

Smart Wearables with Feedback Control

CNS-1646470

PI: John A. Stankovic
Department of Computer Science



Motivation

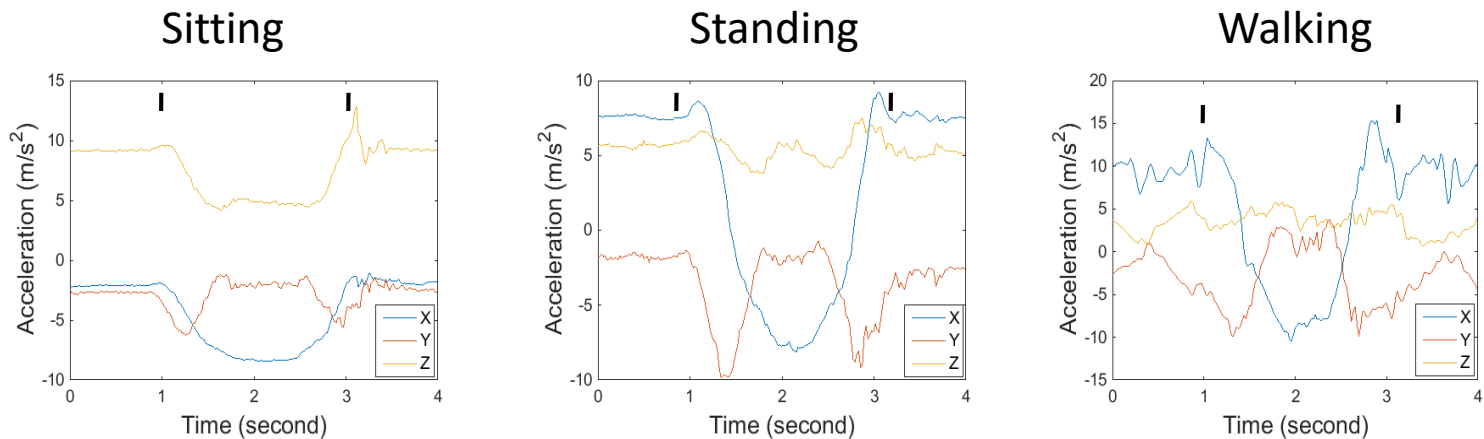
- Human activity recognition has widespread applications in different domains including:
 - Healthcare
 - Safety
 - Behavior Monitoring (e.g., eating)
 - Energy Management
 - Manufacturing
 - Elderly Care
 - Smart Homes and Smart Cities
- Smart wearables can be used to recognize wide variety of human activities in different contexts.

Goals

- Produce new algorithmic approaches for processing signals from wearables
- Bringing human behavior into control loops

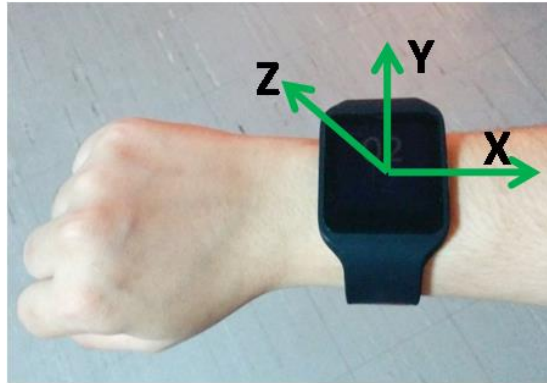
Challenges

- Confounding gestures
 - People perform a wide range of activities
 - Confounding gestures are prevalent
 - Realisms in environment
 - Requires identifying and using discriminative features
- Diversity in the same activity
 - Differences across people, contexts, tools used and postures.



Data from a wrist accelerometer for Cookie Bites

Eating Detection



(a)



(b)

