is controlled by an IR LED and IR receiver pair.
   b. Count how many times the LED lights up in a 10 second period.
   c. If the total count is larger than 10, the microcontroller has met this requirement.

3. 
   a. Measure dimensions with ruler.
   b. Confirm the dimensions are less than 100mm x 100mm.

4. 
   a. Probe input and output to find voltage using multimeter.
   b. Confirm this value is between 4.5-5.5V.

5. Using the values computed in verifications 2 and 3, calculate the power across the LED and ensure it is at or below 150 mW.
### Remote

1. Transmit IR signal > 25 feet
2. Transmit 3-10 different IR patterns
3. Run off coin cell battery for at least 50 hours

1. a. Set up circuit in figure 1 and press buttons on the remote from 25 feet away
   b. Using the Adafruit test code, observe if the microcontroller console displays output upon button press
2. Same as verification 1 except also ensure that the IR patterns displayed on the console are unique for each button press
3. Determine the power consumption (mAh) and current drawn (mA) in the remote and divide the power by the current to get the approximate lifetime

### Coin Cell Batteries

1. Needs to supply between 1.5-4V into the system.
2. Weigh no more than 5g.
3. Volume no more than 2 cm³, has to be able to fit in all aspects.

1. a. Probe positive (outer circle) and negative (inner circle) terminals.
   b. Use multimeter to measure the voltage across the battery.
   c. Confirm that this output voltage is 1.5-4V.
2. a. Use a scale to weigh coin cell battery.
   b. Ensure that it’s less than 5g.
3. a. Measure radius distance.
   b. Use \( V = \pi r^2 h \) to get the volume.
   c. Confirm that the volume is less than 2 cm³.

### Pressure Sensors

1. Detect force less than 10 kg
2. Resistance must be bel2 kOhm with heavy pressure (10 kg +/- 0.5 kg)

1. a. Attach the pressure sensor to an ohmmeter.
   a. Apply weights varying from 0 to 10 kg to the pressure sensor and verify that the resistance decreases with
1. Attach the force sensor to an ohmmeter.
   a. Read the resistance with no pressure applied and verify it’s above 1 MOhm.
   b. Apply 8 kg +/- 0.5 kg pressure (with weight) and verify resistance is below 2 kOhm.

2. Must be bright enough for the user to see it up to 25 feet away.
   a. Attach LED to circuit from figure 1.
   b. Supply power and observe from 25 feet away if the LED is visible

LED

Accelerometer

1. Needs to be able to collect information of user’s movements accurately and in all directions.
   2. Display output data in less than 1 second.
   3. Needs to be able to receive 2g (43mph) of acceleration.
   4. Sensitivity of accelerometer should be between 250-350mV/g.

1. Set voltage of $V_s$ into ST pin, which shoots an electrostatic force into accelerometer beam.
   a. Observe output on xyz axis.
   b. Make sure an there is an output of -1 to -1.25g in the x-axis, 1-1.25g in the y-axis, and 1.5-2g in the z-axis.

2. Using the previous verification test, observe the time it takes for the output to display.
   a. Confirm it takes less than 1 second to display the output

3. Move the accelerometer as fast as we can.
   a. Confirm that the accelerometer is able to detect the speed.
   b. Also check to ensure that the output is able to reach 2g.

4. Input 1g (21.9mph) into accelerometer
   a. Observe output display
   b. Confirm it gives an output voltage of 0.200-0.400V.
| IR Heart Rate Monitor | 1. Pulse is transmitted to the output of the circuit at every heartbeat with an error of max 10 beats/minute. | 1. a. Attach the Signal out in the circuit in figure 4 to the A0 pin of the microcontroller.  
b. Place the IR receiver and transmitter from the circuit in figure 4 against the user’s thumb.  
c. Using code provided by “Make:” tutorials [7], observe the console output and verify that the frequency matches the user’s heart rate (determined by checking pulse with finger on user’s throat or wrist). |
## 2.5 Requirement Summary

