Th2C-2

Radar Assistive System for People with Neurodegenerative Disorders Through Head Motion and Eyes Blinking Detection

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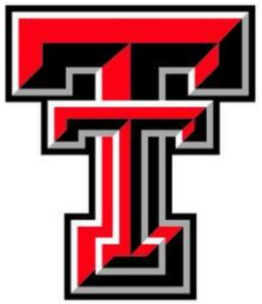
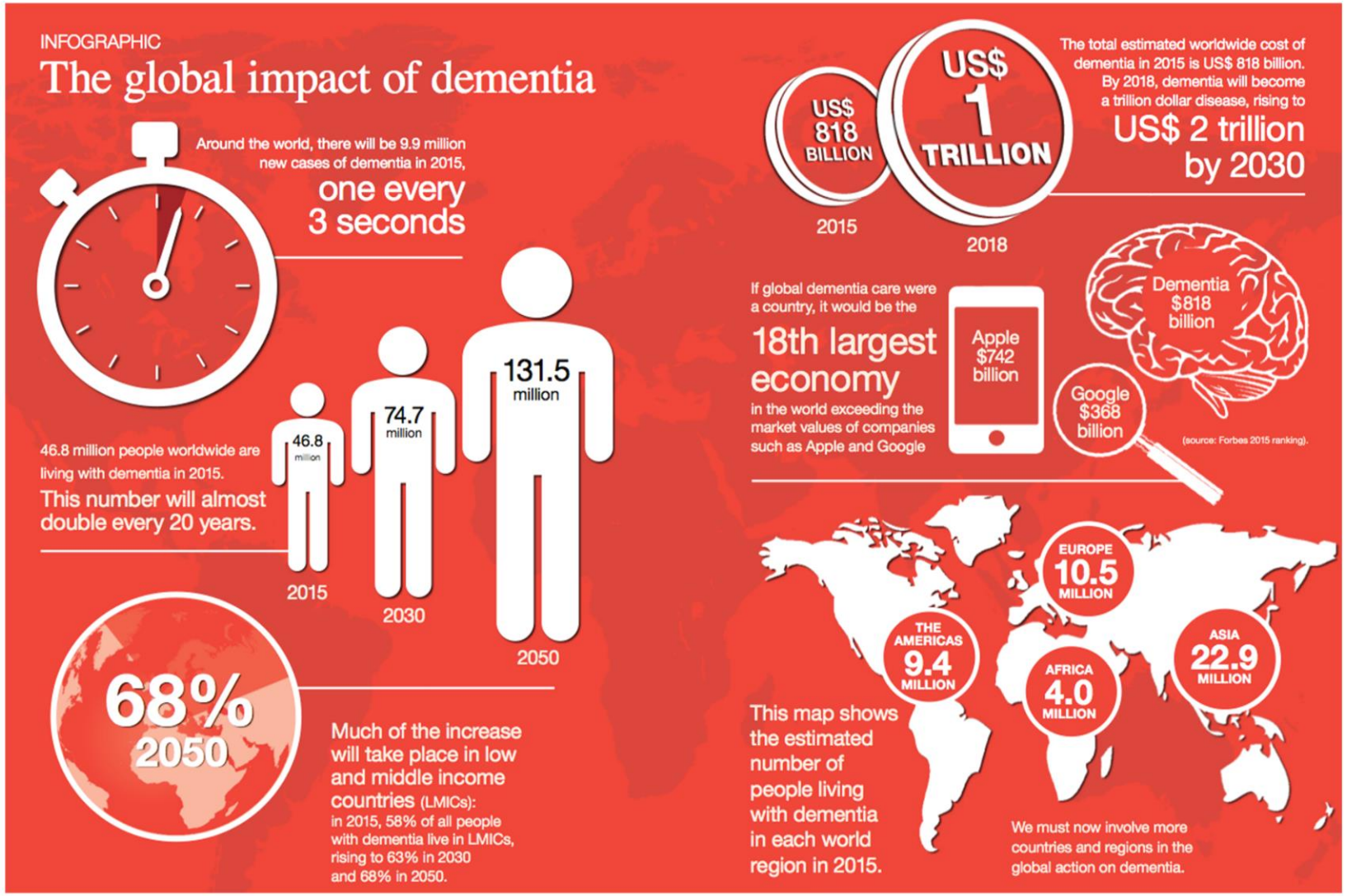


