Dementia Ambient Care: Multi-sensor support to enable independent home-based living for people with dementia

Dr Louise Hopper, Dr Eamonn Newman, Prof. Alan Smeaton, & Dr. Kate Irving

Dublin City University (DCU), Ireland

24th Alzheimer Europe Conference, 21st October 2014, Glasgow, UK

SEVENTH FRAMEWORK PROGRAMME

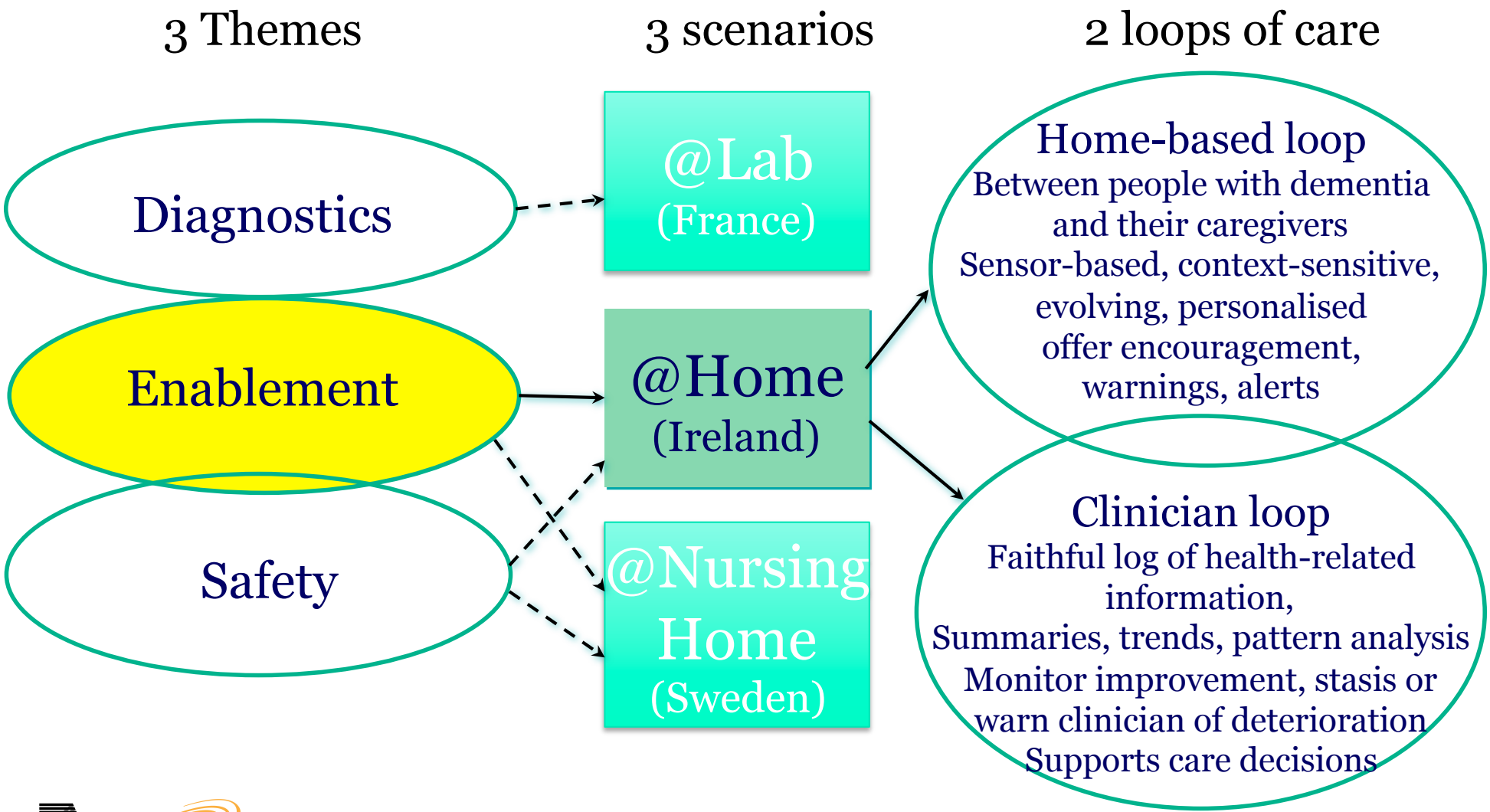
Presentation Outline

- Background
- The Dem@Care Project
- First @Home Pilot
  - Aims
  - Methodolody
  - Results
  - Conclusion
- Next steps for Dem@Care @Home