<table>
<thead>
<tr>
<th>Module</th>
<th>High Level Requirement</th>
<th>Points</th>
</tr>
</thead>
</table>
| Central Hub             | ● Module accurately sends and receives signals to and from the peripheral modules via IR (4 pts)  
|                         | ● The microcontroller handles multiple game modes individually (not simultaneously) (4 pts)  
|                         | ● Microcontroller stores high scores in memory (2 pts)  
|                         | ● The LED panel displays output corresponding to the game being played (determined by the microcontroller) (3 pts)  
|                         | ● The IR remote is able to switch games and connect via IR with the microcontroller (2 pts)  
|                         | 15                                                                                                           |        |
| Whack-A-Mole            | ● This module should send and receive IR signals from the central hub (3 pts)  
|                         | ● The microcontroller receives input from pressure sensor presses (2 pts)  
|                         | ● The microcontroller outputs a unique IR signal (via IR transmitter) back to the central hub (3 pts)  
|                         | ● The module can be placed in any orientation within a 25’x25’ room (3 pts)  
|                         | ● The pressure sensor values vary depending on applied force (2 pts)  
|                         | ● Users can determine which module to hit based on the LED light attached to the module (2 pts)  
|                         | 15                                                                                                           |        |
| Get Moving Test         | ● The microcontroller can record accelerometer data from user arm movements accurately (3 pts)  
|                         | ● The microcontroller connects with the IR transmitter and sends a unique IR signal back to the central hub (via IR transmitter) (3 pts)  
|                         | ● The module doesn’t send an IR signal when another game is being played (2 pts)  
|                         | ● The module stays on the user’s arm during movement (2 pts)  
|                         | 10                                                                                                           |        |
| Heart Rate Monitor      | ● This module should accurately (+/- 10 beats/min) record the user’s heart rate (3 pts)  
|                         | ● The microcontroller sends the score back to central hub (via IR communication) (3 pts)  
|                         | ● The module can fit on a variety of user finger sizes (2 pts)  
|                         | ● The module stays on the user’s finger (2 pts)  
|                         | 10                                                                                                           |        |
|                         | **Total**  
|                         | 50                                                                                                           |        |
2.6 Software Analysis
The following software flow charts provide insight into the decisions and items needed in the software to allow each module to function.

![Central Hub Software Flow Chart](image)

Figure 11. Central Hub Software Flow Chart
Figure 12. Whack-a-Mole Module Software Flow Chart
Figure 13. Get Active Test Software Flow Chart

Figure 14. Heart Rate Software Flow Chart
2.7 Tolerance Analysis

The heart rate monitor is a key aspect of the Get Active Gaming System because it is a personal measure of the user’s activity. It is important that the circuit is able to vary quickly in response to the user’s heart rate so that it can be recorded accurately by the microcontroller to be processed and sent to the central hub. It is also important that the circuit filter out most of the noise to pass a clear signal to the microcontroller.

The below circuit utilizes (from left to right) a voltage divider, an op-amp integrator, and a low pass filter. The resistors connecting the positive inputs to ground allow an escape path for any current that flows towards the op-amp input terminals.

![Figure 15. Heart Rate Monitor Circuit in LTSpice](image-url)

**Voltage Divider**

**Function:** The voltage divider is important because our IR LED receiver will replace “R8” in the simulation circuit. When the receiver receives a signal, it causes the resistance of R8 to change suddenly, creating a change in voltage feeding into the op-amp integrator.

**Tolerance:** In figure 16, the lowest green line (~0.1 V) corresponds to a 1 kOhm resistance of R8. And the highest green line corresponds to 10 kOhm resistance. We can see that as our resistances increase, so does the voltage being passed into the rest of the circuit. It would be ideal to have the IR LED receiver increase resistance to at least 10 kOhm or higher when a signal is detected from the emitter to maximize the amount of voltage flowing towards the output voltage (Vout). Even if the value of R8 is set to 80kOhm or 90kOhm, the maximum output into the rest of the circuit plateaus around 2.5 V and the output after the op-amp integrator plateaus around 4 V (see fig. 17).
So R8’s value (the IR LED in our final circuit) should cause around a 1-2 V drop which results in the 4 V output of the op-amp integrator.

Figure 16. Voltage vs. Time of the input of the op-amp integrator (green) and output (blue)

Figure 17. Voltage vs. Time of the input of the op-amp integrator (green) and output (blue) for R8 = 80kOhm-90kOhm
Op-Amp Integrator

**Function:** The op-amp integrator serves to take the integral of the input voltage. As seen in figure 18, the output of the op-amp integrator increases steadily as the area under the curve of the input voltage stays constant. This is because our input is a DC voltage at or around 5 V from the microcontroller.

**Tolerance:** The rate of increase of output voltage is caused by the parallel capacitor charging, and related to the RC time constant. We can make this process go faster if need be by decreasing the resistor or capacitor value, as seen by the blue lines where a lower resistance value caused a more sudden increase in voltage. Currently, the capacitor is able to charge at a rate of 1 V/12 ms which should be fast enough for our needs and for signal transmission to the microcontroller. Our requirement is that the heart rate monitor can detect the user’s heart rate within +/- 10 beats/minute which means the signals must be sent at least every 0.2857 seconds. Since the RC time constants are on the order of milliseconds, even if we vary the resistance of R8 or R1 (see figure 19) +/- 10kOhm, the requirement should still be met.