Outline

1. Let us focus the problem
2. Our solution
3. System validation
4. Future developments and conclusions

Let us focus the problem

Neurodegenerative pathologies



Improvement of life conditions

⇩

Increase of the life expectancy

⇩

Dramatic growth of the number of neurodegenerative pathologies across all world regions

The continuous decline in the daily living attitude makes the patients unable to communicate

The goal: improving communication

Existing strategies (the head is the last affected section of the body, whereas the eyes are the last organs):

- ✓ Detecting brain signals (EOG, EEG)
- ✓ Recognizing wilful movements (head, eyes motion)

Existing technologies:

- ✓ Recognizing movements through a camera-based image acquisition
- ✓ Detecting brain signals through electrooculography (EOG) and electroencephalography (EEG)

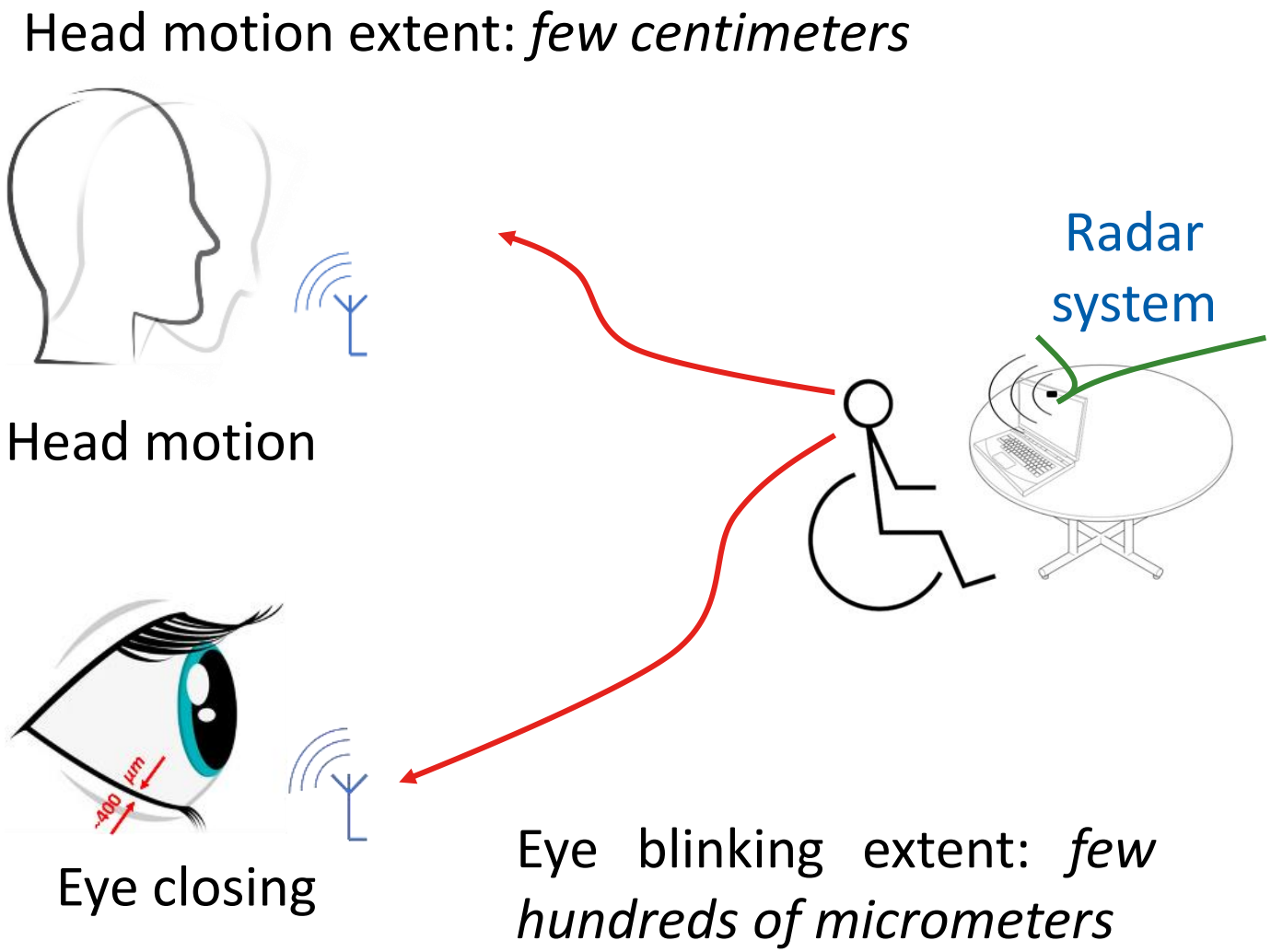
Main drawbacks

- ✓ Large probability of detection errors
- ✓ Need of contact probes (electrodes), affecting the comfort of the user (EOG-EEG)
- ✓ Bulky systems (cameras)
- ✓ Privacy concerns (cameras)

Our solution

Radar-based Scenario

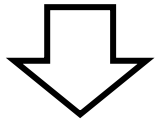
1. The radar is connected or integrated in a personal computer and points towards the user's face.
2. It detects the head or eyes motion.
3. It convert a motion into a request for a certain task



Main body motion effects

Diaphragmatic breathing

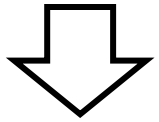
Normal breathing of healthy subject.



The head should not move as a consequence of the respiratory activity.

Costal breathing

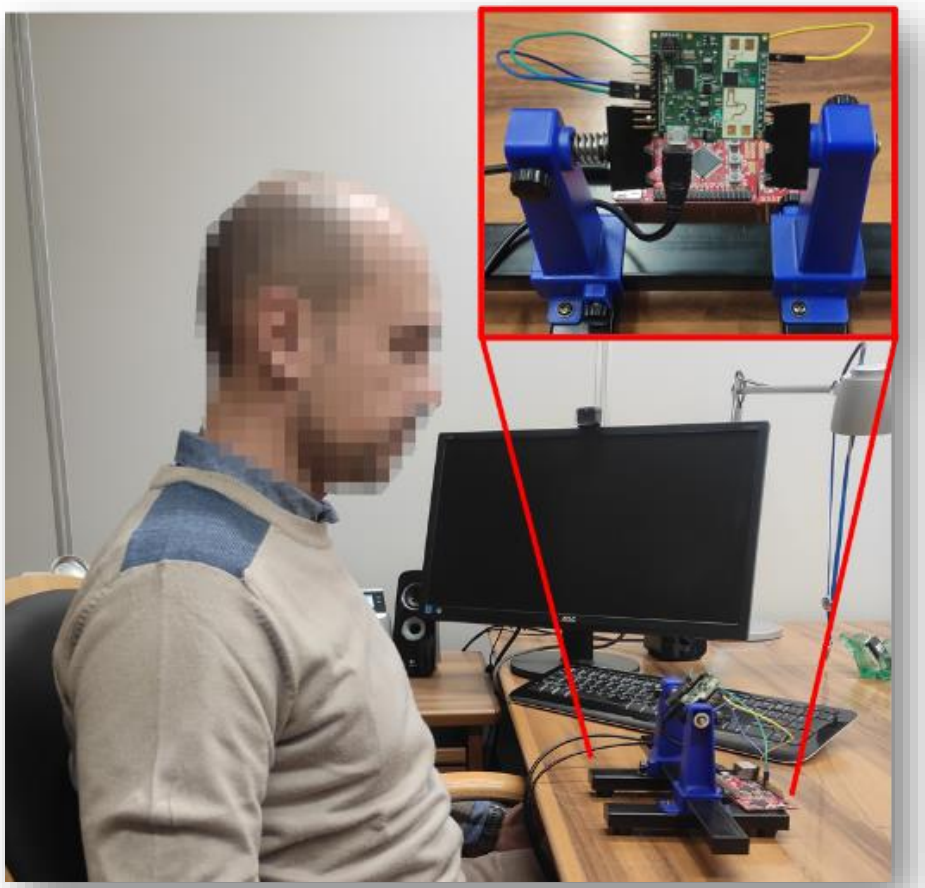
Contraction of the intercostal muscles is also involved in addition to the diaphragm.