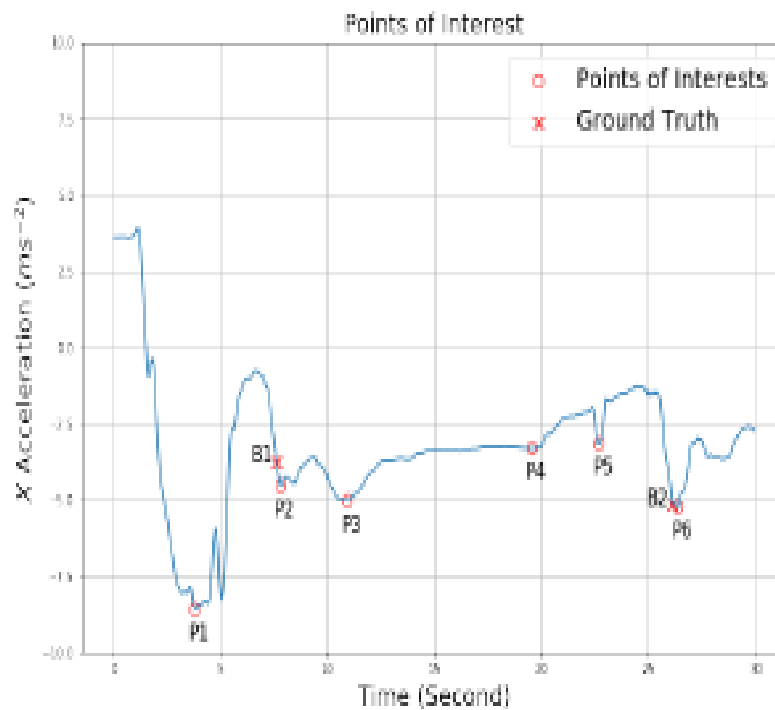


Fig. 5. Points of Interests

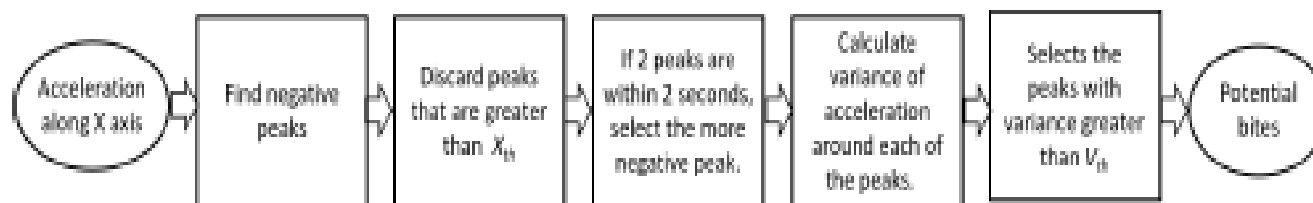


Fig. 6. Flowchart for potential bite detection

CNN

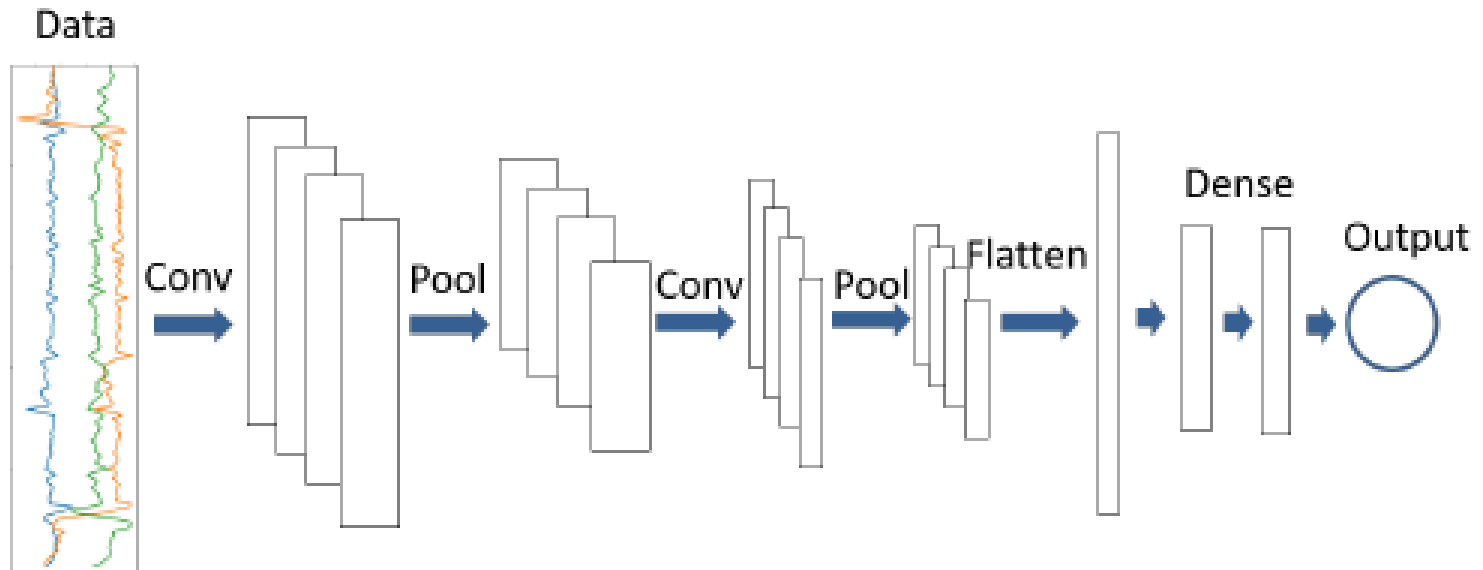