![Figure 18. Voltage vs. Time of the input of the low-pass filter (blue) and output (green)](image-url)
Low-Pass Filter

**Function:** The last portion of the circuit is a low-pass filter with cutoff frequency equal to $\frac{1}{2\pi R_{\text{parallel}}C_{\text{parallel}}}$. With the current values ($R_{\text{parallel}} = 470$ kOhm and $C_{\text{parallel}} = 1$ uF), the cutoff frequency is 0.338 Hz which is preferable since our input is DC. Using 2.12 Hz cutoff, we eliminate any noise above that threshold. It is especially important to eliminate the 60 Hz noise from power lines and our city environment. The different green slopes were caused by the change in input voltage to the op-amp integrator due to the IR LED receiver (R8) resistance changes but doesn’t make a significant difference in the output. There is also a gain due to the parallel resistance increasing ($\text{Gain} = 1 + \frac{R_5}{R_4}$) so if we need a stronger signal, we can increase the $R_5$ resistance.

**Tolerance:** A little low frequency noise is allowable for our circuit so we chose to allow 5 Hz of noise. This would mean that $R_{\text{parallel}}C_{\text{parallel}}$ value needs to be greater than or equal to 0.0318 to guarantee filtering out noise above 5 Hz. Also, by increasing the value of $R_4$, the time it takes for the low pass filter output voltage to reach steady state of around 4 V increases (see figure 20). However, even by increasing the value to 5x its original value only caused the time to increase 3x which is still in the range of milliseconds. To detect a heart rate of maximum 210 beats/minute requires signals to be sent at least at 0.2857 seconds per signal. This is much higher than the order of milliseconds so the circuit will still be able to record user’s heart rate within +/- 10 beats/minute.
Final Output

The final output is around 4 V given our simulation values and a 5 V input. This is ideal because we only lost 1 V within the circuit flow. As the IR LED sends and receives the signals due to reflections against the blood flow/pulse in the user’s finger, the output will be picked up by the microcontroller and pulses will be detected and recorded well because of the filtering of noise and strong voltage.
3 Cost and Schedule

3.1 Cost Analysis

3.1.1 Labor
We estimate ECE Grad earns average of $67,000 (2014-2015) and believe $27 per hour is a fair hourly rate for our work.

\[
\text{Cost} = 27/\text{hour} \times 2.5 \times 10 \text{hrs/week} \times 9 \text{ weeks} \times 3 \text{ workers} = 7,290
\]

Per person: $2,430

3.1.2 Parts

<table>
<thead>
<tr>
<th>Part #</th>
<th>Mft.</th>
<th>Description</th>
<th>Module</th>
<th>Price</th>
<th>Qty</th>
<th>Subtotal</th>
</tr>
</thead>
<tbody>
<tr>
<td>APV-8</td>
<td>MEAN WELL</td>
<td>Power Supply AC-DC</td>
<td>Central Hub</td>
<td>$5.12</td>
<td>1</td>
<td>$5.12</td>
</tr>
<tr>
<td>TSOP38238</td>
<td>Adafruit</td>
<td>IR Receiver</td>
<td>Central Hub, Whack-a-Mole, Get Moving Test, Heart Rate Monitor</td>
<td>$1.95</td>
<td>7</td>
<td>$13.65</td>
</tr>
<tr>
<td>ATMEGA32</td>
<td>Mouser Electronics</td>
<td>Microcontroller</td>
<td>Central Hub, Whack-a-Mole, Get Moving Test, Heart Rate Monitor</td>
<td>$1.96</td>
<td>7</td>
<td>$13.72</td>
</tr>
<tr>
<td>LCD1602</td>
<td>Newegg</td>
<td>LCD Panel</td>
<td>Central Hub</td>
<td>$2.99</td>
<td>1</td>
<td>$2.99</td>
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<tr>
<td>COM-14865</td>
<td>Sparkfun</td>
<td>Remote</td>
<td>Central Hub</td>
<td>$3.95</td>
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<td>$3.95</td>
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<td>CR2032</td>
<td>Energizer</td>
<td>Coin Cell batteries (pack of 6)</td>
<td>Whack-a-Mole, Get Moving Test, Heart Rate Monitor</td>
<td>$7.98</td>
<td>3</td>
<td>$23.94</td>
</tr>
<tr>
<td>SSL-LX5093</td>
<td>Lumex</td>
<td>LEDs</td>
<td>Whack-a-Mole</td>
<td>$0.19</td>
<td>4</td>
<td>$0.76</td>
</tr>
<tr>
<td>RB-Spa-463</td>
<td>Sparkfun</td>
<td>IR LEDs (pack of 25)</td>
<td>Central Hub, Whack-a-Mole, Get Moving Test, Heart Rate Monitor</td>
<td>$7.95</td>
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**TOTAL** | **$154.31**

### 2.3.1 Grand Total

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<td>Parts</td>
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<td><strong>Grand Total</strong></td>
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## 3.2 Schedule