The head moves as a consequence of the respiratory activity;
this affects the head-motion and eyeblink detection.

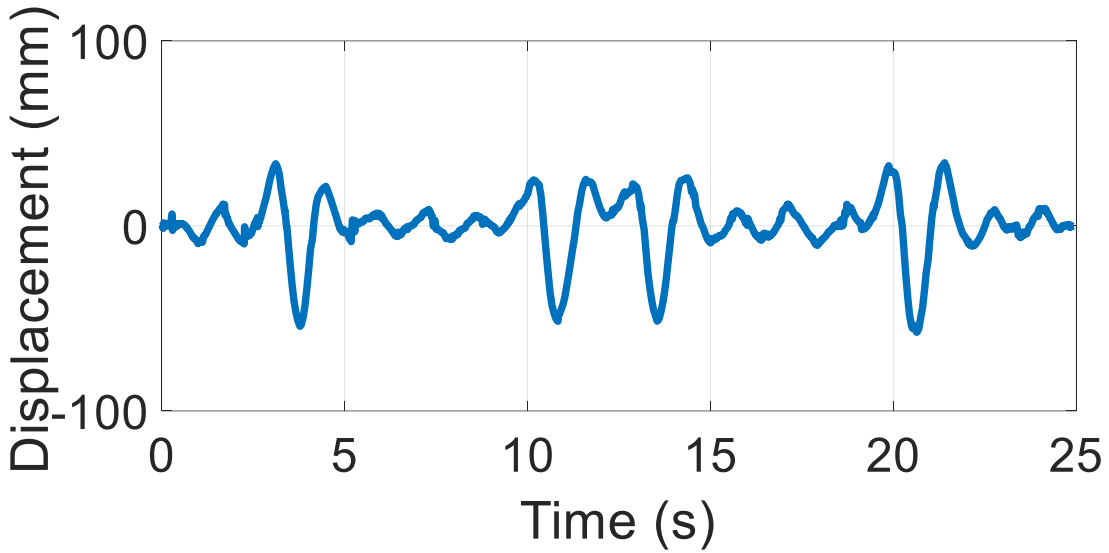
System validation

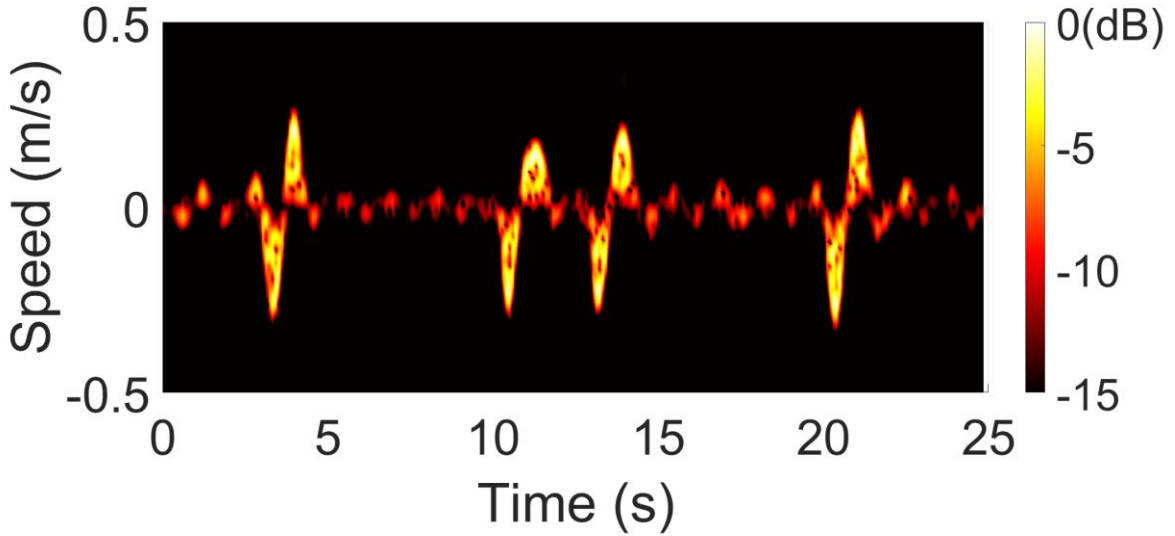
Doppler radar setup



- ✓ The radar system is 40 cm away from radar.
