Panel IoT Ecosystems and Partnerships: Health or Human Centric Sensing and Computing

Datacenter Carbon Footprint

Big Data

The End of Transistor Scaling

IoT sensors and edge

Energy Efficiency

Cognitive Computing

Dense and Efficient Systems Roadmap

Wearables and Healthcare

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Bell’s Law Demands more Integration

- Every 12-15 years restart new generation
- Hardware cost fraction decreases from 100% (mainframe) to <10% adding functionality
- Sensing and communication miniaturized
- Low thermal/electrical resistance enable density
- Sensing and computing meet in wearables
- **Remember: proximity improves efficiency!**
- Efficiency and low cost due to Bell’s law

Data not transferred to cloud but AI transferred to the edge to improve efficiency
Human Centric Sensing and Computing Strategy

- Cost and accessibility of healthcare, blockbuster drugs not personalized
- Stress strong link to human wellbeing
- **Human Centric Sensing and Computing**: Context key for relevant personalized cognitive services
- Personalized cognitive services in preventive medicine / coaching; work safety; wellbeing; elderly care
- Miniaturization for low-cost non-intrusive monitoring to reduce cost in acute and preventive medicine
- **Move intelligence to the edge instead of data to the cloud for solutions to be relevant to people**

Today

- Single channel human reality
- Other channels inaccessible
- Cognitive edge computing & companion

Future

- Multichannel human reality
- All channels accessible
- Context rich cognitive services

IoT / wearables will first revolutionize healthcare starting with chronic diseases and elderly care before enabling data-driven preventive medicine
IoB Platform Building blocks

modular, flexible and scalable platform that adapts to use cases and strengthens base of AI pyramid

Humans as largest data source and largest consumer of cognitive services

Data Science
- SML Algorithms
- Deep Learning
- microservices

Data Collection/Preparation
- Gathering protocol
- Reliable Data
- Data Storage
- Data cleaning
- Segmentation, labeling
- Feature selection

Human in Center and Pyramid Base
- Physiology / Medicine
- Psychology / Behavioral change
- Acceptance / Usability / User experience

User Interface
- Data
- Thresholds and trends

Cloud Services
- Storage
- Big data science

Data Hub and Sensors
- Edge
- Communication
- Alerts
- Commercial and new sensors

Use Cases
- eCompanion – Future Hospital
- CAir – Chronic Disease Mgmt.
- FireFighter – Stress Detection

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eCompanion: IoB Platform Implementations

1. High Quality Show Case
   - Access to cognitive micro-services
   - Cloud connectivity
   - Apps API Storage

2. Hearable Platform
   - Voice interaction
   - Edge-Compute for critical response
   - Customer controlled data stream

3. MVP
   - Plug and play experience
   - Sensor data fusion and feedback to user

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Use Case I: DeStress Monitoring during Firemen Training

**Machine Learning Algorithm:**
- Distinguish mental stress from parallel physical stress
- Best algorithm: C5 decision tree, with >80% precision, Fscore and recall
- Detected all phases for unknown subjects

**Implementation:**
- Heart rate sensor to send RR-intervals via BLE to phone

**Motivation: Stress Impairs Decision Making in Critical Situations**
- Dangerous when someone panics
- Stress: Physiological or psychological

Low HRV → Stressed  
High HRV → Normal

Project DeStress: Stress management for critical tasks
New firemen Stress Monitoring System

- Use on firemen, police, athletes, workplace etc.
- Use machine learning for classification
- Integrated acquisition, labelling, and learning
- Include breath, sweat etc.
- Project name: DeStress

- Heart rate (RR) data is acquired on the firefighter (user) with a pulse-tracker chest-belt.
- BLE data sent to android smartphone APP, that transfers them over a WiFi to the supervisor terminal.
- The supervisor terminal provides a user-interface to the supervisor and runs the real-time stress-detection algorithms and data-collection.

- Assisted labelling process implemented also for transfer learning to data from other sensors than ECG
Use Case II: Management of Chronic Lung Disease*

- Bi-directional electronic communication between patient and physician.
- Continuous patient symptom and activity tracking.
- Prediction of exacerbations based on activity score.
- Personalized and context for virtual agent

*Asthma and COPD: Congestive Obstructive Pulmonary Disease

Less suffering for those with chronic diseases

Electronic medical records + Symptom data + Conversation & Content

Data Science:
- Expert system
- Physiological model
- Machine learning
- Image analysis

Analog: Physician patient interaction

GSM

Recording:
- Medication adherence
- Lung function
- Cough intensity
- Sputum color
- Activity and sleep
- Vital-signs
- Environmental parameters

Physician Dashboard

EMR

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CAir Patient App and Desk

**Patient App**

- CAir Desk
- Vital-Sign & Activity Tracker
- Sputum Collector
- Spirometer

**Device** | **Parameter**
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Smart-phone camera | Sputum color
Smart-phone micro-phone | Cough count
Inhaler | Medication time stamp
Spirometer | Lung function
Activity & multi-vital sign tracker | Steps, Energy expenditure, Oxygenation, Skin temperature, Respiration rate, Heart rate (var.), Electrodermal activity
Environmental sensor | Temperature, Humidity, Particle count, VOC and CO₂
Continuous Patient Interaction and Support at Scale

**Face-to-Face**
- Visits
- Physician-patient interaction
- Holistic interaction
- Situational assessment
- Social bond, trust
- Limited time, reach

**Tele-Platform**
- Text based communication
- Physician-patient interaction
- Disease information
- Questionnaires
- Reminders
- Limited scale

**Virtual Agent (Chatbot)**
- Text based, dialogue (medical) or natural language (life-style)
- Virtual agent to person communication
- Behavioral change and therapy support at scale
- Limited contextual and personalized appearance

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Personality Traits
Transtheoretical model
Precontemplation
Preparation
Contemplation
Action
Maintenance

The Big-5
Personality insights

Behavioral Change Stages

Observation of progress

Just-in-time Intervention

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Integrated system for human-centric sensing and computing

Bridge technology gap to wearables with edge systems

Build platform to apply AI in healthcare and IoT

Support move from acute to chronic and finally preventive medicine

Long-term monitoring (noninvasive wearable sensing) and coaching (with new interaction models)

Use cases demonstrate exemplary the capabilities of the system

Data is not transferred to cloud but AI tools are transferred to the edge to improve autonomy, functionality, latency, reliability, and privacy
Thank you very much for your kind Attention!

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