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<th>Week</th>
<th>Task</th>
<th>Member</th>
<th>Note</th>
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<tr>
<td>10/8</td>
<td>Design Review</td>
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<td>Order parts</td>
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<tr>
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<td>Central PCB design and analyze microcontroller datasheet</td>
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<tr>
<td></td>
<td>Build Heart Rate Monitor IR pulse circuit</td>
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<tr>
<td>10/15</td>
<td>Soldering Assignment</td>
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<td>Test sensors for sensitivity</td>
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<td>Test/Build IR receivers and IR LED and verify requirements</td>
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<td>Test Heart Rate Monitor IR pulse circuit</td>
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<td>10/22</td>
<td>Connect microcontroller connection to led panel</td>
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<td>Test microcontroller communication with IR receiver and IR LED</td>
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<td>Connect microcontroller to heart rate IR pulse circuit</td>
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<td>10/29</td>
<td>Program the central hub microcontroller</td>
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<td></td>
<td>Test power supply</td>
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<td>Assemble and test PCBs</td>
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<td>Test microcontroller communicating with accelerometers</td>
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<td>Time delay tests for receiving and transmitting data</td>
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<td>Test remote communication with IR transceiver</td>
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<td>11/19</td>
<td>Debugging whack-a-mole modules</td>
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<td>Fall Break</td>
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<td>Debugging get active module</td>
<td>Bing</td>
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4 Ethics and Safety

4.1 Ethics
We should have little trouble in following the IEEE and ACM Codes of Ethics [15][16]. The general purpose of the ethical guides is to promote invention based around benefiting society and prevent harm. Our product will not gather any personal information from the user except for their heart rates (which will not be saved, only calculated and displayed) so will not violate confidentiality or privacy (ACM Code of Ethics, #1.6 and #1.7). Our goal with this project is to promote wellbeing of users and encourage them to get more active in life. We aim to improve user wellness and will do so in a game-like manner. This interface will hopefully be fun and attractive to users of all ages so we can appeal to a wide audience. Overall, Get Active Gaming System provides users with a simple yet encouraging way to spend a few minutes a day not sitting down or staring at a screen and enhances quality of life.

We discussed this with our TA, but one consideration we need to keep in mind during our project is to create a unique design for the heart rate monitor, so as to not violate IEEE Code of Ethics, #2 which states we must “avoid real or perceived conflicts of interest whenever possible” [12]. There are many designs along the lines of “DIY IR pulse recorder”s online that we planned to learn from but will not copy. This would mainly pose a problem if we were to manufacture and sell our product and had copied someone else’s idea but should be fine for the scope of this class. Still, we plan to focus on drawing from the best aspects of each one to create a new, unique circuit design that fits our own needs and requirements.

4.2 Safety
IEEE Code of Ethics, #2 states that we must “hold paramount the safety, health, and welfare of the public” [15] which applies to all of our safety considerations mentioned below.

Our project uses a variety of power sources so we must ensure that our circuits are created properly to eliminate the risk of any shocks. Ideally, everything we make will be contained and the only exposed wires may be to the
sensors (IR, pressure, etc.). This also includes safety with the power outlet. It must be guaranteed that wires are properly insulated and don’t pose any more risk than normal power cords.

We also will be drawing power from batteries which can corrode after a long period of time. However, with regular use the user should drain the battery and replace it before this poses an issue.

During design, we need to consider our audience. One demographic we are targeting is children so we need to make sure the box and components are child-proof. If a kid is running around the room pressing sensors, there is a concern of them tripping on exposed wires or falling on or near the box. For this reason, we need to make sure our circuits are contained so no loose wires are exposed and make the box such that it can be placed on a table or away from where the player will be running around. Hiding the wires will also be beneficial if users have a pet at home or if the system will be placed in a retirement home where people may be in wheelchairs.

Another issue we may encounter are with the heart rate monitor portion of our project. According to the ACM Code of Ethics, #2.3, we must “know and respect existing rules pertaining to professional work” [16]. The heart rate monitor uses an IR transmitter and receiver and can be classified as a Class I or II medical device by the FDA since it is interacting with humans and measuring a part of the body [17]. However, we would not need to register it because similar devices exist in hospitals and are pre-approved so our system could be “grandfathered” if need be [18]. We would only need to gain approval from the FDA if we were to put our project on the market. The heart rate monitor also should not pose a serious threat to humans because the IR sensors we are using will come from Sparkfun which we assume has passed human safety tests.

If we were to put our product on the market, we would want to run user tests with volunteer subjects. This would be to ensure our game can detect everyone’s heart rates and arm movements accurately. To do so, we’d need research subjects and need to get IRB human testing approval [19]. It should be relatively easy to get approval for human testing because there are not many risks to a user.
References


