Can a Glove Stop a Heart Attack?

Project ID: 2188

Category: Biomedical Engineering

Division: Senior

Engineering Type Project

Introduction/ Purpose

- Snow shoveling leads to thousands of heart attacks and hundreds of deaths every year. Per studies:

- The day after an 8-inch snowfall, heart attack deaths are 34% higher than normal, and hospitalizations are 16% higher

- Decrease of 1-degree Celsius causes a 0.5% spike in deaths

- In the Northern U.S, January through March have 26 to 34% more heart attack deaths than a normal month

Why does this occur?

- **Arm exercise:** Places more strain on the heart compared to leg exercise

- **Vasoconstriction:** The body responds to cold temperatures by narrowing blood vessels in order to preserve body heat

- **Valsalva effect:** Holding breath while lifting objects is a human habit

- These circumstances increase blood pressure and decrease blood oxygen, creating cardiac issues such as cardiac arrest.

Problems with Current State

There is no commercially available device that:

Monitor Heart rate, Surrounding air temperature, Time, and informs user their health status using these combinations to prevent or detect cardiac issues while doing winter activities.

**Fitness Monitoring Devices on the market are inadequate:**

- Do not account for the temperature of the surroundings.
- Do not provide user information on health status.
- Can easily be forgotten, or slide underneath winter coat or glove, thus limiting their usefulness.
- Expensive
- Not integrated into an accessory which user must wear while doing winter activities.

Engineering Goal

To create a device that will monitor heart rate, temperature of surroundings, time and display health status to the user when performing strenuous winter activities such as snow shoveling to prevent or detect cardiac issues.

Design Criteria

- Detect Heart Rate
- Detect surrounding air temperature
- Measure time
- Display health status information on screen based on the above factors.
- Recommend user to take a break every few minutes to prevent cardiac issues
- Have LED lights that change color based on health status to attract user attention
- Come in a convenient form such as a glove so that no additional device is required
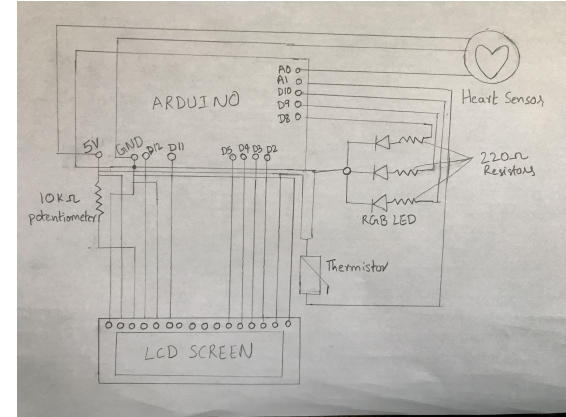
Methods

- Gather materials: gloves, sensors, LCD screen, other electronic components

- Do research on how to program certain parts such as heart sensor

- Program the device to do intended functions such as display the data on the LCD Screen

- Calibrate the temperature sensor by recording what it displayed in two different temperature environments and adjusting it, so they match the actual temperature

- Check if the heart rate sensor is working by comparing it with a commercially available pulse oximeter
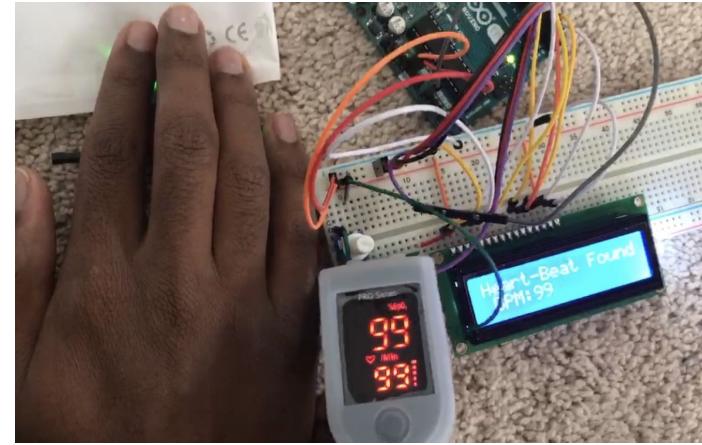

Early Prototype:

Heart rate comparison with commercially available Pulse Oximeter

Designs & Prototypes

The final prototype was able to successfully measure the user's heart rate, temperature of the surrounding, time spent and could provide health status of when the heart rate was too high for the surrounding temperature.