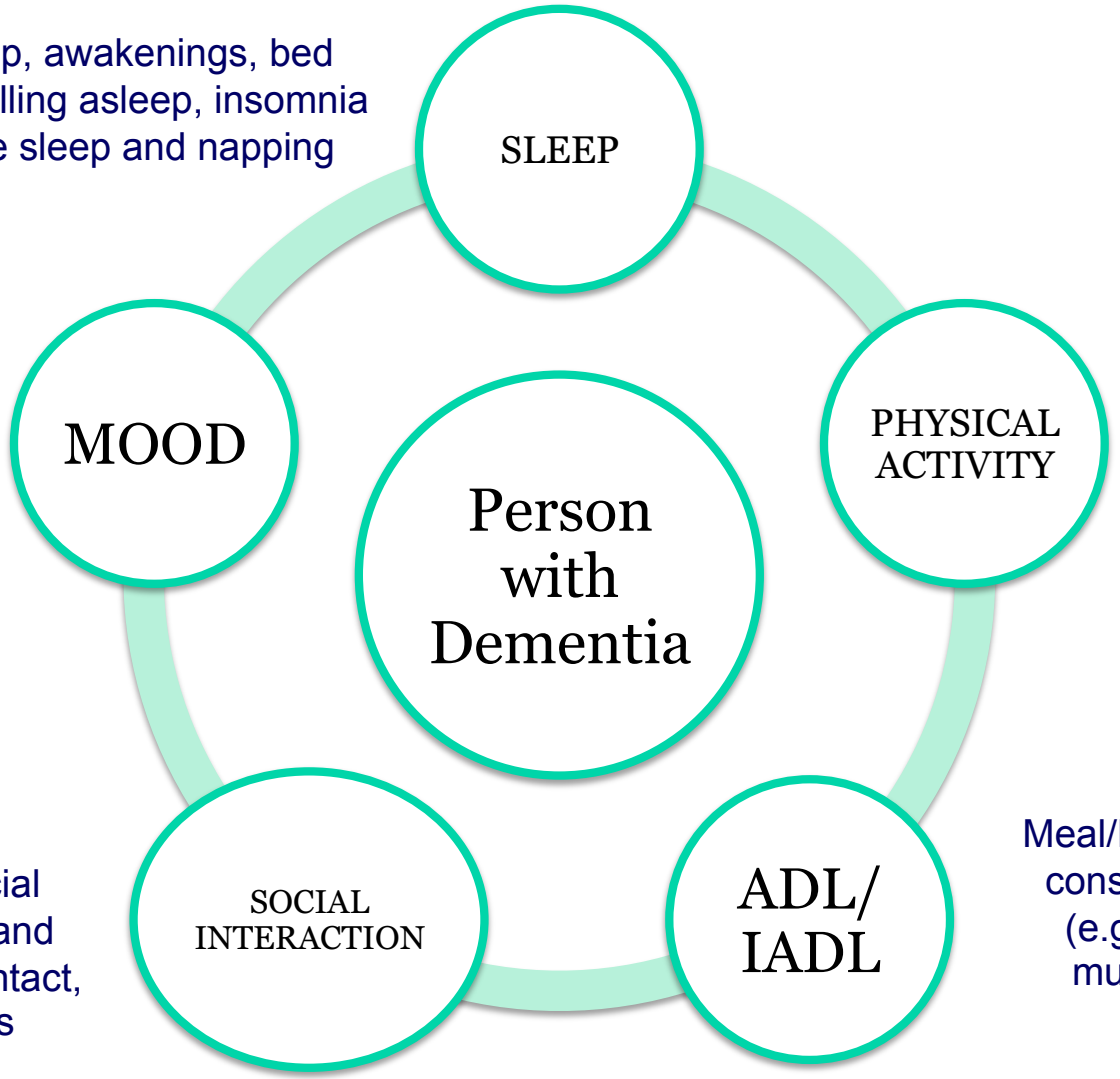
Background

- Increasing prevalence of dementia worldwide means that we must focus on acceptable, cost-effective, home-based solutions to support people with dementia
- Information technologies and in particular ambient assistive technologies (AAL)
  - can support independent living & prolong community-based living, while delaying entry into long-term residential care [1-5]
  - can support diagnostics in lab or home setting [6-10]
  - with the ongoing participation of carers and healthcare professionals
- Dem@Care is a personalised healthcare system that aims to use sensor technology to support the independence of people with early to moderate stage dementia

