Smart sensors for a wearable-free and contactless virtual ward at home

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NodeNs medical

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RGS care

The ExtraCare Charitable Trust

I. Project Vision

- ❑ We are building a friendlier, easier-to-use and more effective health monitor for the home
- ❑ Pendants and smartwatches are uncomfortable and are yet another thing to remember!

- ❑ We are performing research into contactless, ambient sensors for care.
  - ❑ Easy-to-use
  - ❑ No capturing of photos, images, or videos.
  - ❑ No recording of voices; we cannot 'hear' the conversations.
  - ❑ No need to wear any devices or install smartphone apps.

III. Falls Risk Assessment & Prediction

- ❑ Falls are the second cause of unintentional injury deaths worldwide [1].
- ❑ Unaddressed fall hazards in the home are estimated to cost the NHS in England £435 million [2].

NICE GUIDELINES

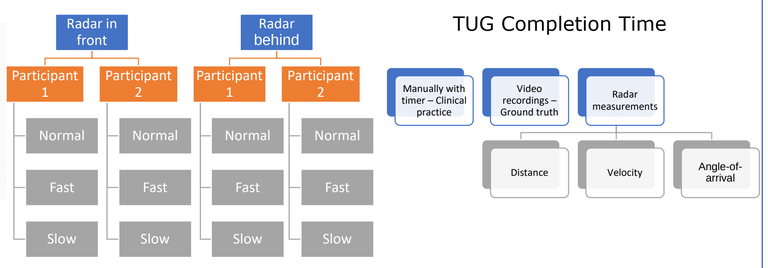
BGS WORLD FALLS GUIDELINES

Initial Falls Risk Screening → Multifactorial Falls Risk Assessment → Intervention

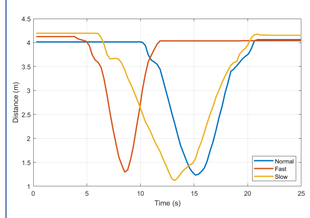
Problems
- Post-fall approach
- A snapshot in their best time
- Devices are not effective in-home settings
- Falls are underreported

Benefits of real-time continuous monitoring
- Monitoring while keeping active
- Prediction of risk (finding patterns)
- 24-hour picture of the gait
- Measuring the effectiveness of interventions

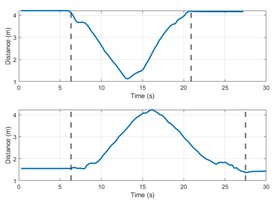
Automation of the Timed and Go Test using Millimetre-Wave Radar



Distance-based Analysis

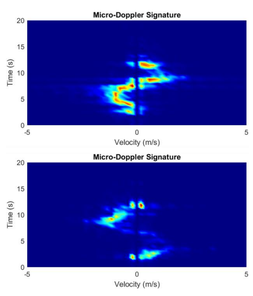


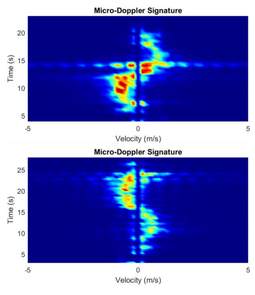
Distance graphs of experiments 4 (normal), 5 (fast) and 6 (slow)



Distance graphs of experiments 6 (radar in front) and 12 (radar behind)

Velocity-based Analysis – Micro Doppler Signatures

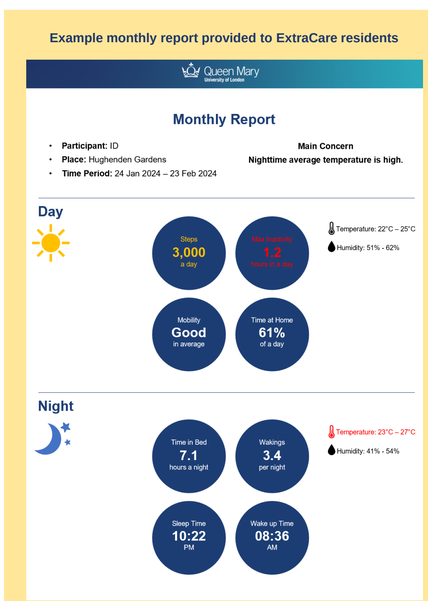




Micro-Doppler signatures of experiments 5 and 11 (fast)

