Wearable Simulator for Enhanced Realism

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Abstract

Simulations are an incredibly useful tool for training medical personnel on high-risk and infrequent scenarios [1]. Although there are many high fidelity simulations on the market, all of them are based around plastic mannequins that lack the ability to interact and move the way a real human could thus breaking a sense of realism for the medical personnel [2]. Therefore, the team proposes a wearable simulation vest that can be worn by an actor or instructor. This will enhance the authenticity of the experience between the medical personnel trainee and the patient by allowing the trainee to interact with someone that can talk, act, and move the way a real patient would. The vest will include speakers that emit heart and lung sounds that are hearable through a stethoscope. Ultimately, the goal is to have a functional simulation vest that has heart and lung sounds and can be used to assist doctors, residents, and nurses in training by providing the most realistic interpretation of any given scenario.

Background

- Medical Simulations
  - Education and training for various situations
  - CPR, surgery, emergency rescue, basic life support [3]
- No more than $500
- Must be a wearable simulator of reasonable weight and size to fit the average person
- Can be used about 12 hours per week
- Outputs can be modified during simulation to respond to interventions
- Simulates heart sounds
- Simulates lung sounds

Competition

There is currently no product like the wearable vest on the market, but SIM mannequins are currently being used for medical education.

Figure 1: The SimMan 3G [4]

- a high fidelity mannequin
- intended to accurately represent a human's symptoms and presentation
- Pre-programed scenarios
- Programable
- Wireless

Figure 2: Gaumard Heart and Lung Sound Adult Torso [5]

- 15 different sounds
- 13 speaker locations
- Palpable anatomical landmarks

Motivation

- Medical simulation is a major part of interprofessional education that requires adaptation as technology progresses
- Current simulations are inanimate mannequins that make it difficult for students to interact in a realistic way
- Vest can have several benefits
  - Make medical education more realistic, valuable, personal, and reliable
  - Provide a low cost option compared to the SIM men
  - Possible use across multiple medical disciplines

Final Design

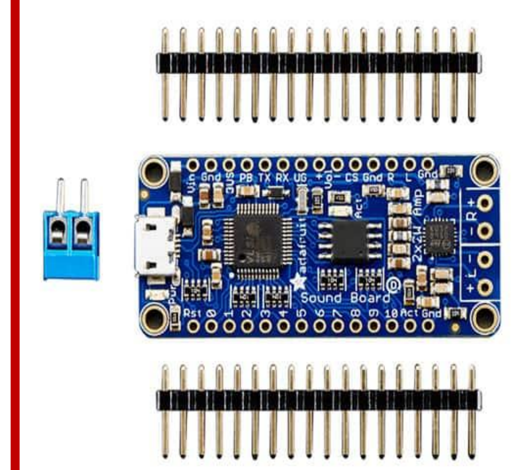

Figure 3: *Adafruit Soundboard*. The soundboard is used to store the sounds and easily switch between different sounds..
https://www.digikey.com/en/products/detail/adafruit-industries-llc/2217/5761278

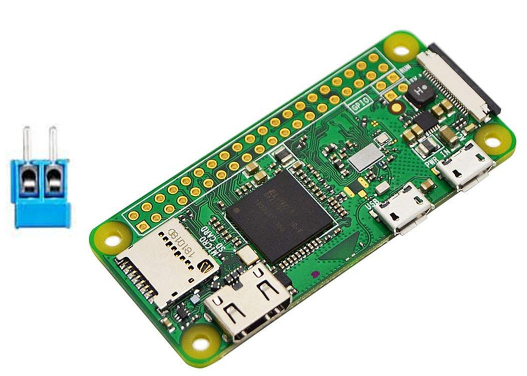

Figure 4: Raspberry Pi Zero. The Raspberry Pi controls the sounds boards and which sounds are being played by each speaker and allows for controller input.
https://www.adafruit.com/product/3400

Figure 5: Speaker. Speakers will be placed around the vest to produce the heart and lung sounds.
https://www.adafruit.com/product/1890

Figure 6: Weight Vest. This weight vest features pockets for easy placement of speakers close to desired position and adjustable sides due to flexible cords.
https://www.roguefitness.com/hyper-vest-elite-weight-vest?160=3529&287=3581&gclid=CjwKCAiA8Jf-BRB-EiwAWDtEGuU2LEooie-NRG_3MOTCp2Tq8ohTWPt-dAy-Rfdv_CFXsTwtcae8CRoCuW0QAvD_BwE