The Dem@Care Project



Data Collection in the Five Domains



Night time sleep, awakenings, bed exits, Difficulty falling asleep, insomnia onset, day-time sleep and napping

Amount of physical activity in the home, outside the home, dedicated exercise, movement speed, distance travelled, activity intensity

Meal/Drink preparation and consumption, daily tasks (e.g. watch tv, listen to music, read, hobbies, chores)

Face-to-face social contact, initiated and received phone contact, speech analysis

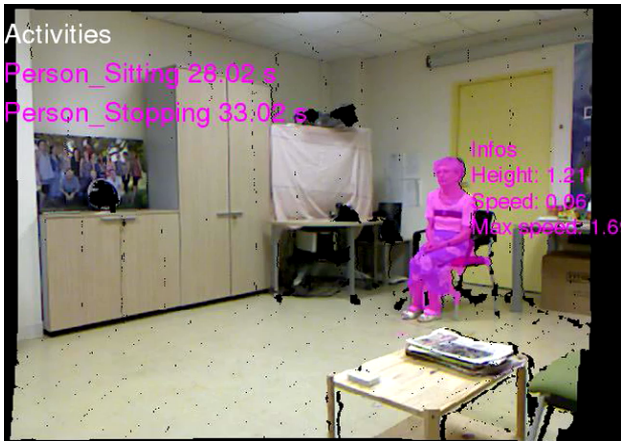
Observed behaviour, physical stress levels , speech analysis, subjective mood reporting