Micro-Doppler signatures of experiments 6 and 12 (slow)

Example monthly report provided to ExtraCare residents



4.26%	6.49%	3.48%
MAPE - Manual	MAPE – Micro Doppler	MAPE - Distance

- ❑ The performance of both methods remains acceptable to health care professionals.
- ❑ The distance measure yielded an even better performance than the manual timing (clinical practice).

II. Aims of the Project

A. Three Research Areas of our Project

Falls Risk Prevention
- Automation of falls risk screening
- Segmentation of activities
- Extraction of gait parameters
- Finding the mobility patterns
- Measuring activity levels
- Classification of activities
- Risk prediction models

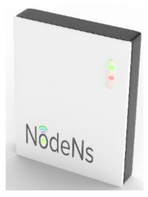
Vital Signs Measurement
- Breathing rate
- Heart rate

Sleep Quality Monitoring
- In/out bed monitoring
- Measuring sleep parameters
- Associations between subjective reporting and objective measures

We have an ongoing study at ExtraCare Retirement Villages with 18 healthy older adult participants.

B. Types of Wireless Sensors

The environment: RGS sensors
- Temperature, humidity, air quality
- Loudness of noise
- Existence of motion



Personal wellbeing: NodeNs (mm-wave radar) sensors
- Mobility: gait speed, step count, room occupancy and activity level.
- Sleep quality: sleeping time, wake up time, number of wakings at night.
- Vital signs: breathing rates and heart rates.

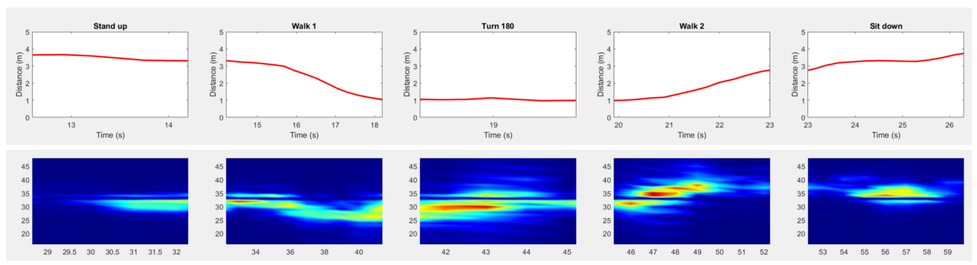
What do our participants say?

"I feel much safer with these sensors in my apartment. Cameras make me feel uncomfortable."

"I would be happy to have these sensors fitted in my apartment for longer periods."

IV. Next Steps

✓ Next step is automated extraction of gait and sleep parameters, and other health indicators, using only passive monitoring. This builds on our lab work and applies it to real-time residential measurements.



✓ Our PPIE studies, involving interviews with expert clinicians and researchers, suggested three areas to focus on:

- ✓ Sleep quality is a nascent field of research with great potential of using radar technology
- ✓ Personalised falls risk profiles and fall risk prediction models using AI and machine learning
- ✓ The combination of sensors can be used to study air pollution source apportionment

✓ We have developed promising relationships which will be the foundation for future research collaborations:

- ✓ Expert researchers/clinicians in the above three areas.
- ✓ Residential care providers (incl. ExtraCare and others) with a focus on innovative care models, and the ability to support research projects with their elderly residential populations.

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References

[1] World Health Organization, 'Falls', WHO fact sheet on falls providing key facts and information on scope of the problem, who is at risk, prevention, WHO response. Accessed: Nov. 08, 2023. [Online]. Available: https://www.who.int/news-room/fact-sheets/detail/falls
[2] Office for Health Improvement and Disparities, 'Falls: applying All Our Health', GOV.UK. Accessed: Dec. 28, 2023. [Online]. Available: https://www.gov.uk/government/publications/falls-applying-all-our-health/falls-applying-all-our-health

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