Future of Healthcare Technologies

driven by Wireless Communications

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Healthcare Facts

• The population of the UK is ageing. In 1985, there were 690,000 people in the UK aged 85 and over, there are going to be **3.6 million by 2035**.

• Half of people aged over 60 have a long term health condition (e.g. asthma, osteoporosis, arthritis, diabetes, high blood pressure, heart problems). They use **50%** of all GP appointments and **70%** of all inpatient bed days.

• Ageing population implies a substantial growth in demand for services.

• Current medical techniques will not be able to meet that demand.

• New technologies will need to be developed.
Modern Hospitals

Can we ever find the comfort of our homes?
What about changing our homes?

Sema’s House

- Internet
- Patient Data
- Vital signs monitoring
- Emergency
- Remote Drug Delivery
- ECG & breathing
- On-body Base station
- Tracking
- Sleep monitoring
- Biosensor (personalised medication)
- Stimulator implant
- Pacemaker
- Movement Sensor
- Hip joint
- Knee joint
- Movement Sensor
- Retina implant
- Biometric sensor
- Personalised medication
- Hip joint
- Knee joint
- Movement Sensor
Body Area Networks

- We will come to see the human body as a wireless network of interconnected sensing, monitoring and therapeutic devices.

- Toshiba’s Silmee, monitoring ECG and body temperature, movement
- Medtronic’s smart pacemaker
- Google Glass
- Sony SmartWatch
- Telecom Italia’s Knee Rehabilitation
- TRL’s Smart Orthopaedic Implants

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User acceptability

• NO activity restriction
• NO behaviour modification
• NO breach of privacy

• The sensors should be as small as possible
• The battery should last forever (!)
• Sensors should be reliably linked to the gateway (especially for the vital signs).
• There are numerous technical challenges to be overcome.
The antenna is a device which transforms guided electromagnetic signals into electromagnetic waves propagating in free space.

The antenna
- directs electromagnetic waves towards certain direction
- determines the propagation mechanisms
- heavily effects the energy efficiency of the whole system
- for microwave frequencies, is one of the largest elements in a mobile wireless communication system.

Antenna design is one of the biggest tasks in forming a Body Area Network!
Connectivity and Efficiency

**Aim:** Designing novel antennas in order to create reliable and efficient body area networks!

**Challenge:** Human body is extremely lossy, BAN channel is extremely dynamic

**Requirements:** Tiny or flexible, efficient, reconfigurable

**On-body link**
- Vertical polarization
- Omni-directional
- Isolated from the body

**Off-body links**
- Directional
- Isolated from the body

**In-body links**
- Directional
- Magnetic antenna: less susceptible to dissipation in human body

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Wearable Antennas

On-body link and off-body links should be formed by the same device:

Flexible fabric antenna prototype
45mm x 45mm x 4.8mm @2.4 GHz


Wearable Antennas

Smaller antenna achieving radiation pattern steering by changing the frequency band:

10mm x 50mm x 2.5 mm @2.4 GHz

Collaboration

• Sphere [http://www.irc-sphere.ac.uk/](http://www.irc-sphere.ac.uk/)
  SPHERE is developing sensors for the home to diagnose and help manage health and wellbeing conditions.

• University of Bristol
  Developing a numerical human body phantom

• Southmead Hospital
  Smart Hip Implant Design