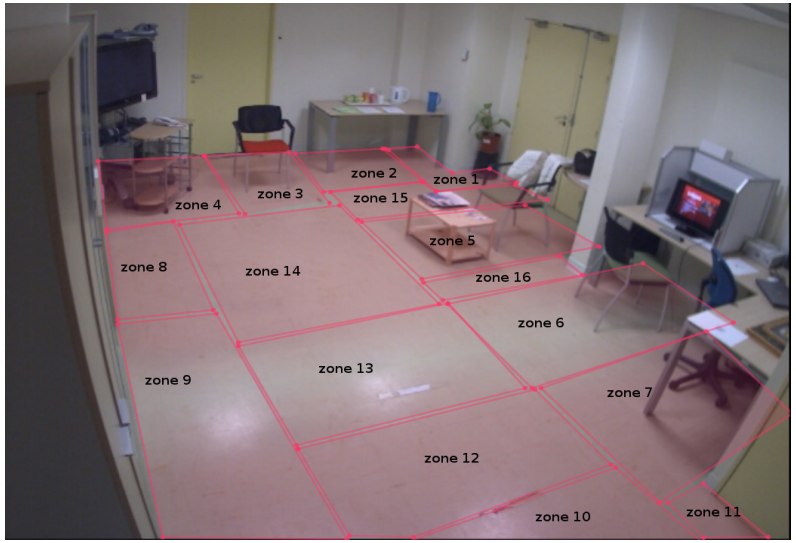
Dem@Care Sensor Toolbox

1. Ambient Video Cameras

- *2D*

3D



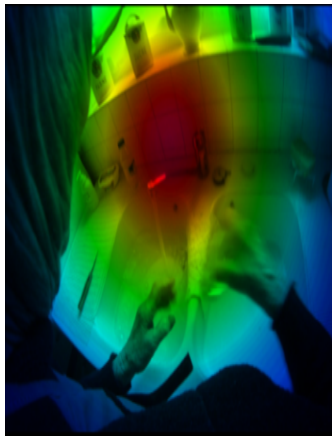


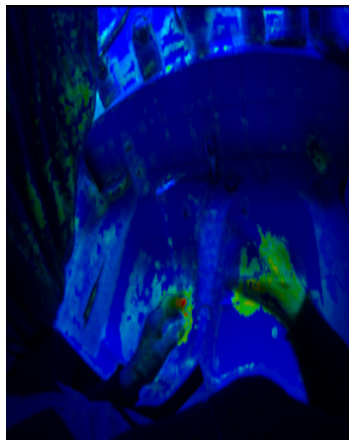
Dem@Care Sensor Toolbox

2. Wearable Video Camera

2D

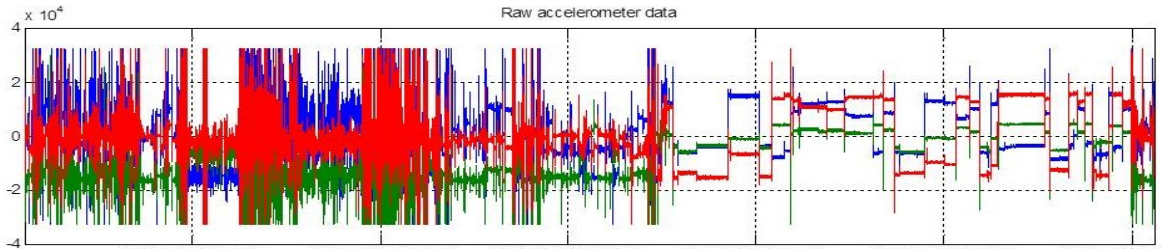
3D





Dem@Care Sensor Toolbox

3. Physiological Sensors (Philips DTI-2 Bracelet)



4. Sleep Sensors (Lark Beddit, Withings Aura, Gear4 Sleep Clock)

5. Audio Sensors

Wearable Microphones and smartphone Apps

@Home: Aims and Methodology

- Research Questions
  - Is the system acceptable in the home, is it non-intrusive, and useful to people with dementia and their families?
  - Can the system optimise the functional status of the person with dementia as operationalised in the 5 domains?
  - How autonomous and independent is the person with dementia and can the deployment of this system support this autonomy?

- Multiple case study design, person centred, co-design
  - Initial assessment of acceptability and usability (n=5 dyads)
  - First pilot with 1 lead user for 6 months
  - Second and third pilots with increasing numbers of participants

Person with Dementia/Carer Dyads (n=5 interviews)

Openness to using Dem@Care
In 4 dyads, the person with dementia "*abhors*" or was "*allergic to computers*" and 3 would not consider their use at all
In 3 dyads the carer was open to using technology, but 1 felt he was "*managing fine*" and felt strongly that no external help was needed
Another carer has a "*busy day*" so he "*would not wish to be disturbed during the day by the unit for any reason*"
1 dyad (younger – early onset dementia) had an open and exploratory attitude to technology, and were willing to try anything that might help their circumstances

Acceptability and Usability
All 5 indicated that it was difficult to give feedback without using the system
All agreed that it must not incur extra hassle or work for the carer - 2 of 5 would NOT want interruptions (alerts) during the day
Happy to accept wearable sensors but they must be comfortable and unobtrusive
High level of acceptability for sleep sensor – seen as very useful But hesitant to accept cameras when others are living in the home

First @Home Pilot: Recruitment Protocol

- Person living at home with early dementia - family caregiver
  - Initial semi-structured functional assessment interview
    - *General questions to determine if there are concerns in an area*
    - *If yes, proceed to psychometric measures; If no, move to next domain*

Sleep	PSQI, Epworth Sleepiness Scale, Insomnia Severity Index, Morningness - Eveningness Questionnaire, Scale of Older Adult's Routine
Physical Activity	Rapid Assessment of Physical Activity, Physical Activity Scale for the Elderly
Eating / IADL	Bristol ADL Scale (proxy), Everyday Competence Questionnaire, Mini-Nutritional Assessment
Mood	Geriatric Depression Scale
Social Interaction	Lubben Social Network Scale, De Jong Loneliness Scale

Case Study 1: Sean and Catriona

(pseudonyms)

- Sean (Age 58) and Catriona are married and live with Sean's mother in their own home outside Dublin. They have two dogs.
- Sean was a carpenter and Catriona works 4 days a week in administration.
- At the start of the study, Sean was just post-diagnosis.
- Sean is active and independent and has comorbid epilepsy, which is being successfully managed pharmaceutically.
- They have previously been involved in research with the DCU team, using the SenseCam technology to explore lifelogging.

- Sean's mother is not currently aware of his diagnosis.