Fig. 7. The Convolutional Neural Network for bite classification.

Eating Events

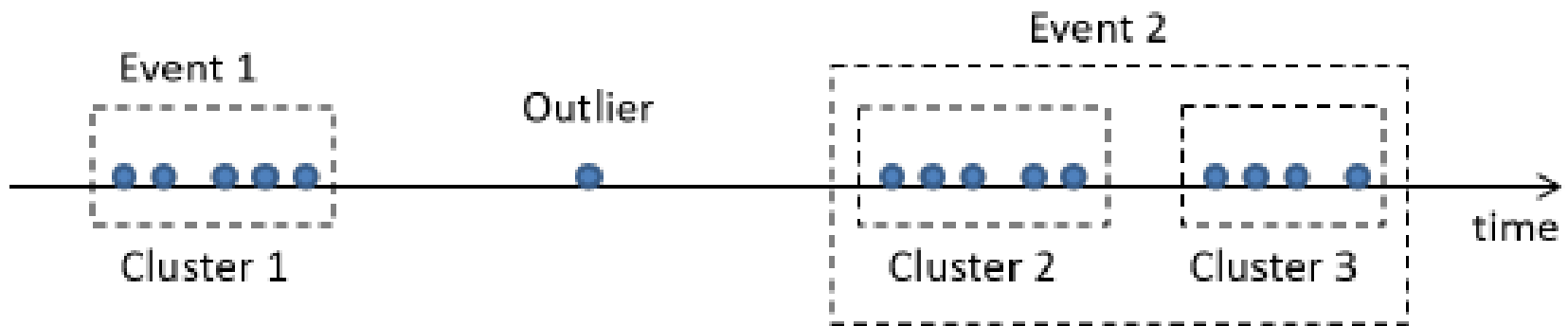
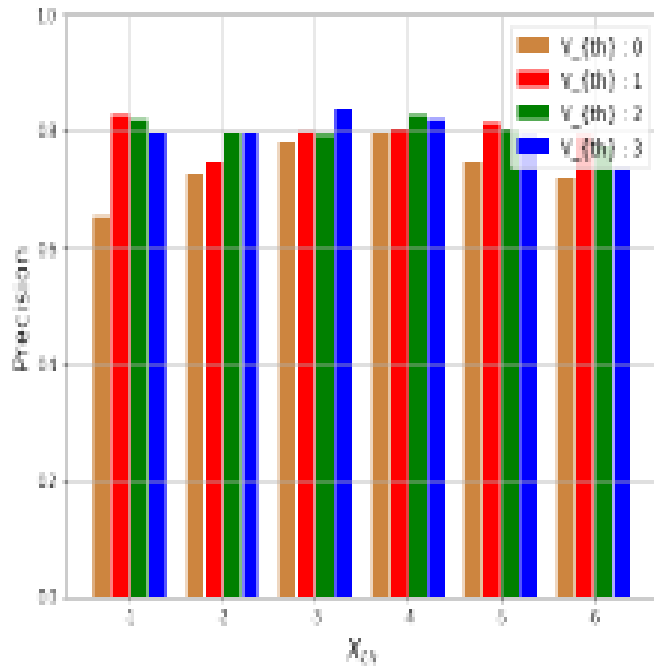
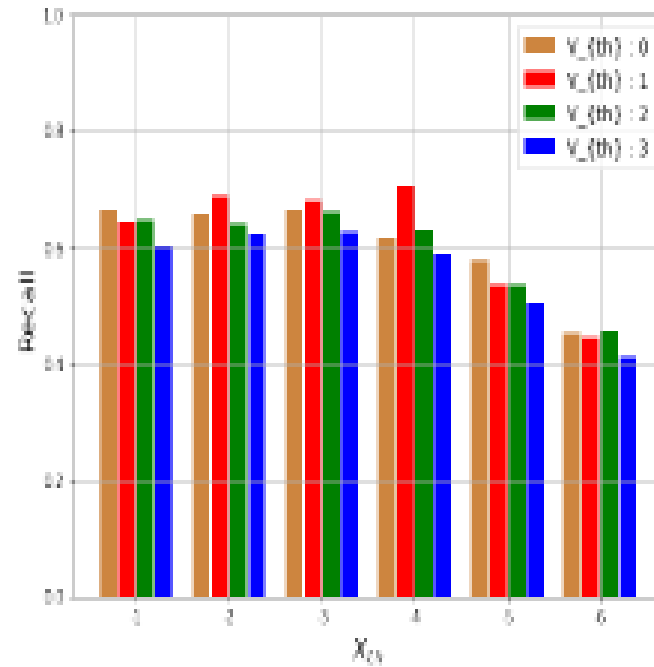


