Design, development and evaluation of Digital Health Technologies

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Expertise in the design, development and evaluation of smart homes, assistive technologies and pervasive and mobile computing solutions.

Group consist of:
• 17 Academic Staff
• 20 Research Staff
• 25 PhD Students
Digital Health Technologies?
Technology as an enabler?

There are benefits to the management of the factors associated with health and wellness challenges.

Known causes or risk factors can be targeted and/or managed.

Technology based interventions are being accepted as one possible solution.
Current model

“Sick Care”
Future model for Healthcare monitoring embracing Digital Health Technologies

“Preventative and Personalised Care”
Evolution of Technology

1950’s

1970

1977

2000

1987

2018

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Home based assistive technology

- Picture dialling
- Date and time
- Location tracking
- Medication management
- Item locators
Home based Technology
Digital TV
Digital TV
Wearable Technology?
Activity Assessment

• Accelerometers can be used to assess levels of activity (Burns, 2010).
• With careful processing it is possible to detect periods of activity and inactivity and within this to further classify fine grained activities.
Random Motion

Repetitive Motion
Unobtrusive sensing

New approach required which is:
- unobtrusive (no invasion of privacy)
- easy to install
- supports delivery of intervention
- offers multiple measurements
- affordable
**Thermal sensing**

The technology provides an unobtrusive solution to monitor a person in their home environment through the use of thermal sensors. An array of 32x32 thermal sensors provides the ability to generate a vast array of metrics which can be used to detect sedentary behaviour, falls, agitation, completion of ADLs, to name but a few.

**Computer vision-based gait velocity from non-obtrusive thermal vision sensors**

![Graph showing speed from thermal sensor vs speed from stopwatch]

**Graph:**

- Walking Speed: Fast, Normal, Slow
- Linear fit: $R^2 = 0.941$
Thermal Sensing

Smart Home in a Box, SensorCentral, NFC enabled setup

Approach to Intuitive setup
Thermal sensing arrays

Fall Detection and Intervention
Thermal imaging
Delivering the intervention: Mobile Apps
Sustained engagement

- More than half of consumers who have owned a modern activity tracker no longer use it.
- A third of consumers who have owned one stopped using the device within six months of receiving it.

![Graph showing percentage sustained use over months]

- 32% dropout after 6 months
- 50% dropout after 14 months
Analysis of reminding technologies

Number of reminders Set

% of reminders acknowledged

Time taken to acknowledge reminders
*acknowledged only
Tech supported behaviour Change

- **Pre-contemplation**: No intention to change
  - Increase awareness of need for change

- **Contemplation**: Aware a problem exists but with no commitment to action
  - Encourage plan making for needed change

- **Preparation**: Intent to taking action to address problem
  - Help develop action planes

- **Action**: Active modification of behaviour
  - Help develop action planes

- **Maintenance**: Sustained change; new behaviour replaces old
  - Assist w/ problem solving, reinforcement

- **Relapse**: Fall back into old patterns of behaviour
  - Assist w/ coping, healthy alternatives avoid relapse

- **Upward Spiral**: Learn from each relapse

- **Help cope/ recover from relapse**
- **Identify/ prevent potential relapse**
- **Motivate them to sustain a change**
- **Increase awareness through monitoring and education.**
- **Encourage them to make a change**
- **Help set achievable goals to make change**
Tech and Behaviour change

Gray Matters Aim
• Lessen risk of developing AD through behaviour change
• Smartphone app and wearable
• RCT with 146 mid aged individuals

Gray Matters results
• 77% felt app had at least some impact on health
• 50% felt fuelband had at least some impact on health
• 85% felt Fuelband made them more active
Results

Positive trends in healthy behaviour as a result

App usage had favourable effect on clinical measures
Stakeholder Engagement
The NI Connected Health Innovation Centre (CHIC) is funded by Invest NI to support business led collaborative research.

**Highlight Figures**
- £5m in funding from InvestNI
- Over 6 Years
- 28 Member Companies
- 16 Full Time Research Staff
- >25 Projects
- £500 membership
- Leverage £100,000
Connected Health Innovation Centre
NI-CHIC

CHIC was proposed as an Industry-led competence centre focused on collaborative research to support the connected health industry in Northern Ireland.

Emerging Focus Areas
1. Integrated community care – joining together existing and new technology and process.
2. Point of Care Diagnostics – moving diagnostics closer to the patient.
3. Vital Sign monitors - technology development to support vital sign identification, analysis and communication.
4. Cloud Based Health – use of cloud technology for health solutions.
We work with local business within Northern Ireland to develop capability and competence in the area of connected health.

Collaborators include:
• Technology Based
• HealthCare Based
• Voluntary and Charity Based
What Can CHIC Offer

- Prototype & Algorithm Development
- State of the Art Equipment
- Access to Clinical Expertise
- Product Evaluation/Validation
- Market & Research Assessment
- Leverage Funding

Ulster University
CHIC Exemplar projects

DoorKeeper

A technology solution to doorstep crime

Doorkeeper captures images of the person calling at your front door.

They can then ask for help or indicate that they are familiar with the caller.

Upon requesting help, you see the caller's image on your smartphone and decide if it's safe to let them in or not.

Every time, Doorkeeper reminds you how to safely deal with a visitor at your door.

Figure 8: Thermal images of both real data from patients without knee complications (top row) and data from patients with knee joint complications (bottom row). The red dots represent the knee joint regions of interest, and the green dots represent the other parts of the body. The images show the temperature distribution across different body parts.
Technology as an enabler

**Push Effect**
High risk enabling new solutions

**Pull Effect**
Driven by user requirements and mature solutions

*Meeting user needs*

*New Technology*

*Research*

*New Applications*
Summary
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- Technology based solutions can be useful, if deployed appropriately.

- A lot can be learnt from previous efforts.

- Further evidence required from large scale longitudinal evaluations.

- Consider:
  - technology adoption models
  - the context within which technology solutions are delivered
  - the notion of behaviour change

- A future important topic for consideration is how can engagement with these technologies be both improved and maintained?
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