Case Study 1: Assessment

Domain	Needs	Sensors
Sleep	PSQI score of 6 = pathological sleep issues Duration and latency good; disturbance, efficiency, overall quality poor	Gear4 Sleep Clock DTI-2 Actigraphy Bracelet
ADL / IADL	While general eating, cooking and chores are no problem for Sean, Catriona indicated that certain tasks may need support (CD Player)	Wearable Go Pro video Ambient video camera
Physical activity	No issues detected, although Sean indicated interest in having support in this area	DTI-2 Actigraphy Bracelet
Socialising	No issue detected, although both felt there may be a benefit from support in this area	Periodic psychometric measures
Mood	No issues detected	Periodic psychometric measures

Case Study 1: Sleep Assessment

- 180 days deployment; 152 days of usable data
- Some disruption in sleep duration evident on a day to day basis but very stable patterns over time (Figure 1)

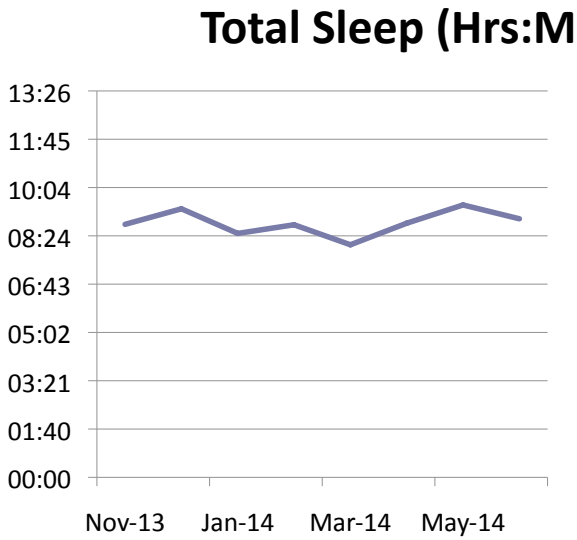


Figure 1. Average Monthly Sleep over 6 months

- Some variation in sleep interruptions evident on a day to day basis but again relatively stable patterns over time (Figure 2)
- BUT, interruption levels quite high and some clear outliers that require further investigation

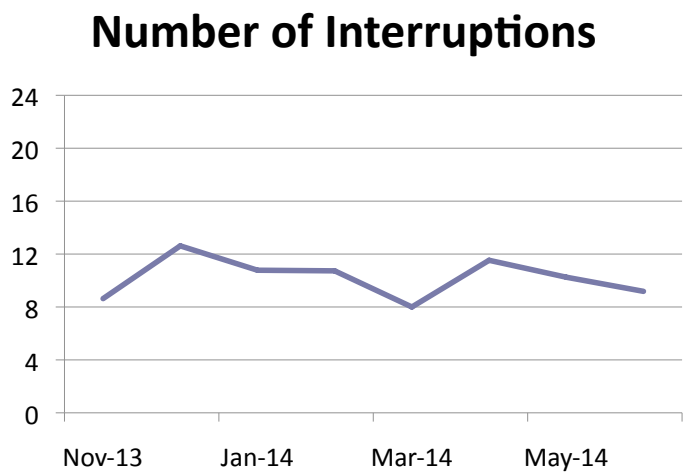


Figure 2. Average Monthly Interruptions over a 6 month period

Case Study 1: ADL / IADL

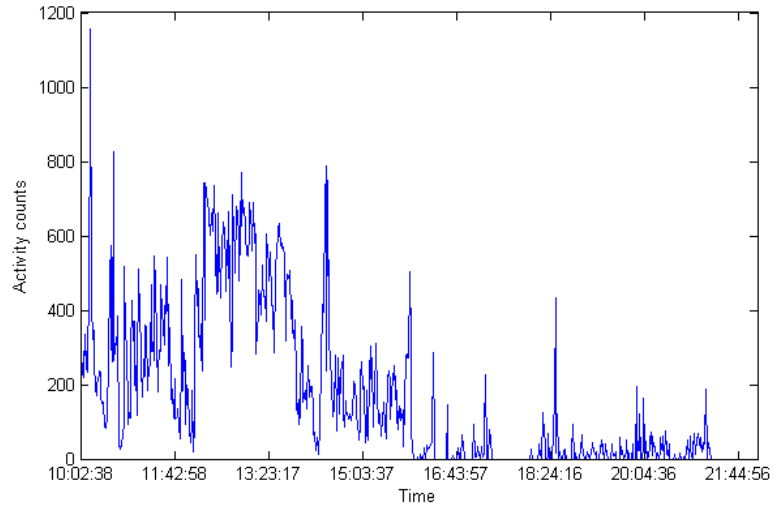
- Catriona laid out the jacket/camera with Sean's clothes every morning
- Most successful data capture was for activities that formed a natural part of Sean's day
  - Making breakfast, tea, watering plants, feeding birds
- Capturing specific activities like 'playing a cd' were not successful unless they took place under the direction Catriona or the researcher
- 33.3 hours collected – 4.33 hours have been manually annotated and are being used to train location, activity, and object algorithms for a second pilot
  - Initial models show promising accuracy levels
  - Feed birds (95.98%), Water plant (85.5%), Talk on phone (74.7%), Prepare drug box (49.7%), Breakfast (45.6%), Meal (46.98%), prepare tea (39.1%)

