CPR Guide Glove

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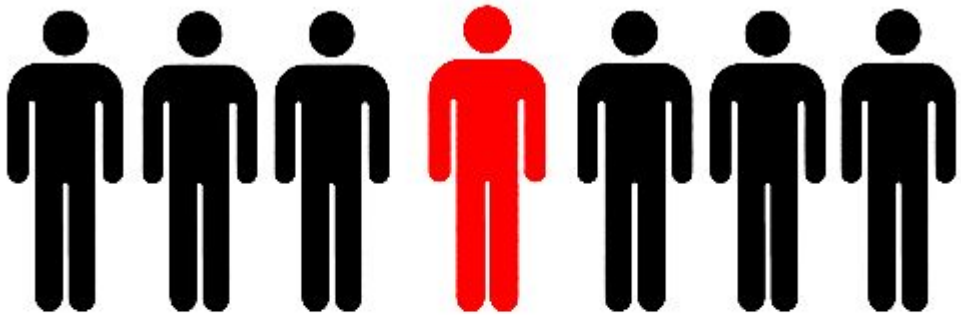

1 in 7 people die of sudden cardiac arrest

American Heart Association, 2020

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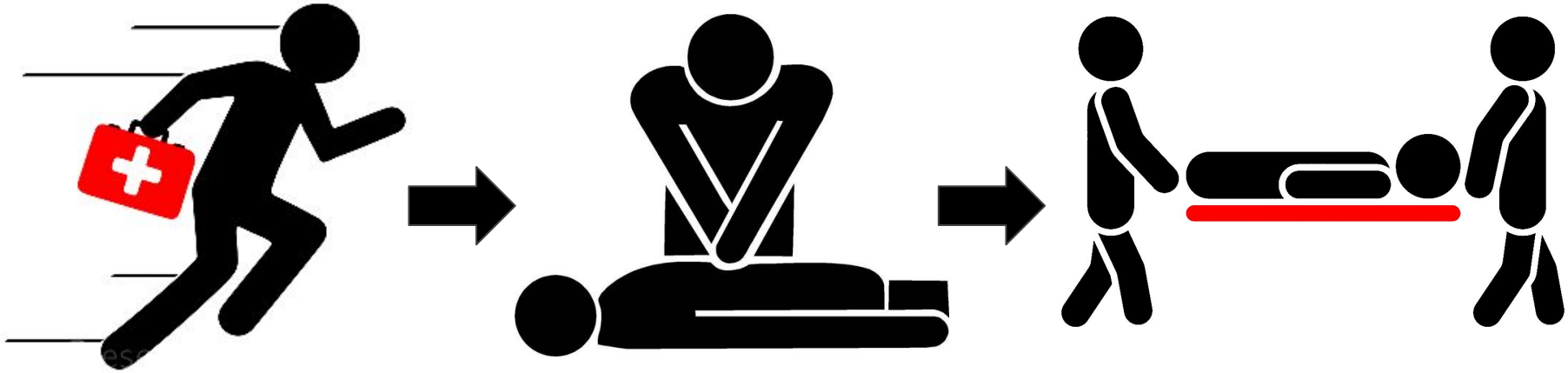

Within 10 minutes of cardiac arrest, brain damage is likely to occur

Weinberger et al., 1940

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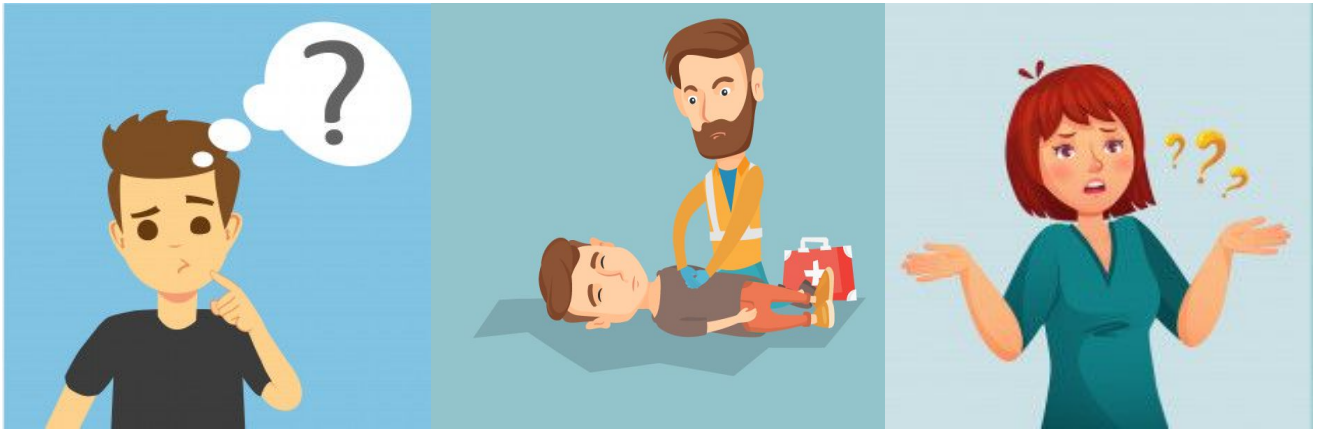