Prototype Version History:

1: Heart rate sensor working, and LCD screen displays heart rate

2: Temperature sensor is now included, and temperature is also displayed

3: Time is now accounted for, and is also displayed

4: RGB led lights are displayed at different colors to provide health status
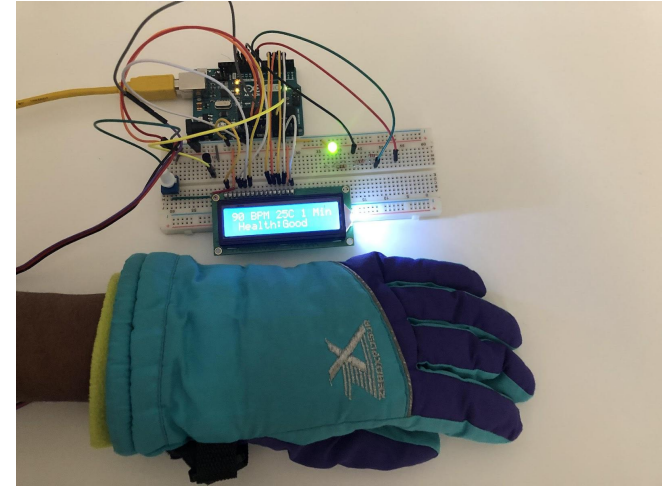
The prototype indicates with its green light that the user's heart rate is good for the temperature, while displaying info on the screen.

Testing/Results

First, I did an experiment to show that temperature influences heart rate: I measured my heart rate before and after doing 10 push ups at 22 degrees and 2 degrees Fahrenheit

Temperature(C)	Initial BPM	BPM After Push Ups
22	95	125
2	92	142

My device divides the temperature in Kelvin of the surrounding by BPM to get a value. If this value is less than a threshold, a red light is displayed. Otherwise, green light is displayed.

Note: Since I cannot simulate a heart attack condition, I adjusted my code to display warning at 23 °C and 115 BPM (Kelvin/ BPM<=2.6).

Then, I ran 5 trials to see if my device would display a warning past this threshold.

Results

- At the beginning of each of the 5 trials, I first checked to see if the prototype would show a green light for my resting heart rate.

- Then after increasing my heart rate by running up stairs at different amounts to get varying heart rates, I evaluated my heart rate and the warning light on the prototype.

- Each time, the prototype was able to detect my heart rate was too high for the temperature and gave me a red warning light.

Trial	Temperature	Initial Heart Rate	LED Color	Final Heart Rate	LED Color
1	23	89	Green	143	Red
2	22	93	Green	125	Red
3	22	92	Green	122	Red
4	24	95	Green	138	Red
5	24	95	Green	125	Red

Effect of Heart Rate and Temperature on LED Color
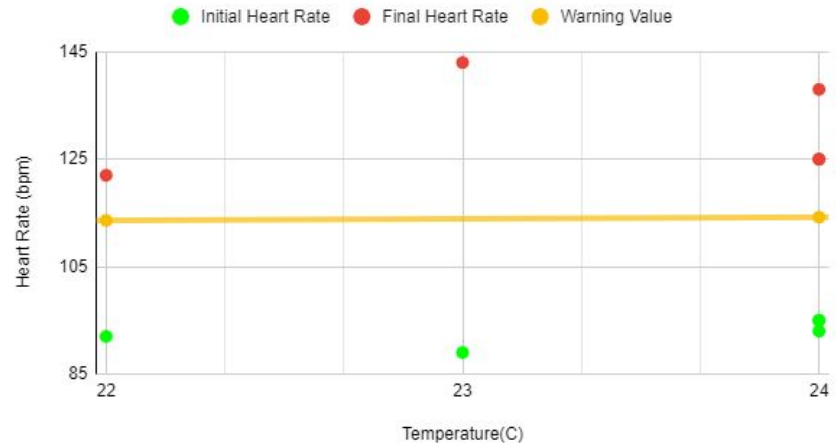
Results

Prototype showing Heart rate, temp, timer, and health status displayed

Health status: Good

Health status: At Risk

Take a break

Improvement Needed:
- Calibration time for heart rate and temperature sensor needs to be improved.
- Take a break warning program works independently but needs to be combined with the health status messages

Discussion

- The data shows that my prototype can successfully display heart rate, temperature, and timer.
- My prototype also demonstrated that it could alert user of their health status with visual indicator lights (red, green, blue) based on their heart rate and surrounding temperature.
- This means, incorporating this technology into a winter glove can save thousands of heart attacks and hundreds of lives when shoveling snow.

Possible errors:

- The temperature sensor was fluctuating to some extent during the trials. This can be overcome with high quality temperature sensor in the final design.

Observations:

- The heart sensor data and temperature sensor data sometimes would take a few seconds to stabilize, so I had to wait a few seconds to record results.

Conclusion

- It can be concluded that 'A Glove Can Stop a Heart Attack' and save hundreds of lives each year while user is performing strenuous winter activities such as shoveling given that the prototype successfully warned user of health status when at risk consistently.

Future plans:

- Incorporate battery power to glove.

- Incorporate WIFI and an automated emergency contact notification feature when the health status is at risk so that additional actions can also be taken by the loved ones to reduce or prevent heart attacks and deaths.

My Winter Glove with wellness Monitoring can save lives

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