- ✓ The radar works in Doppler mode within the 24 GHz ISM band.
- ✓ A custom ADC interface has been to measure target speeds up to 31 m/s.

Head motion detection during costal breathing

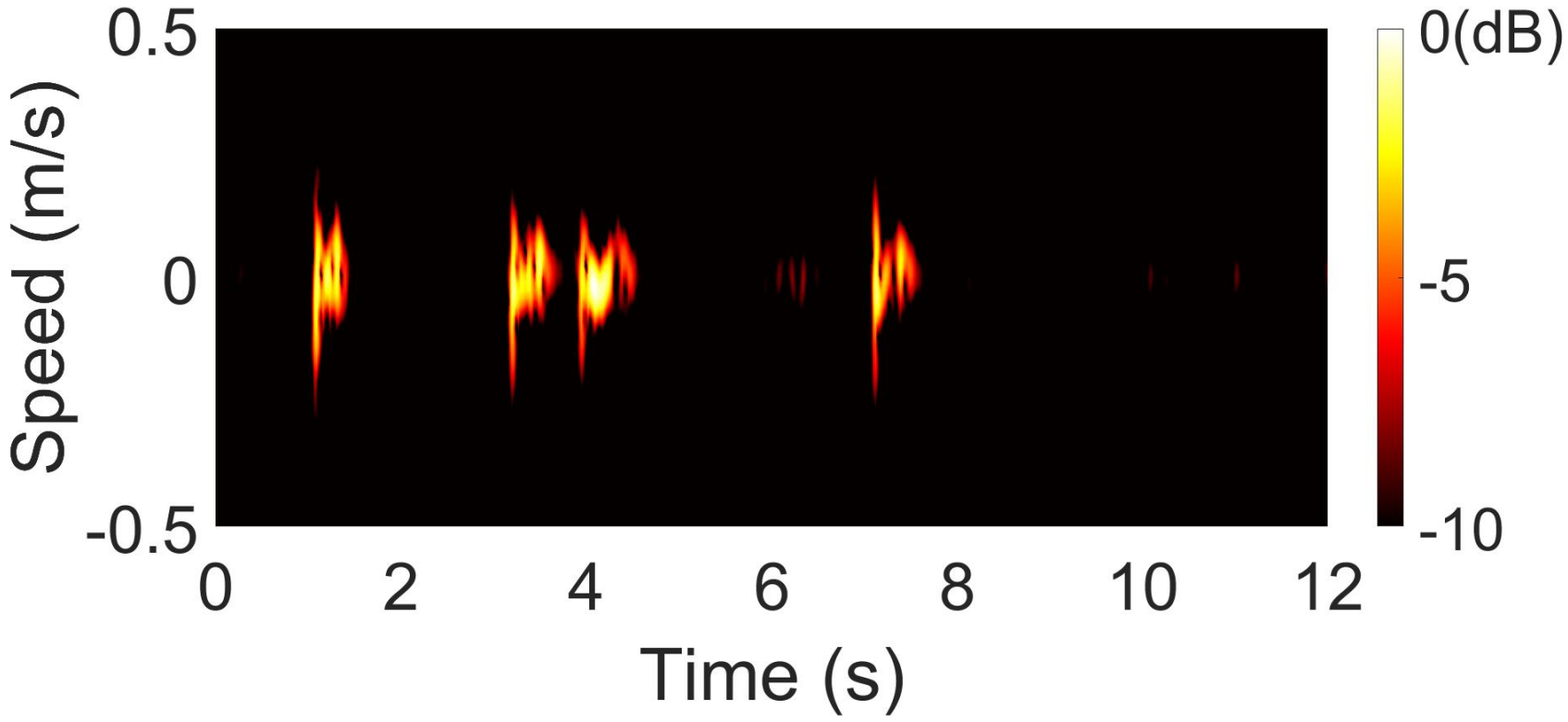




Micro-Doppler signature and displacement associated to the head motion during **costal breathing**.