Only 30% of Americans are confident in their abilities to perform CPR

American Heart Association, 2020

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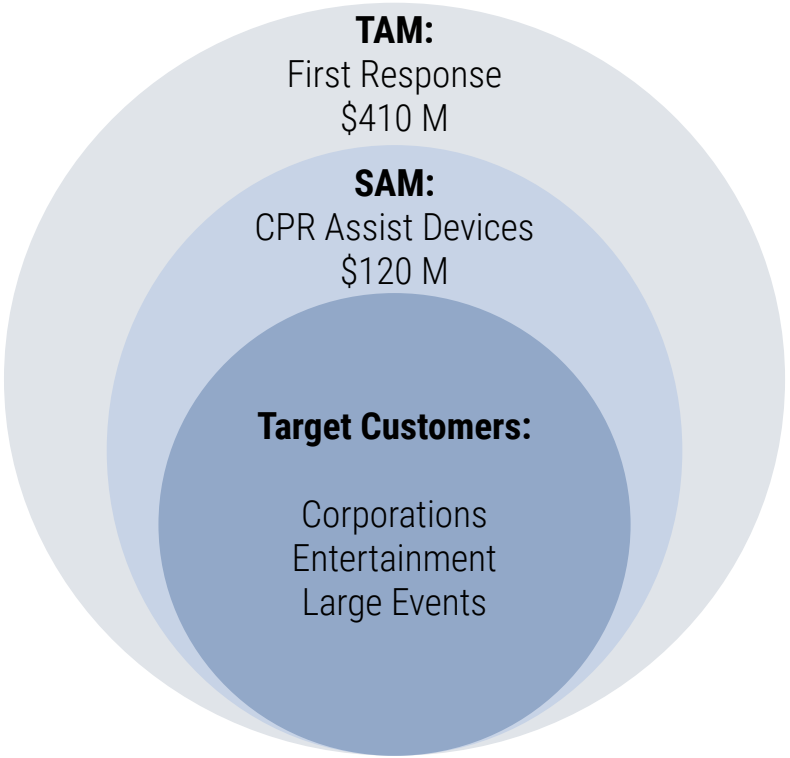
Market



- First Aid Kit Companies
- Medical Supply Companies
- Additional use in training

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Products on the Market

- Expensive
- Inefficient design
- Ineffective guidance
- Inconvenient
- Difficult to Use

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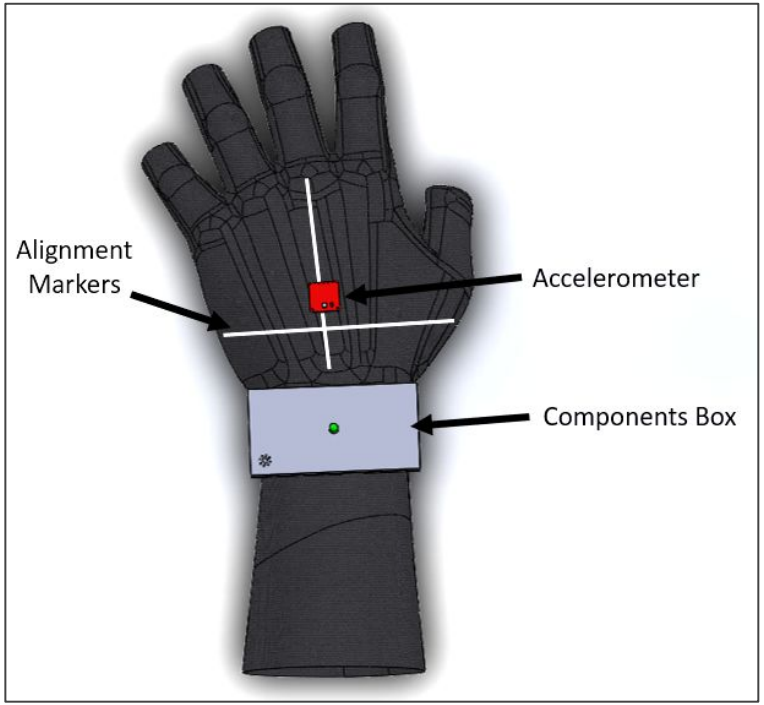
Device: CPR Guide Glove



