Pervasive Sensing for Lifelong Health and Wellbeing

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Global Healthcare Trends

- Ageing populations
- Rising costs
- Prevention
- Urbanisation & environmental impact
- Personalised medicine
- Chronic and infectious diseases
- Emerging economies and healthcare policies
- Technological advances
The world's population is expected to reach 9.1 billion by 2050, with virtually all population growth occurring in less developed countries.

Even so, the growth rate of the world's population has been on a downward trend and, in developed countries, will turn negative by 2030.
The world’s population is aging and, in developed countries, the size of the elderly population has already surpassed that of the 12–24 age group.

Today, just 11 countries have a median age above 40 years. By 2050, it is projected that there will be 89 countries in that group, 45 in the developing world.
The Population Pyramids

1950

2000

2050

1950

2000

2050

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The Ageing Body

Brain and nervous system

Visual and sensory systems

Respiratory system

Musculoskeletal system

Circulatory system
Burden of Chronic Diseases

- Diabetes
- Hypertension
- Chronic Heart Failure
- Asthma
- Depression
- Rheumatic disease

- 5% of the population –
- 60% of the Health Costs
Urbanisation

- Major demographic shifts in many countries in the world.
- Both body mass index (BMI) and blood cholesterol levels rose rapidly in tandem with increases in national income and level of urbanization (Ezatti et al).
- Other observable factors are (WHO- Allender et al.):
  - Low levels of activity in urban areas.
  - Low consumption of fruits and vegetables.
  - Higher body mass index.
  - Higher rates of smoking.
Human Health

- Climate Change
- Diverse Pathways
- Desertification and Land Degradation
- Altered precipitation
- Water Quality and Safety
- Population Displacement
- Freshwater Decline
- Biodiversity Loss and Ecosystem Function
- Decline in Ecosystem
- UV

Wilfried Thuiller, Nature 448, 550-552 (2 August 2007)
How can we address these challenges?

- Communication technology and health
- Providing safe water systems and sanitation
- Innovative environmental research
- Maternal and child health
- Innovative medications for infectious and chronic diseases
- Providing an understanding of the ageing process and novel research in elderly care
- Preventative medicine
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Evaluation
Prevention
Treatment
Diagnosis
Current Monitoring Tools

- Medical Records
- History
- Special Tests
- Imaging
- Peak Flow
- ECG
- Blood Tests
- O2 Sats
- Blood Pressure
- Exam

Only a **SNAPSHOT** of a patient’s health
Prevention

- Many of the chronic diseases are preventable. Spending on chronic diseases accounts for 75% of spending in the US.
- Providing colonoscopies, endoscopies, mammograms for high-risk groups.
- Encouraging activity as well as healthy eating.
- Identifying people with a high risk through tests.
- Shifting the global agenda towards prevention.
Sensing Development

SAPHE eAR sensor

Cardionetics ECG

SAPHE low power radio module

SAPHE environmental Blob sensor

Cardionetics

PIR sensors

SAPHE mobile hub

Door sensors

Imperial College London

BT

PHILIPS

Cardionetics

doc@HOME
SAPHE Home network

SAPHE environmental sensors
SAPHE set top box
SAPHE mobile hub

Secondary display (e.g. picture frame)
Computer
Telephone
PSTN
Internet

IP + PSTN

Standard Home Gateway (WiFi + Ethernet + PSTN)

Bluetooth devices (Docobo, scales, BP, remote control, etc)

SAPHE ‘Common Nodes’:

= bluetooth
= ultra low power radio + body sensor
= Zigbee / 802.15.4 + environmental sensor
Sensor Fusion and Data Analysis

- Fusing Ambient and Wearable Sensors
- Behaviour Profiling and Pattern Mining
- Behaviour Profiling using location
- Pattern-mining of Patient Data
- Dealing with Noisy/Missing Data
- Database Design
- Visualisation

Activity grid across several rooms showing the patient in pink and other people in different colours

Daily activity view
Database design
Visualisation to users
BSN use body as the media and a source of inspiration, energy to provide long-term, continuous sensing and monitoring
What does BSN Cover?

- Biosensor Design
- Biocompatibility & Materials
- Wireless Communication
- Low Power Design & Scavenging
- Autonomic Sensing
- Standards & Integration
Trust, Security and Policy

Self-configuration, healing, managing of software components

Network Storage and Decision Support Agents

Multi-sensor Analysis and Fusion

Environment Sensors and Context

Sensors and Context
Innovation for Life Long Health

- Prevention and early intervention is playing an increasingly important role in medicine.
- We are at a tipping point from interventions that treat disease to interventions that may prevent disease due to earlier detection and the emergence of lifestyle drivers of disease.
- Increased longevity and survival after major illness result in many patients being more likely to have co-morbidities.