Explore the next sense

ACCONEER
Smart presence detection

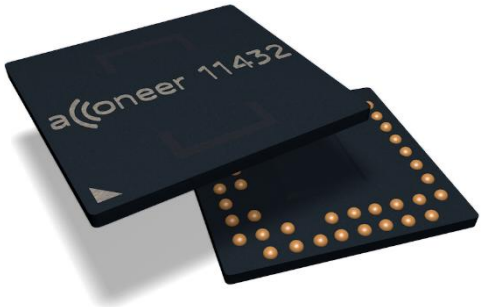
May 2020

Smart presence detection

Devices and appliances to be aware of their surroundings and interact with users.

- Presence detection — Detect when people are present, even if they are still
- Movement detection — Detect direction of people moving
- Range and zone detection — Trigger activities within detection zones
- People activity falling — Detect when people are sitting, standing, walking or
- People counting entrance — Count people when walking in or out of

Acconeer A111 radar sensor for people presence



A111 Pulsed Coherent Radar

Robustness	No natural disturbances
Advanced Detection	Micro Motions
	Distance and detection zones
	Speed
Power consumption	Ultra low power with pulsed radar system
Easy integration	Small package and integrated antenna
	No need for aperture, bult in behind plastic

Technology comparison

	Pulsed Coherent Radar	Image recognition	Passive Infrared detectors	IR sensors	Acoustic sensors
Detection and robustness	High accuracy and robustness, not affected by light-, sound, fog, dust, colors or transparency objects.	Sensitive for low light conditions	Incapable of distinguishing between objects that irradiate similar thermal energy levels.	Sensitive for ambient light and dark colors.	Low accuracy, sensitive for soft fabric (absorbs sound) and temperature.
Integration and cost	Low cost	High cost. Requires top-quality cameras.	High cost	Low cost	Los cost
Integration	Small size no need for aperture.	Need lens	Need aperture	Need aperture	Need aperture
Processing and power consumption	Low	High, advanced software to ensure accuracy and speed.	High	Low	Medium

Smart presence detection

Device wake-up use case

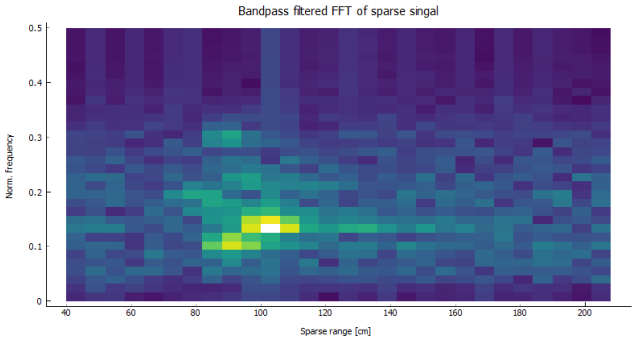
Detection Zone Direction

Use case

- Detect people approaching device
- Disregard people passing by

Benefits

- Robust detection
- Easy integration
- Possible gesture control with same sensor



Proof-of-concepts

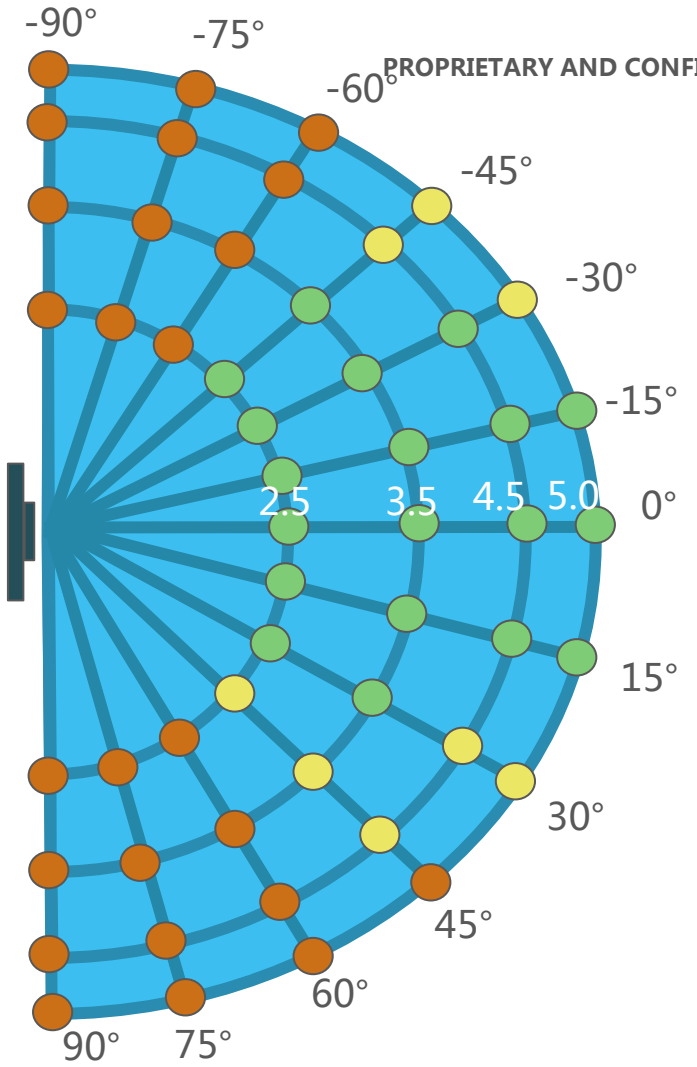
Presence detection in front of TV

- Acconeer evaluation kit with one A111 radar sensor
- Person sitting still for 25 seconds per measurement at distance mark
- Angles tested were -90 to +90 degrees from boresight with 15 degree increments
- Adding multiple sensors for increased field of view