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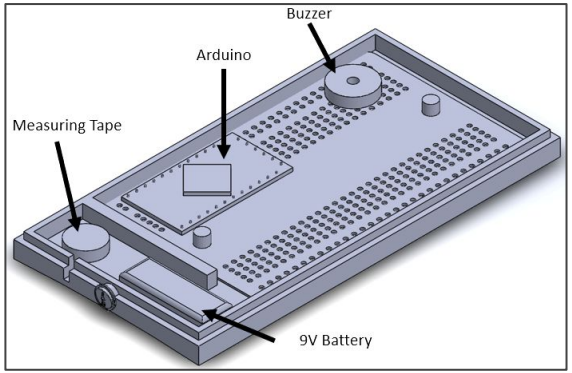
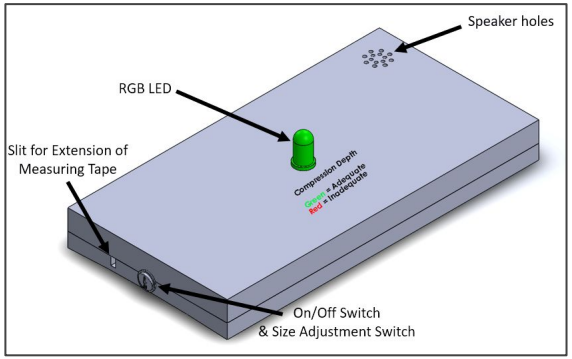


Inside of the Components Box



Outside of the Components Box

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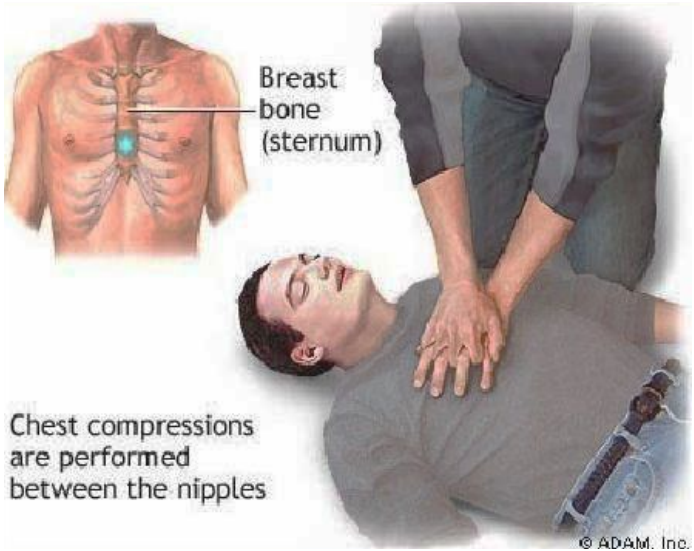
Primary Functions

Using audio and visual cues, the CPR Guide Glove aims to address the three metrics of high-quality CPR:

1) **Hand Placement**
2) **Compression Depth**
3) **Compression Pace**



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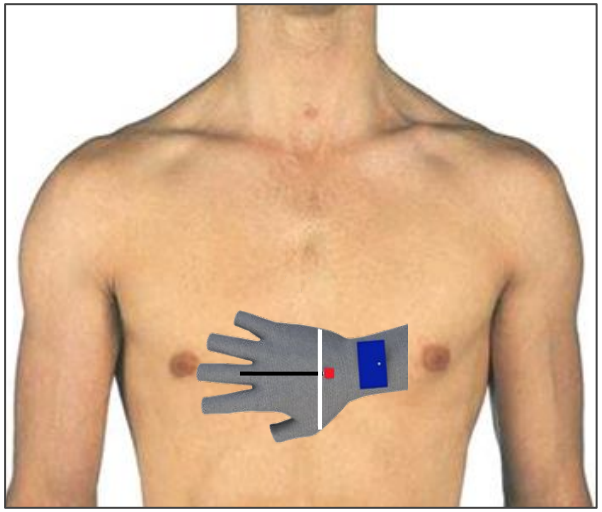
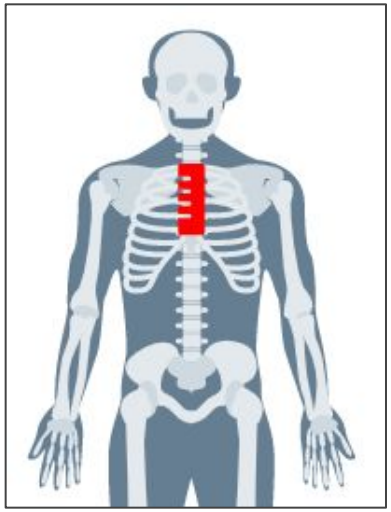
Hand Placement





1) From the view of the user, the vertical line is aligned with the nipple line of the patient
2) The horizontal line is aligned with the sternum
3) The end of the extension tool will be placed at the patient's sternal notch

Compression Rate

- AHA Guidelines: 100 to 120 beats per minute
  - CPR Guide Glove's buzzer/metronome: 120 bpm
- Frequency of the tone: 2 Hz
- Each beep represents one single chest compression

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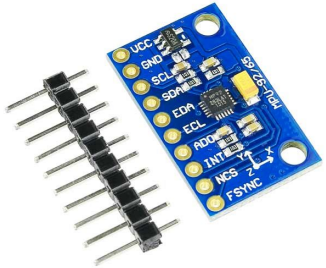
Compression Depth

- MPU-9250 Accelerometer
  - High sampling rate
- Arduino Nano processes the data
  - FFT between each integration
  - Blackman window w/ low pass filter
  - Double integration
- Device provides feedback through LED
  - Green = adequate compression depth
  - Red = inadequate compression depth



MPU-9250 Accelerometer

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Size Selection

- Different height and weight settings

  O: Off

  I: Average Patient (2 - 2.4 inches)

  II: Obese Patient (2.2 - 2.6 inches)

KCD3-103 Rocker Switch

Testing

- **Test 1**: Compare the measured distance from correct position for CPR to subject's actual position for CPR between control and experimental group
  - Control Group (n = 50): Users without the CPR Guide Glove
  - Experimental Group (n = 50): Users with the CPR Guide Glove
- **Test 2:** Compare time to achieve 5 good compressions in a row between control and experimental group, gather data regarding user-friendliness
  - Control Group (n = 50): Users without the CPR Guide Glove
  - Experimental Group (n = 50): Users with the CPR Guide Glove
- **Test 3:** Determine the accuracy of the depth-feedback mechanism by comparing the actual displacement with the desired displacement
  - Control Group (n = 20): Known distance
  - Experimental Group (n = 20): Calculated distance

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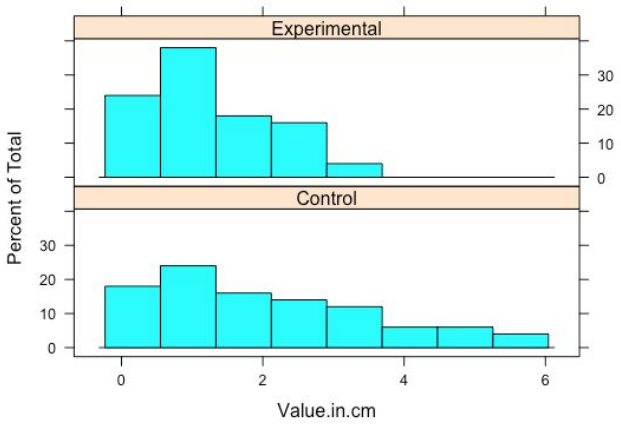
[mock data]

