Activity Monitoring for Behaviour, Health and Well-being

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Overview

activity monitoring

- Why monitor activity?
- Technologies in use
- PAM in Mental Health
- USEFIL in Independent Living
- Conclusions
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Exercise

Why monitor activity?
daily activities
active living

why monitor activity?
long term conditions

rehabilitation

obesity

why monitor activity?
independent living
activities of daily living

why monitor activity?
chronic fatigue syndrome

why monitor activity?
ADHD

why monitor activity?
mental health

why monitor activity?
Overview

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Sensors & Systems

environmental/ fixed sensors

- Mechanical detection (door switches)
- Passive Infra-Red (PIR)
- Optics/ motion capture (video/ camera systems)
- Light, temperature, sound
- Gait analysis/ Kinect
- Radio Frequency Energy (radar, microwave and tomographic motion detection)
Sensors & Systems

body-worn/ wearable sensors

- Mobile phone
- GPS
- Wearable kinematic sensors:
  - 3-axis Accelerometers
  - Actigraphy
  - Data-logger
  - Pedometers
Wearable Technology

m-health development platforms

eZ430-Chronos: a highly integrated, wearable wireless development system in a sports watch
Model Architecture

Wearable Sub-System:
- Data processing & rules engine
- Pre-processing & communication algorithms
- Wearable Node
  - Accelerometer
  - Light Sensor
  - Sound Sensor
  - GPS

Mobile Phone (Smart Node)

Environmental Sub-System:
- Data processing & rules engine
- Pre-processing & communication algorithms
- Smart Node
  - PIR Sensors
  - Camera
  - Environmental Node
    - Light Sensor
    - Sound Sensor
    - TV Sensor
    - Pressure Mat
    - Door Switches

Legend:
- Sensor
- Node
- Smart Node
- Wireless Communication
- Wired Communication
- Internet Communication

Technologies in use
Processing Architecture

technologies in use
Overview

*activity monitoring*

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I in 4 people in the UK will experience some kind of mental health problem in the course of a year.
Psychiatric illness in the UK

Bipolar Disorder (BD)

- Affects between 0.4 to 1.6% of the population
- £32 billion in lost productivity and treatment costs
- Is very disruptive to a person’s life and often causes hospital admission
- Can be controlled with a mixture of pharmacological and therapeutic care
Symptoms

Mania

- Persistent elevated, expansive or irritable mood
- Increased:
  - Sociability, Talkativeness, Flights of ideas, Pressure of speech
- Decreased need of sleep
- Psychotic Symptoms
- Mood is significantly altered irrespective of circumstances
Symptoms

- Depressed mood
- Loss of interest & enjoyment in nearly all activities
- Reduced: Energy, Activity, Self-esteem, Concentration
- Normal occupational and social functioning will be impaired or may require more mental effort to maintain
Motivation for PAM
personalised ambient monitoring

The PAM project aims to develop a self-help system that can somehow monitor a person’s behaviour patterns and provide an indication of their mental state.
The PAM Architecture

PAM in mental health
Sensors

Environmental
- PIRs
- Camera
- TV Remote usage
- Pressure Mats
- Light & Sound Level

Wearable
- GPS
- Accelerometers
- Light & Sound Level

PAM in mental health
Camera requirements
detecting change in ROIs

- Tested different camera algorithms for change detection
- Evaluated the effect of image resolution
- Evaluated on:
  1. Invariance to changes in lighting conditions (slow and fast changes)
  2. Ability to correctly identify changes in the image
  3. Change detection on smaller image sizes
  4. Algorithm run time
Results
CAM-cooker ROI

CAM-cooker training data showing the days unaligned, before CPM, and aligned after CPM

latent trace for CAM-cooker data
Results
CAM-cooker: Weighted Behavioural Difference score

PAM in mental health
Results

PAM in mental health
Discussion
performance of the PAM system

- Behaviour tracking can be achieved using average WBD score
- Single, easy to use, metric
- Threshold for abnormality can be defined
  - Days under this threshold deemed 'different'
  - Data can be drilled down into
  - Specific sensor data can be identified as the cause
  - Data can be examined and reasoned with
- Sensors can be added and removed
  - Tailoring to specific needs of users
- Compound data streams can be created and used to provide more detailed information


PAM in mental health
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**USEFIL: Unobtrusive Smart Environments for Independent Living**

- Addresses the practical needs of elderly by developing advanced but affordable in-home unobtrusive monitoring & web communications

- Use low cost, off-the-shelf technology

- Develop applicable services that will assist the elderly in maintaining their independence & daily activities

- System to be software driven & based on open source platforms, so applications can be easily added or subtracted
The Wrist Wearable Unit
android based wrist worn mobile phone
The Wrist Wearable Unit
android based wrist worn mobile phone

- Tri-axis accelerometry; GPS; Camera
- ADL; Falls; Messaging; HR
- Part of a wider system so can perform communications and messaging function
- Outdoors – GPS for geofencing/ activity
GPS via mobile phone
[relative] activity out of the home
GPS via mobile phone
locations of relevance
Overview

Why monitor activity?

Technologies in use

PAM in Mental Health

USEFIL in independent living

Conclusions
Conclusions

Activity monitoring has varied applications across healthcare and wellness management.

The technologies are varied but are usually either:
- Wearable, or
- Environmental, or
- A combination of both

Through activity measurements much can be inferred about state of health or well-being.

Wearable intelligent systems using small, lightweight, high capacity platforms allow for high throughput of data for activity monitoring.