Fig. 8. Eating event formation from bites.

In the Wild Accuracy



(a) Precision

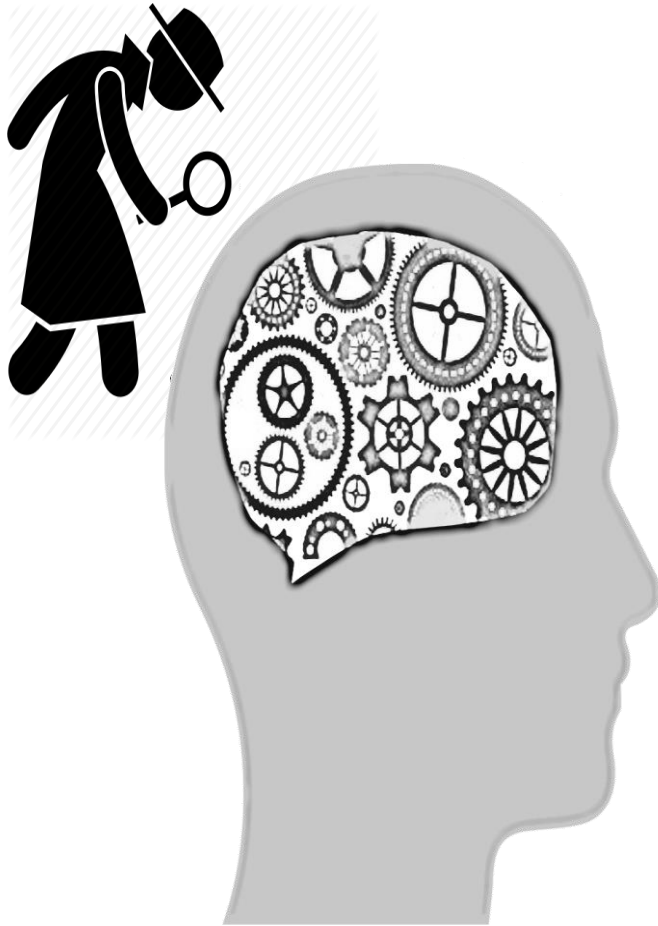


(b) Recall

Fig. 10. (a) Precision and (b) Recall of bite detection for different values of V_{th} and X_{th}

