MoSHCA – My Mobile and Smart Health Care Assistant

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1 Motivation

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5 Conclusions
Management of chronic disease is problematic

- Medical management of **chronic conditions** (e.g. COPD, asthma, heart failure, hypertension, diabetes mellitus, ...) requires $4 \times$ **more resources** than for non-chronic conditions

- Management can be much improved: deterioration of health status over time often remains unnoticed

- Currently: regular visits to the GP or hospital are needed, and observed data are interpreted by health-care professional (costly and time consuming)

- **MoSHCA**: use of mobile technology for smart health care assistance
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The MoSHCA Project

- EU project under the ITEA2 umbrella
- Partners from the Netherlands, Spain, Luxembourg, Korea
- Academic partners: Radboud University Nijmegen and University of Girona
- SMEs: Evalan, Sound Intelligence, Actimage, Anware, etc.
- Close collaboration between academia and industry
MoSHCA: Key selling points

• What is the key selling point?
  • intelligent decision-making support
  • reducing the gap between the patient and medical staff
  • mobility, simplicity, and use-centered
  • harmonization for different sensor types

• Application fields:
  • COPD
  • Rehabilitation
  • Epilepsy
  • Diabetes
  • Hypertension
  • Hypertension in pregnant women
  • General health and fitness
  • Baby monitoring
MoSHCA architecture
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Challenge 1: Multiple sensors and biosignals

Electrocardiography

Vascular doppler measurements

Spirometry
• Heterogeneous evidence: $e_1, e_2, \ldots, e_n$, providing uncertain information about a hypothesis $h$

• General fusion scheme with the characteristic that the more $e_1, e_2, \ldots, e_n$ tell about $h$, the higher the certainty

$$h = f(e_1, \ldots, e_n)$$

$\Rightarrow$ intractable large number of interactions

• Solution: for example, Bayesian networks

  • Relationships in a graph imply (in)dependences
  • Potential exponential reduction of the number of interactions
Not just sensor data, so different types of measurement errors:

- Symptoms: subjective
- Signs: measurement errors made by nurses and physicians
- Biosignals are:
  - results of measurement (errors)
  - transformed (averaged, filtered, Fourier transformed, wavelet transformed, windowed)
  - sampled

Can be estimated from data and reduced by combining information from multiple measurements (cross checking)
Challenge 3: Contextual awareness

Interpretation of patient data (biosignals) in a clinical context:

- Collect
  - symptoms and signs
  - biosignals

and interpret them taking into account their mutual dependence

- Clinical knowledge is the context of this interpretation (so needs to be represented)

- Only then, clinical decision support is possible
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MoSHCA platform using Bayesian networks
Example chronic disorders

**Chronic Obstructive Pulmonary Disease – COPD**

- Exacerbation detection and prediction
- Questionnaire data
- Sensor data:
  - Pulse-oximetry measurements
  - Spirometry measurements

**Hypertension in pregnancy**

- Detection and prediction of malignant hypertension (i.e. pre-eclampsia)
- Prior risk-factors
- Sensor data:
  - Blood pressure measurements
  - Protein and creatinine in urine (using the camera)
Various types of data need to be collected, from symptoms and signs to lab and sensor data.
The patient gets immediate feedback ...
Prediction models employed

- Probabilistic graphical model with causal interpretation; example for hypertension and pregnancy:

- Smartphone can compute predictions
Summary of advantages

- For the patient:
  - Available anytime and anyplace
  - Automatic interpretation of all relevant data, yielding personal advice
  - Generation of alerts
  - Guided involvement in management of own disease

- For the health-care professional:
  - Improved control over chronic disease progression
  - Saves time

- For society:
  - Saves costs
  - Resulting in improved health
A view on the future

- Various applications of MoSHCA which can be commercialised
- Generalisation of models to other diseases (heart failure, asthma) is feasible
- Exchangeable disease models using a standard monitoring framework
- Challenges such as security and privacy issues will be tackled within the MoSHCA project