Towards Predicting Risky Behavior among Veterans with PTSD by Analyzing Gesture Patterns

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Introduction

- Veteran population has a higher rate of PTSD compared to the civilian population → Prone to Risky behaviour

- Collection of accelerometer data from subjects performing risky gestures and detecting them using machine learning techniques

- Our research aims :
  - to detect the risky behavior among veterans by studying and analyzing their gesture pattern, and thus detect crisis events.
  - To identify the early warning signs of risky behaviors, we focused on determining the gestures by conducting an extensive ethnographic study on collecting accelerometer data and physiological data from wearable sensors.

By predicting risky behavior, we intend to intervene *(if possible)* before a crisis event goes out of hand

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Initial Work

- We aim to merge the two fields of behavior analysis and gesture recognition
- Past experience of researchers working with Veterans
  - Dryhootch of America, a non-profit organization
  - MCAT: A generic m-health tool for continuous assessment, automatic intervention, and analysis of veteran mental health-related issues
- Challenge is to get timely information and accurate data about target behaviors and symptoms
- Our solution: a wearable wristband, collecting physiological data and accelerometer data
  - connected to the internet via smartphones
  - collected nearly 39,000 data points from the accelerometer sensor

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Research Method

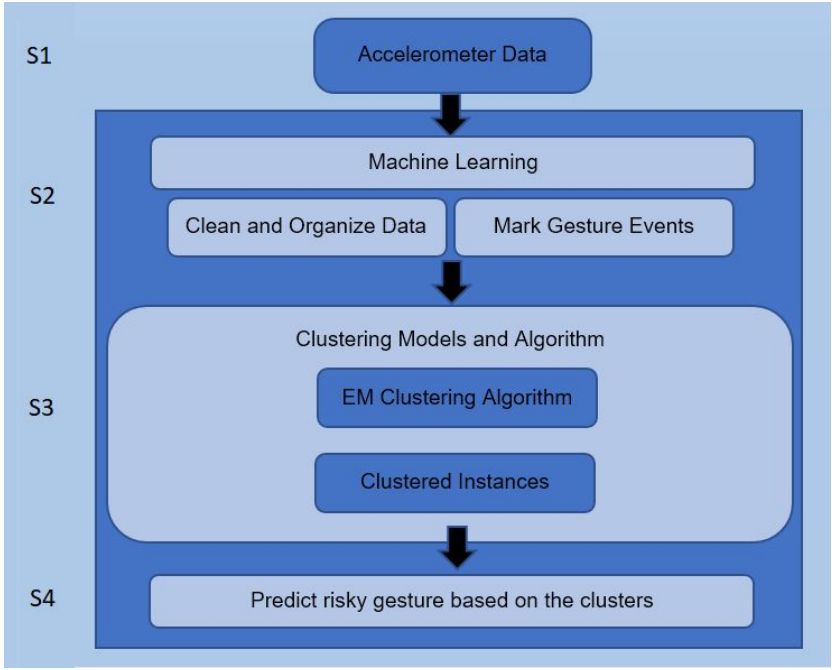

Fig: Research Methodology

- Step1: 3-axis accelerometer sensor data from the E4 device
- Step2: label the data with timestamps and gestures
- Step3: expectation maximization clustering algorithms, supervised learning algorithm
- Step4: evaluation and validation of the predictive model from the classification output

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Ethnographic Research

- We conducted extensive ethnographic research from small focus groups with high-risk veterans

- Multidisciplinary research team
  - consisting of anthropologists, computer scientists, and clinical psychologists
  - met with three high-risk veterans for seven sessions to conduct the ethnographic research

- Open-ended interviews to elicit the contexts and bodily experiences leading up to angry outbursts.

- Descriptive coding to develop a list of dimensions to design a general taxonomy of warning signs (scenarios, social settings, and gestures)

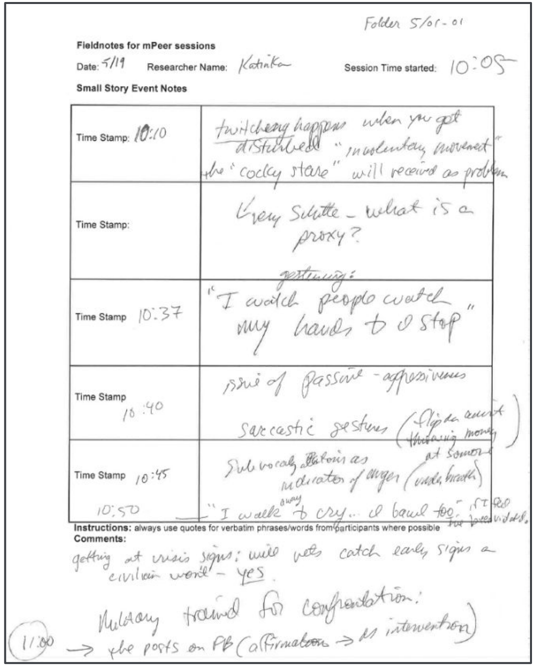

Fig: Field note from focus group

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Simulated Aggressive Gesture

- Challenge: Data collection
- Goal: Collection of meaningful accelerometer sensor data from E4 to predict risky behavior that veterans might demonstrate
  - By simulation of aggressive crisis events and anger outburst moments in a veteran's life using actors
  - based on the initial detailed ethnographic view on veteran's lived experience with anger that we obtained

