Anti Drown

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Motivation For The Project

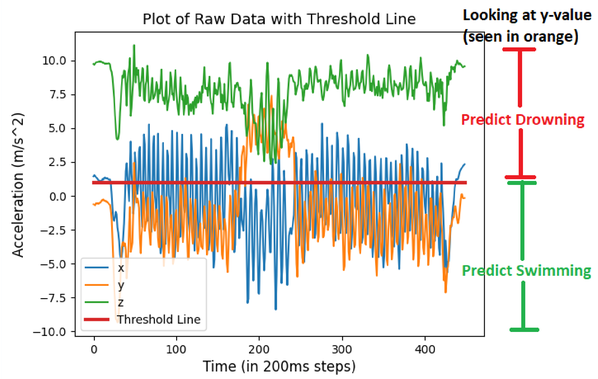
- According to WHO, drowning is the 3rd leading cause of unintentional injury death (worldwide), accounting for 7% of all injury-related deaths [1]
- To address this issue, this project aims to create a device that, based on a user's arm movements and heart rate, can detect when a swimmer is drowning and inflate to bring them above the water
- This could be particularly useful in open water swimming where swimmers are more vulnerable and could be popular for parents who want an extra level of safety for their children

Data Collection

- Smart phone and heart rate sensors were used simultaneously to collect accelerometer and average heart rate data respectively
- The phone and sensor were strapped to wrist as seen in image below
- 4 participants performed various swimming strokes and simulated drowning in fresh water and swimming pool environments

- Heart rate data was taken every 5s this needed to be spread across the accelerometer data which was every 200ms.

Initial Model



Method

- Looked at raw data of swim
- Noticed that y acceleration value significantly increased when drowning was simulated
- Set threshold so if y acceleration value is greater than 1, predict drowning
- Otherwise, predict swimming

Results

- When tested on data file in which the threshold of 1 was chosen, gave accuracy of 90%
- However, this method is very specific to how an individual swims and their flailing action
- When method tested on a data set of two other people, produced accuracies of 68% and 70%

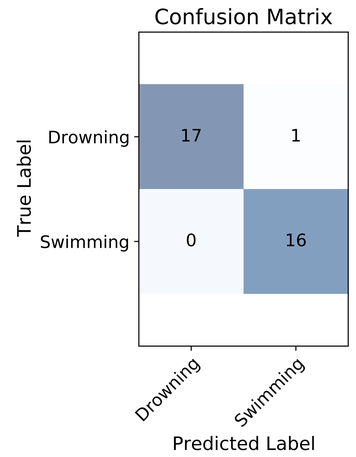
Neural Network Model

Wavelet Transform

- Similar to Fourier transform but allows for time-dependant features have a high resolution in the time domain and vice-versa for frequency domain
- The model converts data into small wavelet signals. These signals are made using a sliding window technique that looks at sections of the data as they change throughout time
- These signals are then input to the CNN

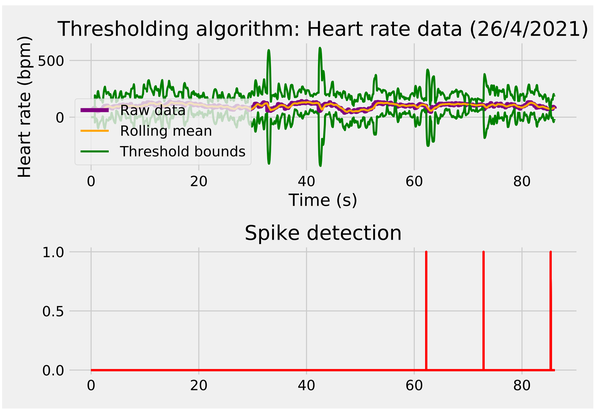
Convolutional Neural Network (CNN)

- X, Y and Z data from an accelerometer and heart rate data is split into 5 second chunks which can then be used for training and testing the CNN
- Data for training the CNN is split into swimming and drowning so the CNN will predict either of these classes
- The model can differentiate between swimming and drowning with 97% accuracy



Thresholding Algorithm

- Record a spike when threshold bounds are crossed as shown in bottom subplot
- Spike if difference between the datapoint and the previous moving average value is greater than the product of the set threshold and the previous moving standard deviation



Conclusion & Future Work

The model can correctly predict with 97% accuracy whether someone is swimming or drowning based on the data we collected. If more data was provided for the model this accuracy would increase rapidly. Additionally,

- The heart rate data used was an average over 5 seconds, if the heart rate data was continuous or taken over shorter time periods this would likely improve the accuracy of the model
- Collect data from users where they are not drowning but system is still alerted, this would help deal with false positives
- Investigate how heart rate and motion actually changes when someone is drowning and not use simulated data
- Use thresholding algorithm as a secondary check for the CNN

References

[1] World Health Organisation. Drowning Fact Sheet. https://www.who.int/news-room/fact-sheets/detail/drowning, 2021. Online; accessed 2 Feburary 2021.

EDI Statement

- Cannot accurately simulate drowning without putting people at risk
- Could have a sample bias if data is only collected on confident swimmers, since inexperienced swimmers are unlikely to want data collected of them
- Not possible to collect data from children due to health risks and need for parental consent