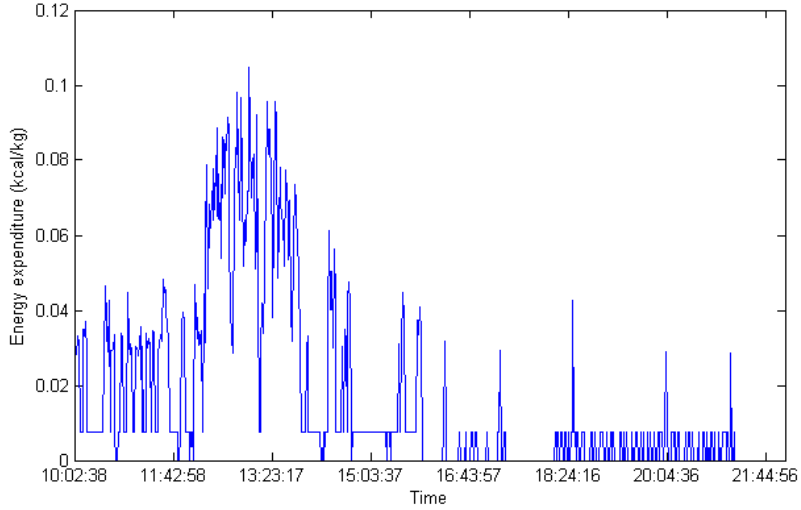
Case Study 1: Physical Activity

Activity Levels

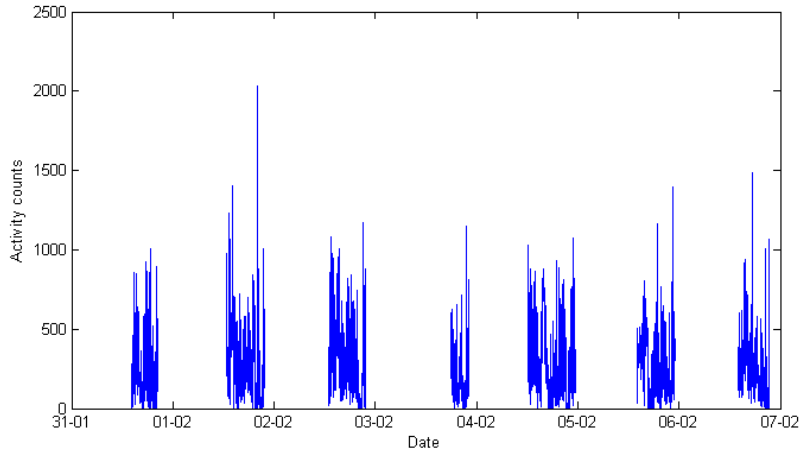
Energy Expenditure

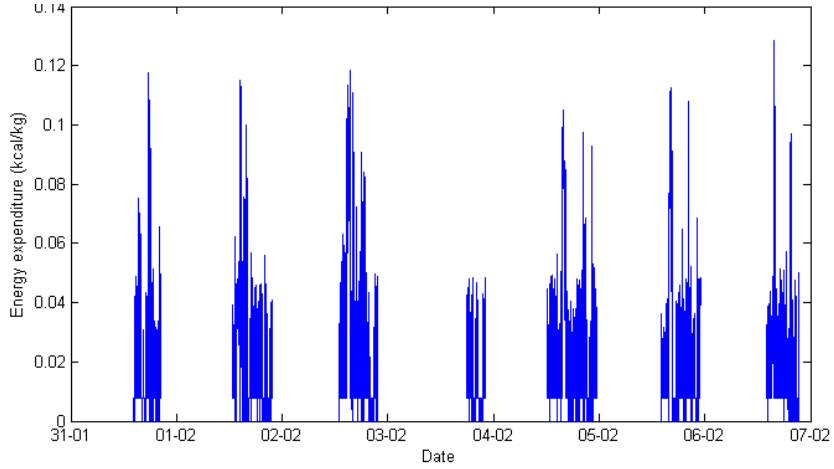
Day





Week





First @Home Pilot: Key Issues

- Recruitment difficulties
- Sensors
  - Training period required – initial anxiety regarding sensor use
    - *Need to balance the idea of co-design and the introduction of an incomplete system with a person with dementia*
- Ethics
  - Third party data capture and privacy
- Need for functionality available in later prototypes
  - Lack of triangulated data (integrated feedback) limits the usefulness of the system for all end-users
  - Easy to use data transfer and analysis and automated feedback
  - Caregiver still required as primary source of support

Conclusions and Future Direction

- Analysis of sensor level data shows promising results although the real value of the Dem@Care system will come from the triangulation of data from various sensors, and the ability to subsequently identify improvement, stasis, and/or deterioriation over time
- Perceived usefulness at meeting perceived needs, and easy to use technology that does not interfere with daily life is the key to acceptability
- Importance of the interaction with the researcher/therapist

Next Steps:

- Currently 2 lead users; a 3rd due to come on stream in November
- Recruitment difficulties and feedback from the first pilot have resulted in the designed a cognitive rehabilitation intervention (12 weeks) within which appropriate sensors will be introduced

References

1. Fujisawa, R. and F. Colombo (2009), *'The long-term care workforce: overview and strategies to adapt supply to a growing demand'*, OECD Health Working Papers No. 44.
2. Chapman, A., "*There's no place like a smart home*", Journal of Dementia Care, Vol. 9, No. 1, pp. 28, 2001.
3. Stefanov Dimitar H; Bien Zeungnam; Bang Won-Chul, "*The smart house for older persons and persons with physical disabilities: structure, technology arrangements, and perspectives.*", IEEE transactions on neural systems and rehabilitation engineering : a publication of the IEEE Engineering in Medicine and Biology Society, Vol. 12, No. 2, pp. 228-50, June 2004.