Results: Test 1

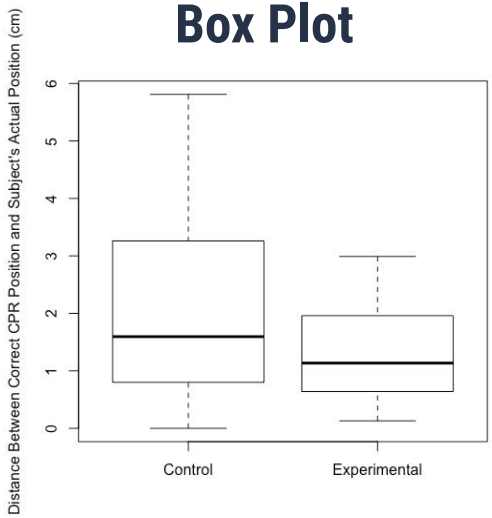
Null hypothesis (H_0): $\mu_{control} - \mu_{experimental} \leq 0$

Alternative hypothesis (H_A): $\mu_{control} - \mu_{experimental} > 0$

Histogram



Box Plot



	Mean (cm)	Variance (cm)
Control	2.0446	2.3769641
Experimental	1.2920	0.7450816

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Results: Test 1

- **Fligner-Killeen test**: test for homoscedasticity (equal population variances)
  - $H_0: \sigma^2_{experimental} = \sigma^2_{control}$
  - $H_A: \sigma^2_{experimental} \neq \sigma^2_{control}$
- Because p-value < .05, we reject the null hypothesis and proceed with Welch's t-test (performed when homoscedasticity is violated).

Fligner-Killeen test of homogeneity of variances

data: Value.in.cm by Group
Fligner-Killeen:med chi-squared = 9.8682, df = 1, p-value = 0.001682

- **Welch's t-test**:
  - $t(76.971) = 3.0118$, $p = .001756$
  - Because p-value < .05, we reject the null and conclude that the average distances for the control group are greater than the average distances of the experimental group.

data: Value.in.cm by Group
t = 3.0118, df = 76.971, p-value = 0.001756
alternative hypothesis: true difference in means is greater than 0
95 percent confidence interval: 0.3365737 Inf
sample estimates:
mean in group Control
2.0446
mean in group Experimental
1.2920

Testing

- **Test 1**: Compare the measured distance from correct position for CPR to subject's actual position for CPR between control and experimental group
  - Control Group (n = 50): Users without the CPR Guide Glove
  - Experimental Group (n = 50): Users with the CPR Guide Glove
- **Test 2:** Compare time to achieve 5 good compressions in a row between control and experimental group, gather data regarding user-friendliness
  - Control Group (n = 50): Users without the CPR Guide Glove
  - Experimental Group (n = 50): Users with the CPR Guide Glove
- **Test 3:** Determine the accuracy of the depth-feedback mechanism by comparing the actual displacement with the desired displacement
  - Control Group (n = 20): Known distance
  - Experimental Group (n = 20): Calculated distance

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Expected Results: Test 2

NUMERICAL DATA

- Average time for control group < average time for experimental group
- Significant difference in time between experimental and control

SURVEY DATA

- More confidence in ability to perform CPR with glove
- Higher likelihood to perform CPR on a stranger with glove

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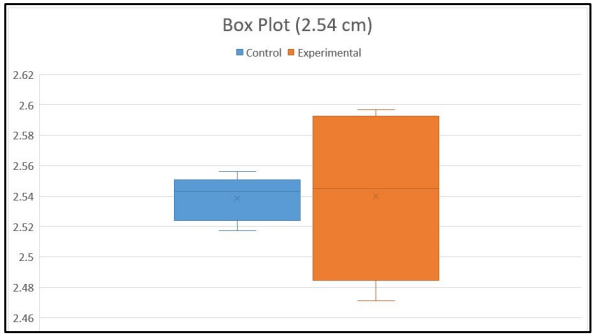
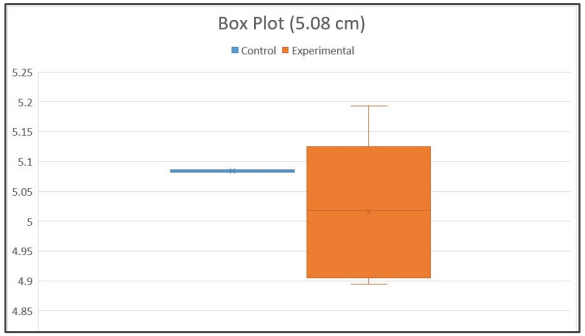
Testing