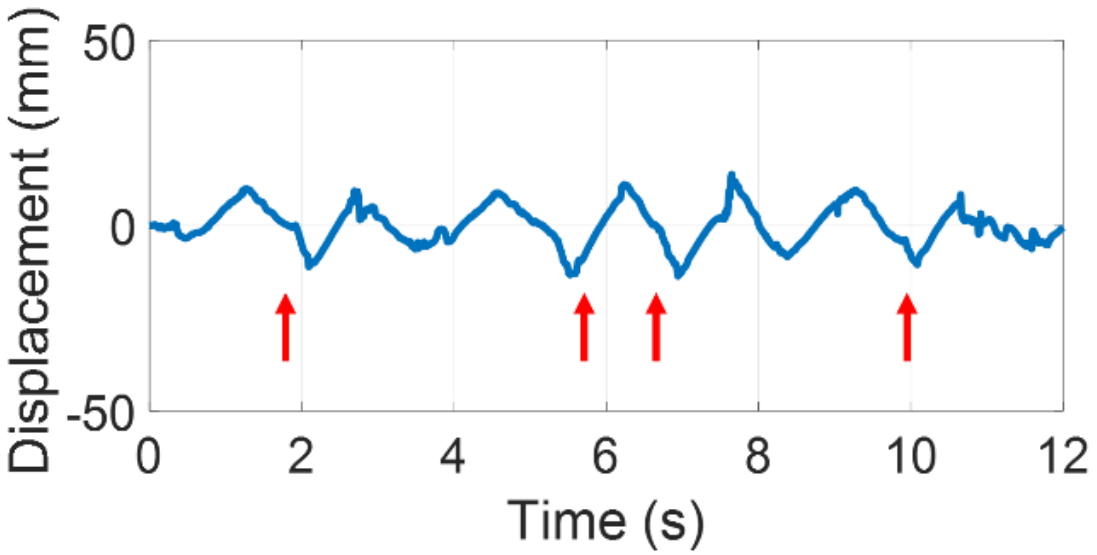
The user is 40 cm away from the radar

Eyes-blinking detection during diaphragmatic breathing



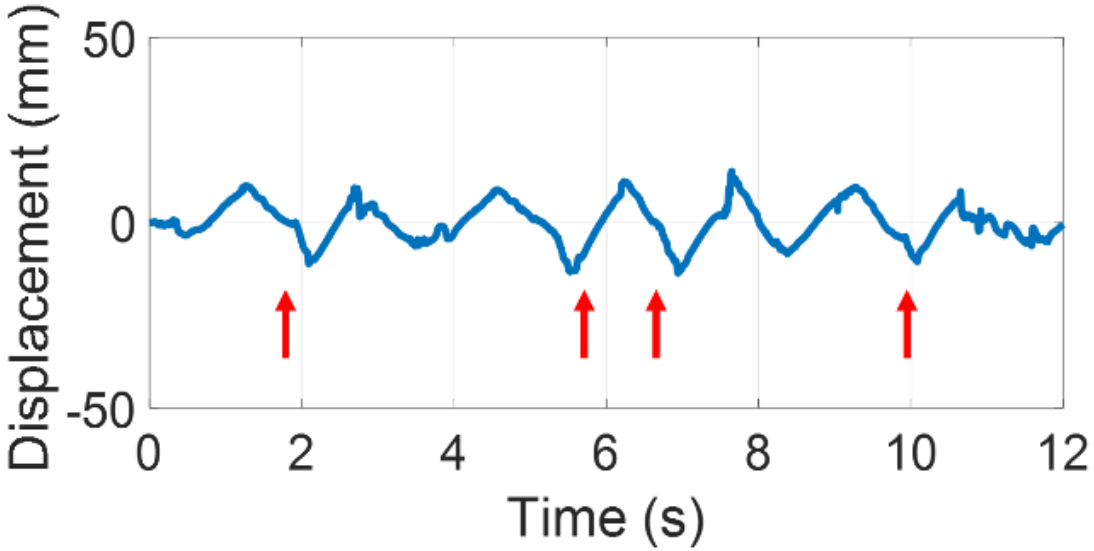
Micro-Doppler signature due to the eyes-blinking during **diaphragmatic breathing**.