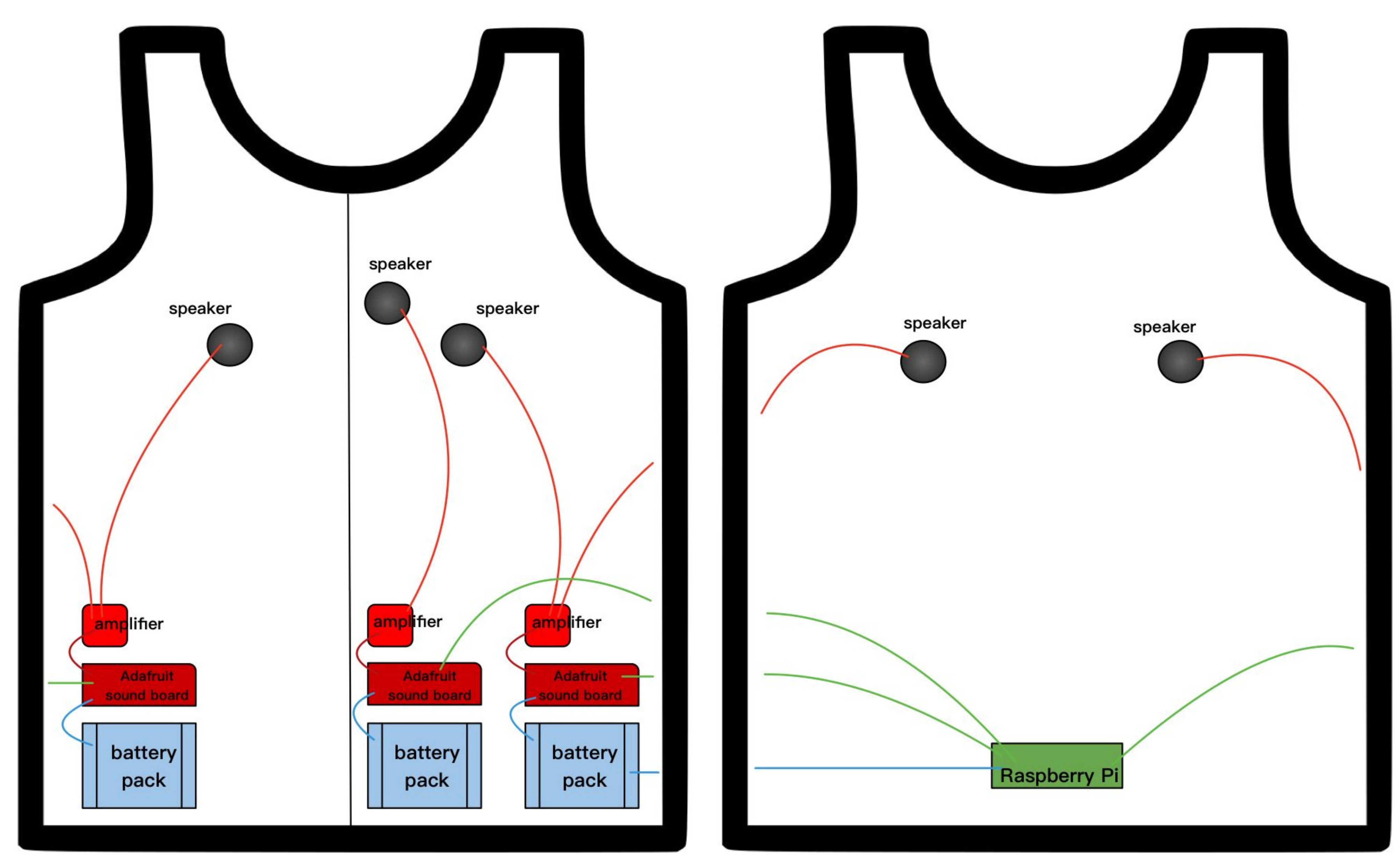

Figure 7: This is an illustration of the placement of the electronic components in the vest including the speakers, amplifiers, sound boards, battery packs, raspberry pi, and communication via connection wires.

Testing

1. Functioning Circuitry
   - ✓ Run code without errors
   - ✓ Speakers output sounds
   - ✓ Play different sounds on different speakers at once
2. Sound Accuracy
   - ✓ Be able to identify heart and lung sounds
   - ✓ Be able to locate the heart and lung sounds
   - ✓ Be able to differentiate the sounds from each speaker
3. Ability to Manipulate and Interact
   - ✓ Controller can change the sound outputs of each individual speaker
   - ✓ Quantify the time it takes from command to output
4. Vest
   - ✓ Comfortable for extended periods of time
   - ✓ Adjusts to different body types
5. Statistical Analysis
   - ✓ Null Hypothesis: The multimeter will detect no difference from output of speaker to actual heart sounds, will measure mean amplitude and use 1-sample T-test.
   - ✓ Alternative Hypothesis: The multimeter has detected a difference from the output of the speaker to a heart.

Future Work

- Fabricate and test a vest using the materials and designs outlined in the final design section.
- Make the design fully wireless so that the controller can change sounds to respond to interventions in real-time either through a handheld device or web interface.
- Incorporate ECG signals that correspond the heart signals being read from the vest.
- Add pulse points.
- Add additional speakers to more accurately represent all of the different stethoscope listening points on a patient.

References

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