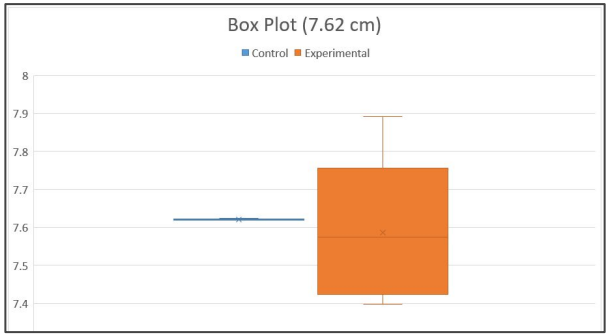
- **Test 1**: Compare the measured distance from correct position for CPR to subject's actual position for CPR between control and experimental group
  - Control Group (n = 50): Users without the CPR Guide Glove
  - Experimental Group (n = 50): Users with the CPR Guide Glove
- **Test 2:** Compare time to achieve 5 good compressions in a row between control and experimental group, gather data regarding user-friendliness
  - Control Group (n = 50): Users without the CPR Guide Glove
  - Experimental Group (n = 50): Users with the CPR Guide Glove
- **Test 3:** Determine the accuracy of the depth-feedback mechanism by comparing the actual displacement with the desired displacement
  - Control Group (n = 25): Known distance
  - Experimental Group (n = 25): Calculated distance

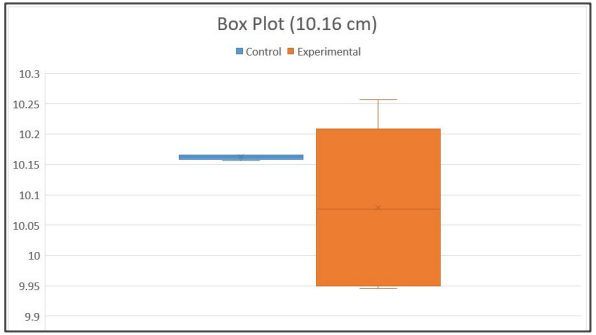
[mock data]

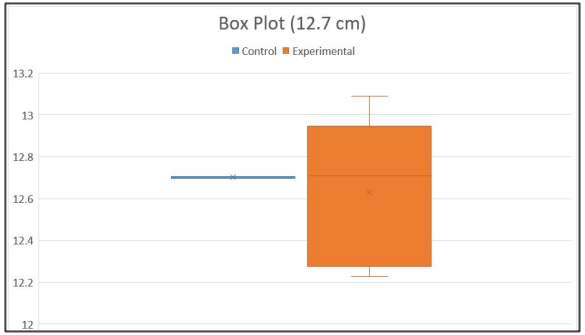
Results: Test 3











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Results: Test 3

Levene's test:

Null hypothesis (H_0): $\sigma^2_{control} - \sigma^2_{experimental} = 0$

Alternative hypothesis (H_A): $\sigma^2_{control} - \sigma^2_{experimental} \neq 0$

- 2.54 cm Group: $p = 0.019797$
- 5.08 cm Group: $p = 0.021988$
- 7.62 cm Group: $p = 0.036392$
- 10.16 cm Group: $p = 0.009255$
- 12.7 cm Group: $p = 0.004032$

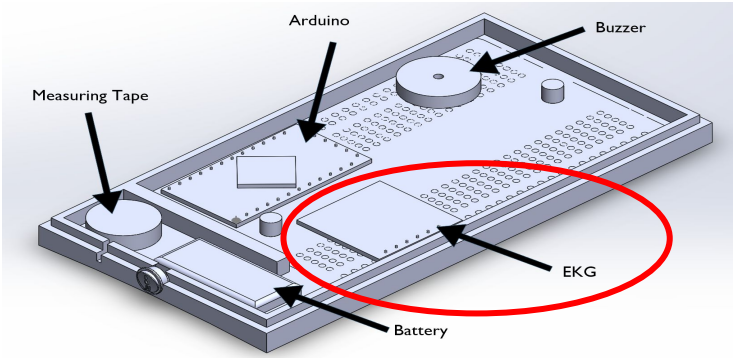
Welch's t-test:

Null hypothesis (H_0): $\mu_{control} - \mu_{experimental} = 0$

Alternative hypothesis (H_A): $\mu_{control} - \mu_{experimental} \neq 0$

- 2.54 cm Group: $t = -0.05493$, $p = 0.958319$
- 5.08 cm Group: $t = 1.278362$, $p = 0.270259$
- 7.62 cm Group: $t = 0.39727$, $p = 0.711454$
- 10.16 cm Group: $t = 1.393418$, $p = 0.235929$
- 12.7 cm Group: $t = 0.453433$, $p = 0.673747$

Future Work: Pulse Check



- Electrocardiogram (EKG):
  - Retractable leads to attach to the patient
  - Detect electrical signals of the heart
  - CPR is unnecessary if heart is beating

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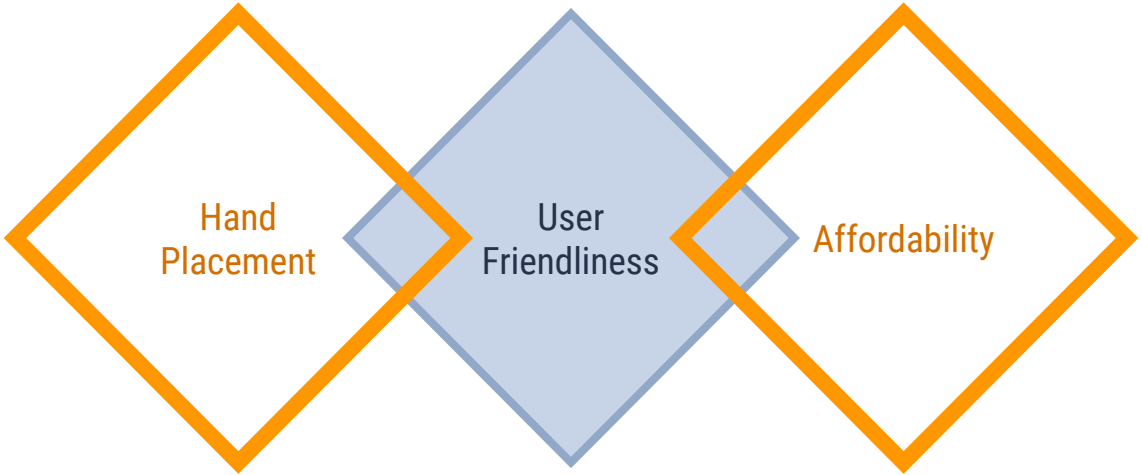
Conclusion

Overall, the CPR Guide Glove improves on existing technology through:



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Thank You!

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Appendix

Background: Statistics

- Heart complications are the leading cause of death in the United States
- 73% of cardiac arrest cases occur outside of the hospitals
- Cardiac arrest is one of the leading causes of heart-associated deaths with approximately 475,000 deaths in the United States each year
- The average survival rate is 10.6% and survival with good neurologic function is 8.3%
- Nearly one in three victims survives when the arrest is witnessed by a bystander

Competitors

	CPR Guide Glove	CPR RsQ Assist	TrueCPR	Mechanical CPR devices
Cost	$300	$87.65	$1990.90	> $10,000
Customer	Bystander	Bystander	First responders	First responders
Hand Placement	✓	✗	✗	✗
Compression Depth	✓	✓	✓	✗
Compression Rate	✓	✓	✓	✓
Size Adjustment	✓	✗	✗	✓
Requires User Action	✓	✓	✓	✗
Drawbacks	Impacted by user error	Does not assist with hand placement and does not have size adjustment	Expensive, does not adjust to different sizes, inconvenient design	Expensive