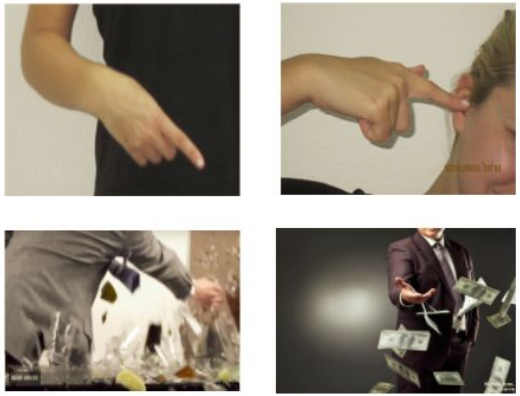

Fig: A portion of the acted gestures

Fist in the Air	Pounding fist	Giving the finger	Shove
Hands on head	Sweep things off the table	Italian street talk	Throwing keys
Knife hand	Throwing things	Pointing	Throwing money on
Poking chest			

Fig: List of the gestures

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Simulated Aggressive Gesture

- Selected 13 gestures for the actors to act out, based on the findings from the ethnographic study
- Scenarios acted were a formal scripted interaction using Shakespeare and modern theater scripts
- Actors were also free to use other gestures and were encouraged to improvise
- Veterans were present in the room while data was collected

Fig: Data collection in presence of Veterans

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Experimentation

- Wearable device: E4 wristband from Empatica
  - high-quality real-time sensor-based physiological data with 5 sensors onboard
  - 3-axis accelerometer data, blood pressure volume, heart rate variance, body temperature, and galvanic skin response
- The acting scenarios involved three states
  - Started off with a high-intensity anger condition
  - Continued to a graduated anger condition scenario, and
  - Ended with a non-anger but intense emotion condition
- These data collection sessions were video recorded
- A single database was created for data analysis
  - included data from all the sensor with precise time-stamps

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Clustering Gesture Data

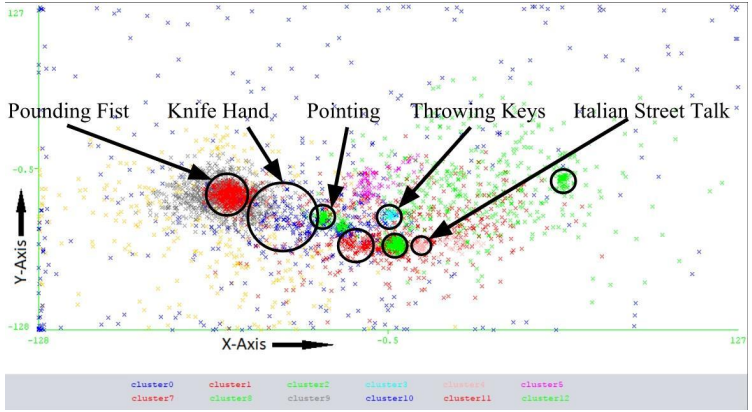

Fig: Output from EM algorithm showing clusters

Gesture Clusters	Accuracy
Knife hand	93%
Pounding fist	87%
Pointing	84%
Throwing keys	74%
Italian street talk	69%

Fig: Top five clusters identified representing the gestures

- Expectation Maximisation (EM) algorithm
  - Weka *(Waikato Environment for Knowledge Analysis)* version 3.8.1 Machine Learning suite
  - Train test split 75:25

- Successfully detected 12 clusters
  - Throwing money and Throwing things were closely related

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Classification Algorithms

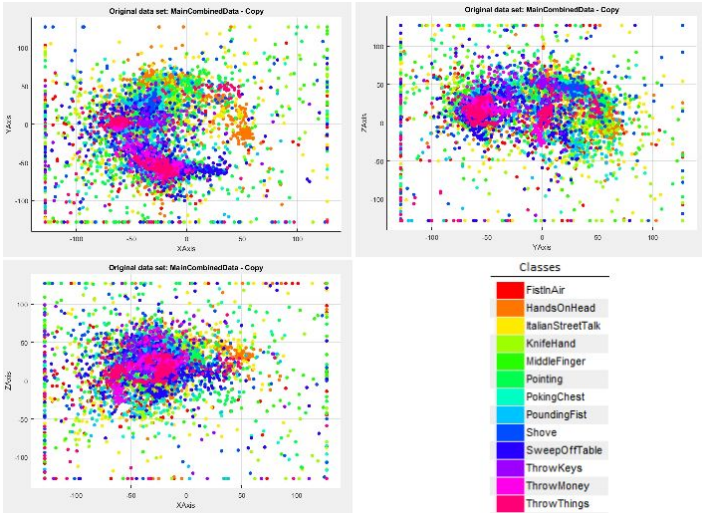

Fig: Scatter plot of accelerometer sensor data along different axes and class labels

- Support vector machine (SVM):
  - quadratic SVM classifier on MATLAB
  - Low accuracy (~23.6%)
- k-NN algorithm:
  - Better accuracy: ~66.7%

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Results

- Distinctively and reliably identify a set of clusters representing aggressive gestures
  - Successfully detected 12 gestures after applying EM algorithm
- Narrow down to the smallest number of gesture that are most informative
  - focused on the top 5 gesture clusters for strong cluster
  - For top 5 gestures, accuracy was 81.72% for EM Algorithm
- Pin-point labeling of the accelerometer data and gestures
- Development of a predictive model with classification algorithms
  - weighted k-NN, linear SVM, quadratic SVM, Ensemble boosted trees
  - k-NN algorithm was able to classify each gesture correctly with an accuracy of 67.7%

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Ongoing Studies

- Potential extension: Alert trigger to the healthcare facility or law enforcement agencies warning about probable risky behavior when the aggressive gestures are detected
- Parallel study: Building a veteran peer mentor social support model using smartphone application (Dryhootch Quick Reaction Force (QRF) smartphone application)
- Potential extension: Merging of alert trigger system with QRF smartphone application

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THANKS!

Any questions?

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