Detecting Mental Disorder

Social Anxiety and Depression



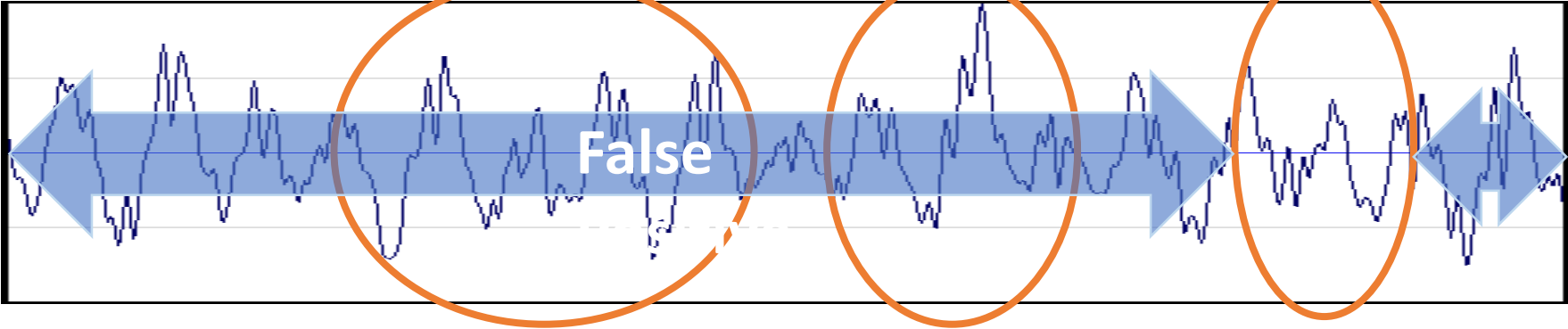
Challenges

- Only trained clinical psychiatrists can label the data
- Limitation of real human training data
- Moreover, only segments of data show symptoms

Challenge: Weakly Labeled data / MIL

True Positive

Positive sample (from persons with mental disorder)



Indicates anxiety disorder

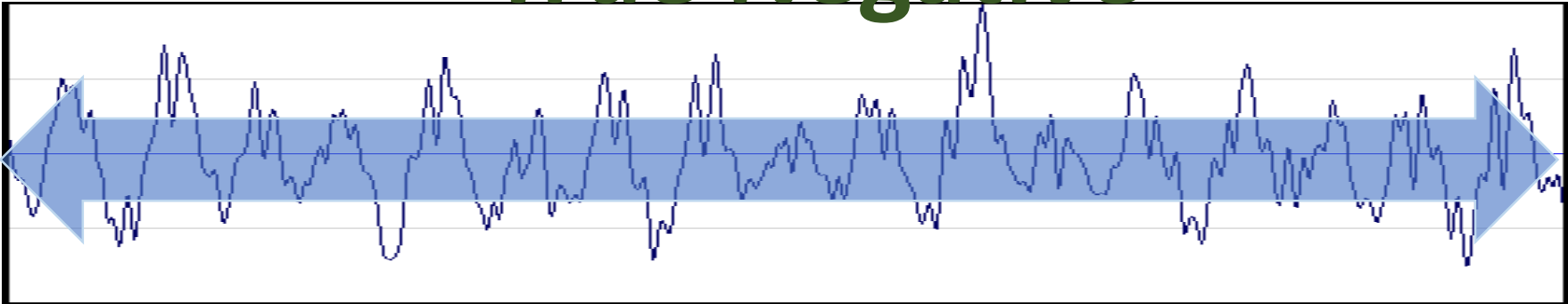
Audio Samples are large (20min)

False positives are significantly large

Limited training data

True Negative

Negative



Evaluation

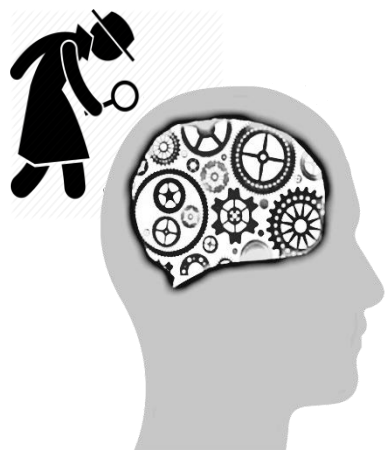
Social Anxiety	Depression
<ul style="list-style-type: none">• 105 Participants• Mean Age: 19.24, SD: 1.84• Mean audio clip length: 3 minutes• Labeled by Licensed Clinical Psychologists• Social Interaction Anxiety Scale (SIAS) and Social Phobia Scale (SPS)	<ul style="list-style-type: none">• Distress Analysis Interview Corpus - Wizard of Oz (DAIC-WOZ)• 142 participants• Mean audio clip length: 12 minutes