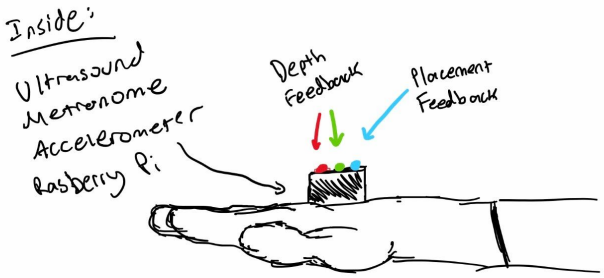
TrueCPR

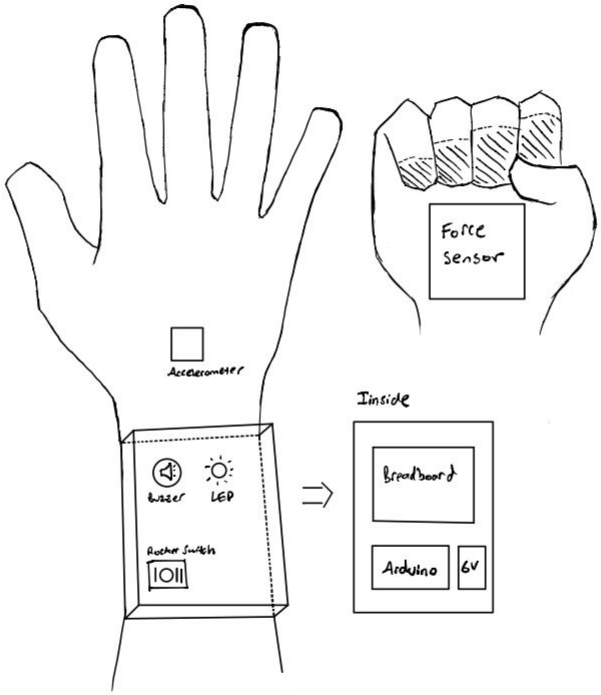
CPR RsQ Assist

Mechanical CPR Device

CPR GuideGlove

Design Iterations: Sketches



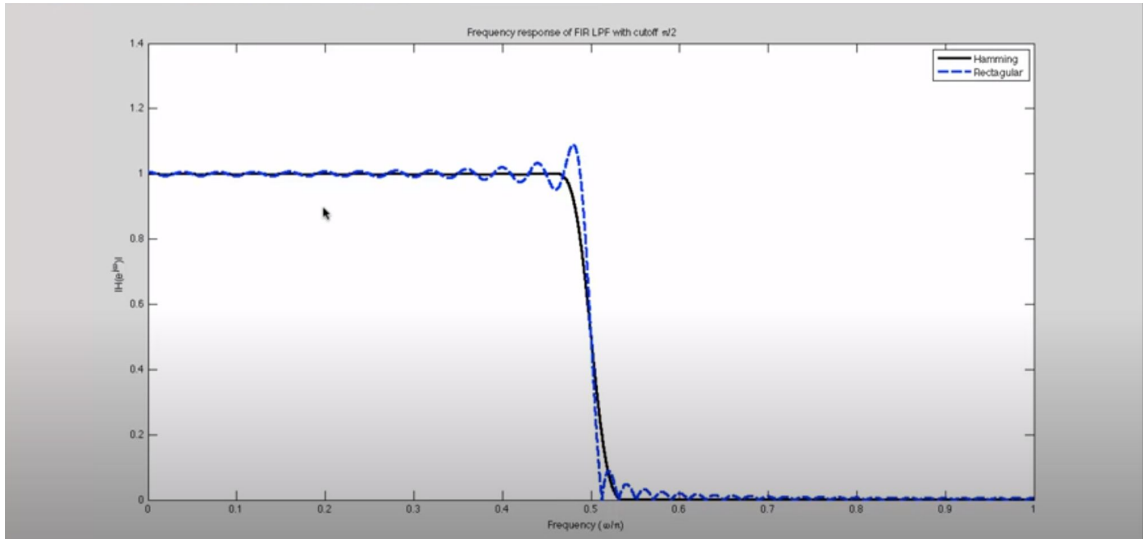


Nyquist-Shannon Theorem & Gibbs Phenomenon

- The Gibbs Phenomenon is commonly referred to as a “ringing signal” which is due to the use of sinc filters.
- The Nyquist Theorem states that a minimum of 2 times the maximum signal frequency is needed to reconstruct a signal.

Windowed FIR Filter

- Applying a window to a sinc filter helps to counter the effects of the Gibbs Phenomenon (indicated by the black line)



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Statistical Analysis: Equations

Welch's t-test

Degrees of Freedom

$$\nu = \frac{\left(\frac{S_X^2}{n_X} + \frac{S_Y^2}{n_Y}\right)^2}{\frac{\left(\frac{S_X^2}{n_X}\right)^2}{n_X - 1} + \frac{\left(\frac{S_Y^2}{n_Y}\right)^2}{n_Y - 1}}$$

Test Statistic

$$t^* = \frac{(\bar{X} - \bar{Y}) - D_0}{\sqrt{\frac{S_X^2}{n_X} + \frac{S_Y^2}{n_Y}}}$$

Battery

- Rechargeable and replaceable 9V battery
- Battery will be in a convenient spot for easy replacement

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