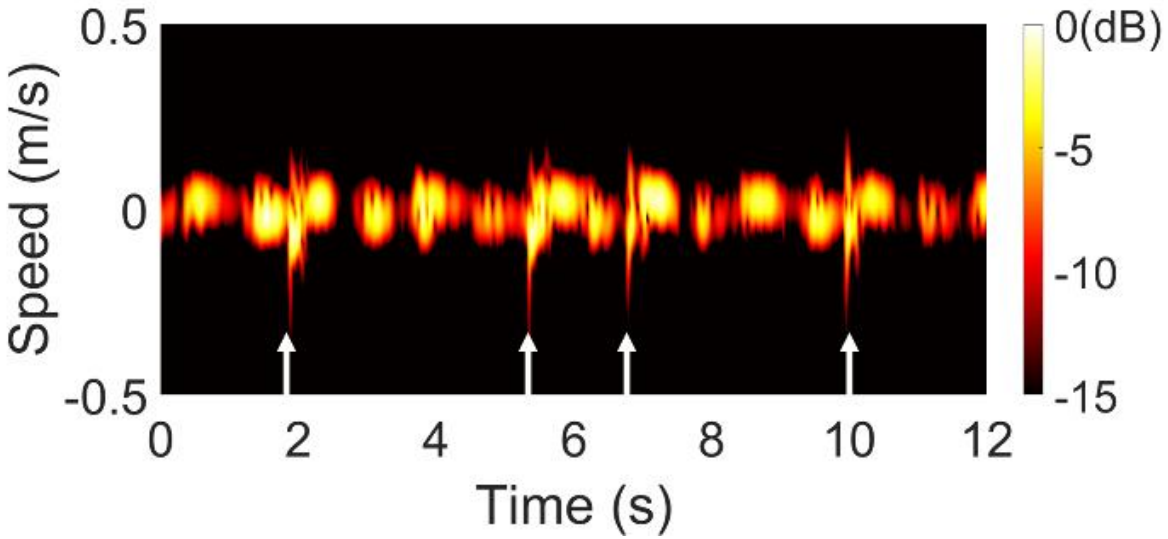
Eyes-blinking detection during costal breathing



Displacement due to eyes-blinking during **costal breathing**. It is <u>not</u> possible to notice the eyes-blinking occurring in the points indicated by the red arrows.

Eyes-blinking detection during costal breathing





Displacement due to eyes-blinking during **costal breathing**. It is <u>not</u> possible to notice the eyes-blinking occurring in the points indicated by the red arrows.

Micro-Doppler signature due to the eyes-blinking during **costal breathing**. The white arrows indicate the <u>recognizable</u> eyes-blinking.

Future developments and conclusions

Further Improvements

Limitations

Both the head and eye movements could be affected by additional physiological motions generating false alarms or concealing the intentional motion.

Solution

If the radar platform moves together with the user head, the effects of body motion would be significantly suppressed.

Future developments

Radar chip on the **frame of a glass**

Higher **body movement suppression**

Easier focusing on eye related movements

Outline

1

In this contribution, a radar-based aid for people with heavy neurodegenerative disorders has been presented.