Evaluation

- Leave-one-speaker-out cross-validation
- Metrics: F-1 score and accuracy

Detecting Mental Disorder

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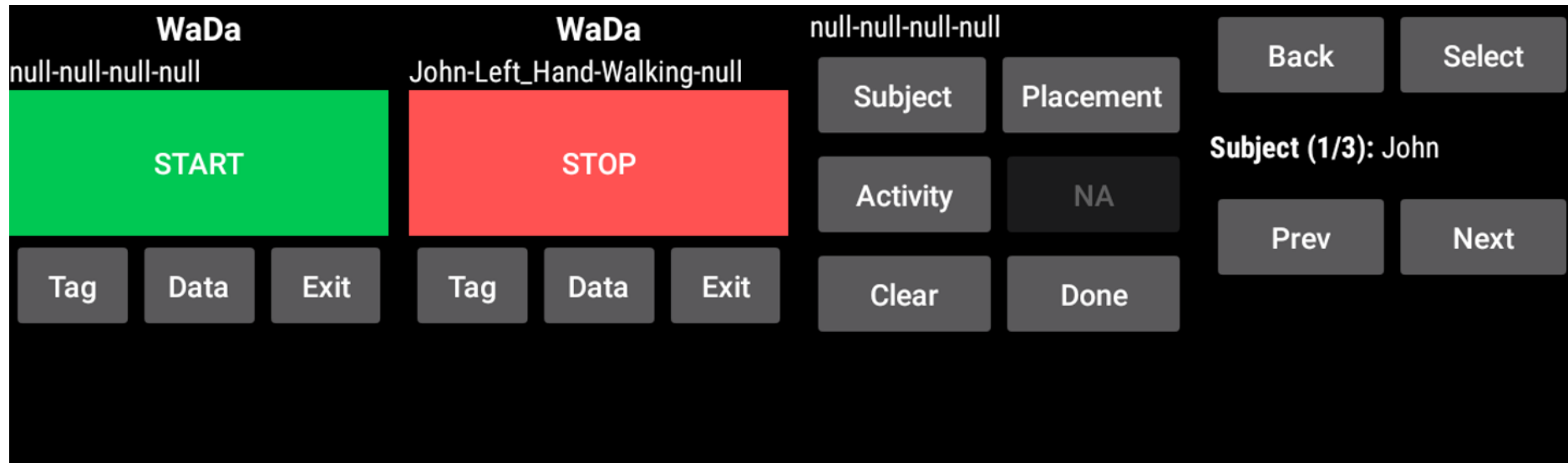


Solution Summary

- Use shallow network (scalable)
- Adaptive
- Can optimize with small training set

Mental Disorder	Previous Best Baseline approach	Improvement in F-1 score
Social Anxiety Disorder	I-vector with BLSTM	20.7%
Depression	DepAudioNet: CNN with LSTM	33%

WaDa – Collecting Data from Wearables: A Utility



For Android Smart Watch
Video Available

https://drive.google.com/file/d/1_y7579fCGRwSa5ZcPp-PvSimgGa5e0iQ/view

iAdhere – verbal medication and exercise reminder system

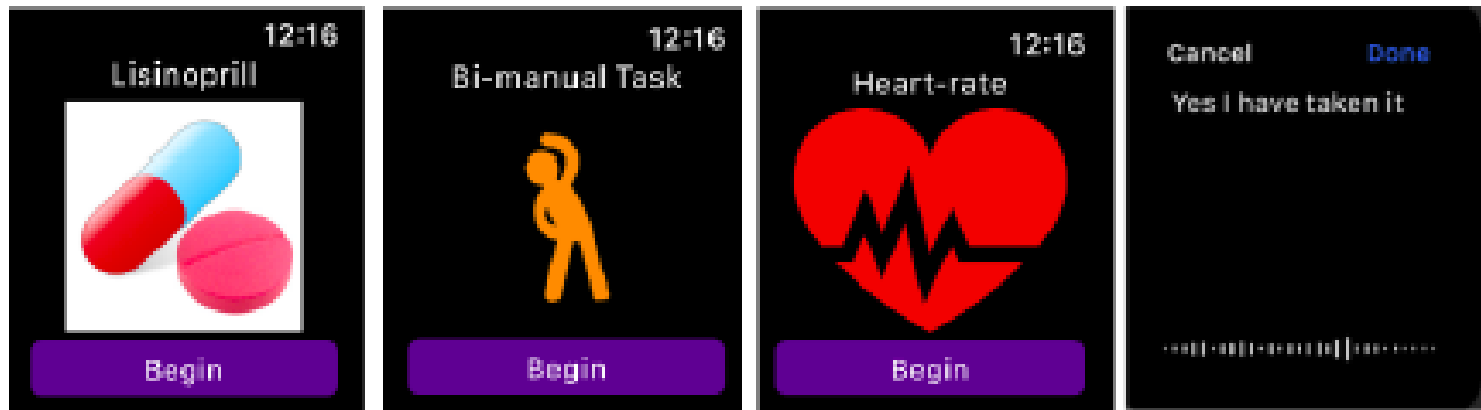


Figure 1: User Interfaces of the reminders to and the response from the users

Using Apple Watch – with microphone and speaker