Mobile health systems automation for point-of-care monitoring and health self-management

Prof. Walter Karlen, walter.karlen@hest.ethz.ch
Mobile Health Systems Lab,
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Active in solving challenges in preservation of health and quality of life
- Demographic development (progressively aging population)
- Increasing proportion of chronic diseases (health care system issue)

Where we contribute
- Prevention: Providing measures through basic research
- Therapy: Targeting effect and efficacy criteria
- Technology: Rehabilitation and diagnosis focus

Education and research
- Multidisciplinary and translational
- Integrating multi-scale research, i.e. cell → organism → society
- Systemic and multidisciplinary approach for a new generation of students in health sciences and medicine
D-HEST Research Areas

Medical Engineering

Movement Sciences and Sport

Neurosciences

Food and Nutrition
Research Priorities & Local Partners

- Healthy Aging
- Biomaterials in Health
- Health-Tailored Food and Nutrition
- Neural Control, Plasticity and Rehabilitation
- Mechanobiology and Regenerative Technologies
Interface of Engineering, Information Science and Medicine

Sensors & Systems

Intelligent Diagnostics

Quality Assurance
Mobile Health Systems Goals

Bringing health care technology closer to the patient

Health tools for reliable **diagnosing** and **monitoring** at the point-of-care and away from medical centers

- **Context and situation aware** systems providing **real-time feedback to users**
- Mechanisms for **safety** and **reliability** to ensure **integrity** of systems and data **quality** independent of device, location, size, and user
Applications

Low resource settings
- Pneumonia Diagnosis in Children
- Dehydration monitoring
- High sensitivity Malaria rapid diagnostic tests

Chronic Disease Monitoring
- Sleep tracking
- Wound monitoring
Chronic Wounds

- Slow or not healing over longer period of time
- *Causes:* poor circulation, systemic, illness, repeated trauma
- *Examples:* diabetic foot ulcers, venous leg ulcers
- Negative outcomes: pain, low quality of life, amputation
Current State

- Institution based approach
- Late identification of wound state
- Non-adherence
- Amputation
Remote Monitoring (tele-health)
Automation and Prediction
Prediction of Chronic Wound Healing

- Automated analysis of chronological recordings of wound images
- Discovery of novel imaging biomarkers
- Patient self-management
- Remote monitoring of patient behavior
- Personalized approach with distributed sensors
Standardized Imaging

- Normalized distance
- Normalized lighting conditions
- Chronological consistency
- Real-time user feedback
- Interfaces for lay users
- Multimodal image capture

Automated Image Analysis

- Wound area recognition
- Generation of labels
- Biomarker recognition
- Classification of healing status

Personalized Prediction Modelling

- Prediction of wound development
- Treatment recommendations
- Patient behavior modelling

Need for Digital Health and Big Data approaches
User interactions to improve image quality
App for Crowdsourcing of Wound Labels

Step 1: Mark Overall Wound Region

Step 2: Mark Special Wound Regions

Step 3: Provide Short Wound Assessment
Study Design

- 12 participants of 3 groups:
  - Professionals: Clinicians and nurses active in wound care
  - Medical Students: Basic knowledge
  - Laypeople: Engineering student with no wound background

- 100 images were labeled by 3 experts a priori
- Delivered to a personal smartphone to participants over 2 weeks
Completion Rate

Number of labeled wound images vs. Number of labelers

- Wound Professionals
- Medical Students
- Layperson
Key Performance Indicators (KPI)

- Overlap between raters
- Well suited for in-depth comparisons between two labellings

Professionals have little time for labeling wounds
  - Automation is desirable
There is no better agreement within wound professionals than within laypersons or medical students
  - Crowdsourcing wound labels is realistic
Take Home Message

Patient-centered digital health demands for new concepts and solutions in user interaction and automation
Thank you!