2

It can detect sub-millimeter body motions to be interpreted as commands. In detail:

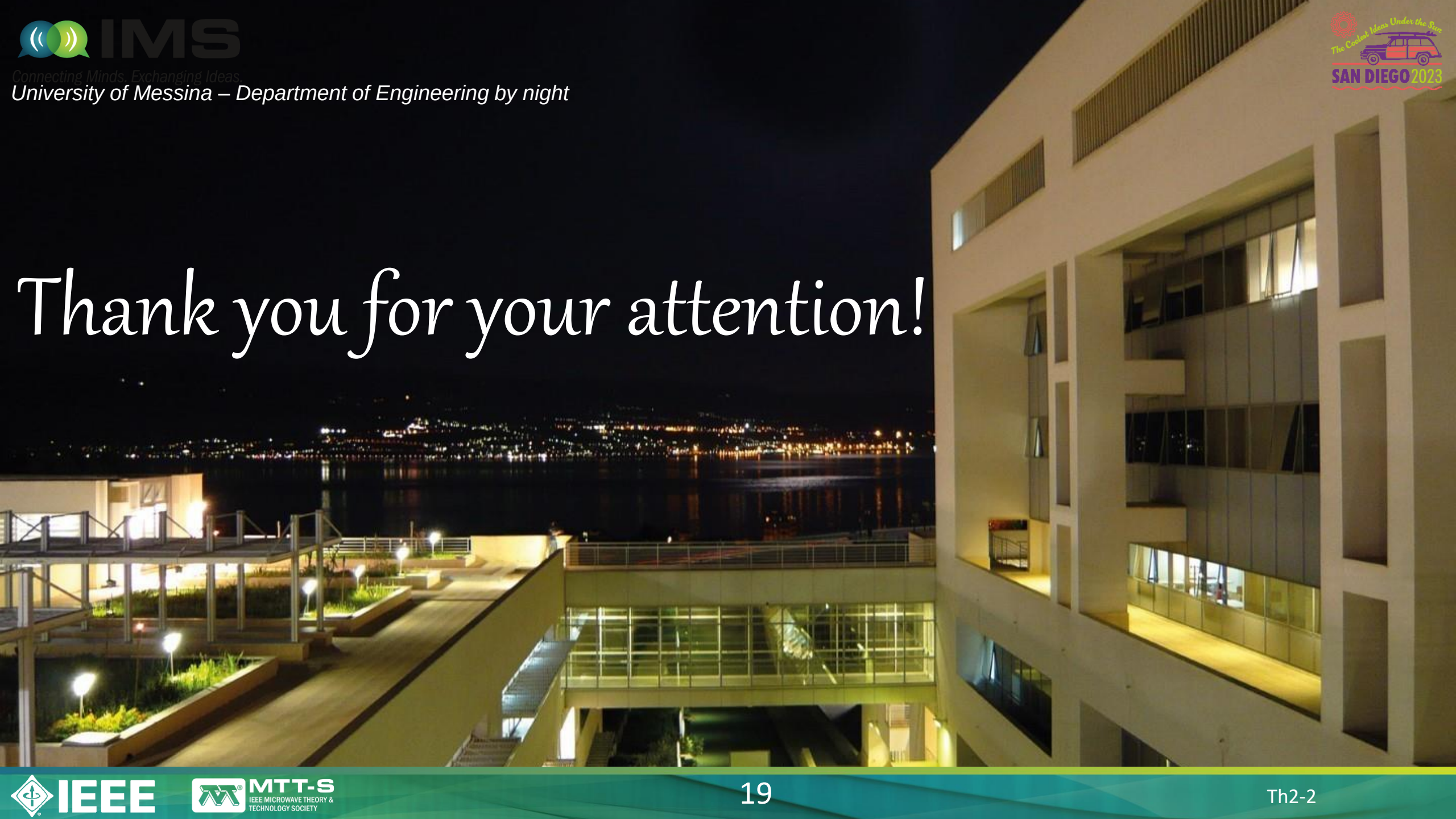
- Movement of the head.
- Eye-blinking.

3

The operating principle and the feasibility of the system have been shown by testing real possible scenarios.

4

It can be applied in a wide variety of scenarios, e.g.: pointed towards a patient lying in the bed, employed to switch the light on/off, call an assisting person or remotely control electric shutters.



University of Messina – Department of Engineering by night