4. Evans Denis A; Grodstein Francine; Loewenstein David; Kaye Jeffrey; Weintraub Sandra, "*Reducing case ascertainment costs in U.S. population studies of Alzheimer's disease, dementia, and cognitive impairment-Part 2*", Alzheimer's & dementia : the journal of the Alzheimer's Association, Vol. 7, No. 1, pp. 110-23, January 2011.
5. Topol, Eric J., "*Transforming Medicine via Digital Innovation*", Science Translational Medicine, Vol. 2, No. 16, January 20
6. Chamberlain ME, Fulwider BD, Sanders SL, Medeiros JM. Does fear of falling influrnce spatial and temporal gait parameters in elderly persons beyond changes associated with normal aging? *Journal of Gerontechnology* 2005, Vol. 60A, No 9, 1163-1167.
7. David R et al. Ambulatory actigraphy correlates with apathy in mild Alzheimer's disease. Dementia: The International Journal of Social Research and Practice 2010, Vol. 9, No 4, 509-516.
8. David R, Mulin E, Friedman L, Le Duff F, Cygankiewicz E, Deschaux O, Garcia R, Yesavage JA, Robert PH, Zeitzer JM. Decreased daytime motor activity associated with apathy in Alzheimer Disease: An ctigraphy Study. Am J Geriatr Psychiatry 2011.
9. Plancher G., Tirard A., Gyselinck V., Nicolas S., Piolino P. Using virtual reality to characterize episodic memory profiles in amnestic mild cognitive impairment and Alzheimer's disease: Influence of active and passive encoding. Neuropsychologia. 2012 Apr;50(5):592-602.
10. Sterke CS, van Beeck EdF, Looman CWN, Kressig RW. An electronic walkway can predict short-term fall risk in nursing home residents with dementia. Gait & Posture (2012)

Thank you for your attention

For further information:

www.demacare.eu

louise.hopper@dcu.ie

Funding Acknowledgement:

The research leading to these results has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement 288199

This project is funded by the European Union

Dem@Care Consortium partners