Funded Mobile Projects in Healthcare Sensing and Imaging

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Project 1: AlcoGait Intoxication Sensing
1 Masters student: Spring + Summer
AlcoGait: Intoxication Detection

- Can we test drinker’s before DUI? Prevent it?
  - **Vision:** Test gait at party, during walk to car
- How? Alcogait smartphone app:
  - Samples accelerometer, gyroscope
  - Extracts accelerometer and gyroscope features
  - Classify features using Machine Learning (SVM, naïve Bayes, Random Forest, etc)
  - Notifies user if they are too drunk to drive
- Video: [https://www.youtube.com/watch?v=pwZaoKmfq8c](https://www.youtube.com/watch?v=pwZaoKmfq8c)
Project 2: SmartPhone
Wound Imaging
3 PhD Students
Sugar Diabetes App
PI: Strong, co-PIs: Tulu, Agu, Pedersen UMASS: Harlan, Pagoto, Ignotz, Dunn
ECE PhD Student: Lei Wang (wound analysis)

- NSF-SCH funded project: smartphone app
  - Diet, blood glucose, exercise, weight
  - Analyzes wound healing from pictures
    - Wound boundary detection
    - Generates wound healing score
  - Behavior change (reminders, goal-setting)
- Funding: $1.2 million, 2011-2015

Wound image acquisition  
Color pattern
Color Correction
Unsupervised Segmentation
Sugar Wound Assessment: Sample Steps

Wound Image

Wound boundary determination
(Conditional Random Fields)

Tissue composition analysis
(Red-Black-yellow model)
K-means Clustering
3 Versions of Wound Detection Algorithm

- **Version 1:** Mean-shift segmentation + footbox
- **Version 2:** 2-stage Cascaded SVM + no footbox
- **Version 3:** Associative Hierarchical Random Field (AHRF) + calibration patch
Healing Score

- Weighted proportion of red, yellow and black tissue

\[
S_n = 1 - \frac{WA_n - WA_0}{WA_0} \times G = (1 + G) - G \frac{WA_n}{WA_0}
\]

- High level of agreement with physician-assessments
- Krippendorff’s Alpha Coefficient ranging from 0.42 to 0.81
SmartPhone Biomarkers for TBI/Infectious Diseases
2 PhD Students
Smartphone BioMarkers

- Smartphone biomarker
  - Smartphone-sensible user behaviors that can reliably indicate the health status, ailment symptoms and condition of the smartphone user.

- **Example:** depressed smartphone users:
  - Fewer step count per day
  - Smaller radius away from home
  - Fewer conversations
  - Difficulty sleeping at night

- All signs above can be sensed with a smartphone
TBI & Infectious Disease Smartphone BioMarkers

- US military would like early signs of warfighter has:
  - Traumatic Brain Injury (bomb blasts, explosions, fall, etc)
  - Infectious diseases (e.g. tuberculosis, pneumonia, measles, meningitis, malaria, Ebola, cholera and influenza)
- WASH Concept: Smartphone biomarkers may manifest first
Approach: Gather Data

- Gather up to 1 million subjects from Military cohort pools
  - Smartphone sensor data (accelerometer, GPS/Bluetooth, light, etc)
  - Medical reports (Sleep, anger, depression, pain, etc)
Extract Features +
Correlation with TBI, Infectious Disease Symptoms
Generate TBI, Infectious Disease e-Score

- Cluster symptoms/smartphone biomarkers into disease families
- Detect anomalous warfighter behaviors

![Diagram of TBI and Infectious Disease e-Score process]

1. **Smartphone Data**
2. **Feature Extraction**
3. **Correlation Based Feature Selection (CFS)**
4. **Multi-dimensional Clustering**
5. **Statistical Analysis (Anomaly Detection)**
6. **TBI Digital Biomarkers**

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Conclusion

- I have exciting mobile sensing and imaging projects
- Currently hiring funded students for projects (to start in the spring)
  - AlcoGait: 1 masters student for spring semester + summer
    - (accelerometer, gyroscope, heart rate) signal processing + machine/deep learning
  - Smartphone wound image analysis: 3 PhD students, 4 yrs
    - algorithms for wound image analysis + machine/deep learning
    - Algorithms for decision on treatment plan
  - Smartphone biomarkers: 2 PhD students for 4 yrs
    - Early detection of smartphone biomarkers
    - Processing of location, mobile, smartphone sensors + machine/deep learning

- **Note:** We can discuss if you are only a Masters student