Welcome

“The Emerging Role of Mobile Computing in Health”
Shwetak Patel

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The Emerging Role of Mobile Computing in Health

Speaker: Shwetak Patel

Moderator: Marco Gruteser
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The Emerging Role of Mobile Computing in Health

Shwetak N. Patel
Washington Research Foundation Endowed Professor
Allen School of Computer Science & Engineering
Electrical & Computer Engineering
University of Washington

http://ubicomplab.cs.washington.edu/
Quick Research Overview

Energy monitoring

Low-power wireless sensing

Health

New interaction techniques
Personal Health Monitoring
Point of Care Diagnostics
Another Paradigm Shift in Health Care
Mobile Phones as Health Monitors

Smartphone Physical

Curation: Medgadget
Experience: Nurture by Steelcase
Powered by:
iHealth Labs CellScope
Withings SpiroSmart
Masimo AliveCor
EyeNetra ThinkLabs
Welch Allyn Mobisante
Opportunities with Mobile Health

- Chronic disease management
- New screening tools
- Population health
- New discoveries in diagnostics
- Improvement in treatment
- Evolving the patient-provider relationship
Continuous Measurements
The Modern Smartphone

- Headphone jack
- Camera/Flash
- Capacitive touch
- Speakers
- Accelerometer/Gyro
- Microphone
- Wireless Antenna/Signal
- GSM/LTE/WIFI/BT
Mobile Health Sensing

- Using existing sensors on mobile phones for health sensing
Using Mobile Phones for Diagnostics

- Pulmonary
  - Spirometry
  - Cough analysis

- Blood screening
  - Hemoglobin
  - Bilirubin

- Cardiovascular
  - SP0₂
  - Blood pressure

- Disease Specific
  - Sleep apnea
  - Osteoporosis

Shwetak N. Patel - University of Washington
Measuring Lung Function

- **Spirometry**
  - Mainstay of monitoring respiratory conditions (Asthma, COPD, CF)
SpiroSmart: Mobile Phone Spirometer

- No additional hardware needed
  - All done with software
SpiroSmart: Mobile Phone Spirometer
How it Works

- Traditional spirometers use a flow sensor (e.g., turbine) – we only have the microphone
- Vocal tract resonances to infer flow
  - The “noise” in speech recognition
Vocal tract model
SpiroCall
Detecting and Studying Cough

- Cough is a common symptom, but not quantifiable
- Might be useful for studying the spread of disease
- Cough may tell us a lot about a disease
- Human ears may miss subtle characteristics
SpiroSmart and SpiroCall Clinical Trials

![Error Chart](chart1.png)

![Data Scatter Plots](chart2.png)
Sound Analysis from Microphones

- Frequency based analysis with associated glottis model
Sound Analysis from Microphones

- Frequency based analysis with associated glottis model
Studying Tuberculosis

- Highly infectious lung disease
- The spread of TB spreads is still being studied
- Coughing is a major symptom
TB Study in South Africa
Cough Identification & Classification

Cough Identification

![Cough Identification Graph]

- GTFB CNN AUC: 0.98
- GTFB RF AUC: 0.96
- GTFB SVM AUC: 0.96
- MFCC KNN AUC: 0.93
- MFCC SVM AUC: 0.94
BiliCam

- Using mobile phones to monitor newborn jaundice
Current Technology

- Total serum bilirubin (TSB)

- Transcutaneous Bilirubinometer
Bilirubin Levels

Bilirubin (mg/dL) vs. Age (days)

In Hospital

75th percentile

25th percentile
Screening Challenges

In Hospital

At Home

Visual Assessment

- Parents
- Many physicians
- Traveling practitioners

Tend to underestimate
Absorption Properties of Bilirubin
Trial of 530 Newborns

BiliCam
0.91 correlation

TcB
0.92 correlation
Bilirubin in Adults: Pancreatic Cancer

5-YEAR SURVIVAL 6%
Observable Jaundice in the Sclera

Current Bilirubin Level: 0.5 mg/dl
Bilirubin from the sclera

$R^2 = 0.89$
Mobile Phone Hemoglobin
Mobile Phone Hemoglobin
Hemachrome Analysis

Absorbance

Wavelength

\[ I_0 \rightarrow I_m \]

\[ \alpha_{Hb,\lambda} \]

\[ \alpha_{Plasma,\lambda} \]

Plasma

Hb

500 nm

700 nm

900 nm
Hemachrome Analysis

Absorbance

Time

Blood

Tissue

$I_0$

$I_m$

Resting

Heart Beat

Resting
Isolate Blood Absorption
Trial of 81 Patients

- **HbApp**
  - 0.81 correlation

- **Pronto**
  - 0.82 correlation
Peru Deployment
OsteoApp

- Inferring bone density with resonance tracking for osteoporosis
OsteoApp

Healthy bone

Osteoporosis
Considerations in Mobile Health

- Regulatory
- Safety and trust
- Patient - provider interaction
- New applications of computing advances

- Still need to take into accounts other factors such as social determinants
Conclusions

- Opportunities for discovering new biomarkers for health
- Mobile phones as a healthcare delivery platform
- Opportunities for better prediction and individualized care with continuous monitoring
## Thanks!

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Questions?

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