Stable detection

Partial detection

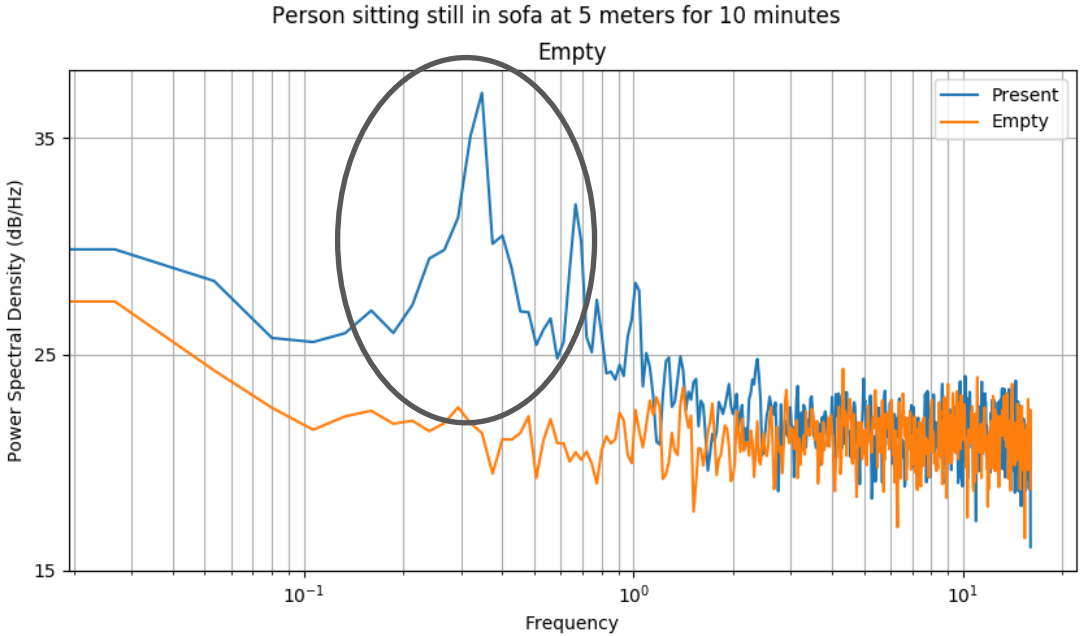
No detection



Measurement, sitting perfectly still

Clear detection of people when they are sitting perfectly still

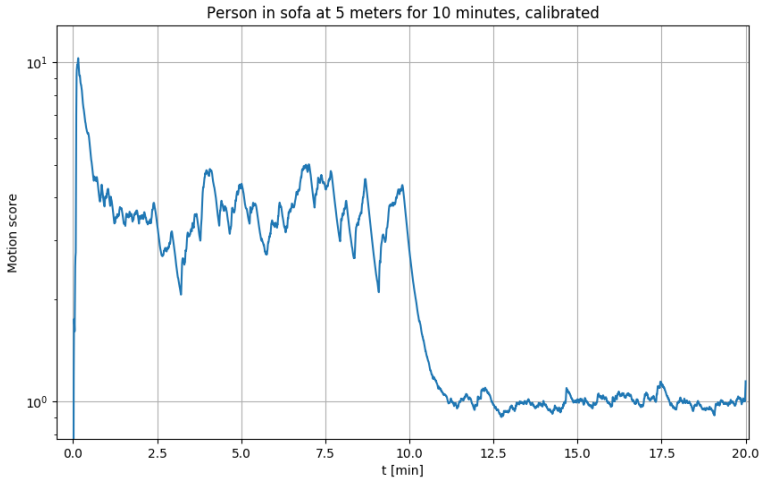
The signal is dominated by the breathing signal at 0.3-0.35 Hz.



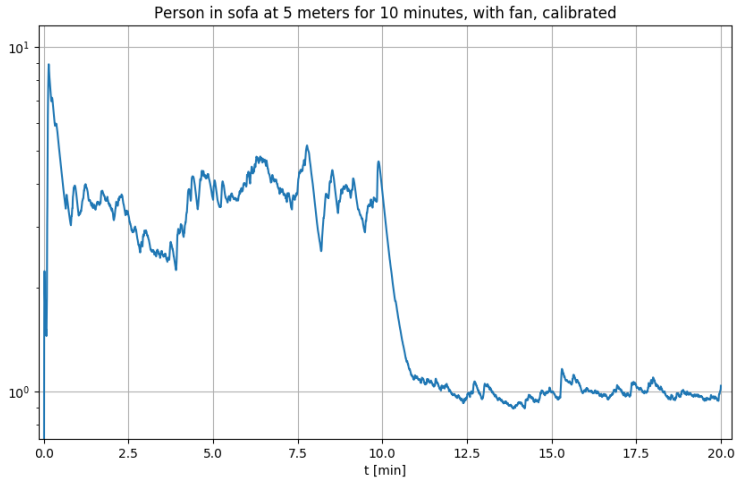
Measurements with and without fan

The presence detector is set to only react to slow speeds (a few cm/s). The motion of the fan is fast, and therefore filtered away

No Fan



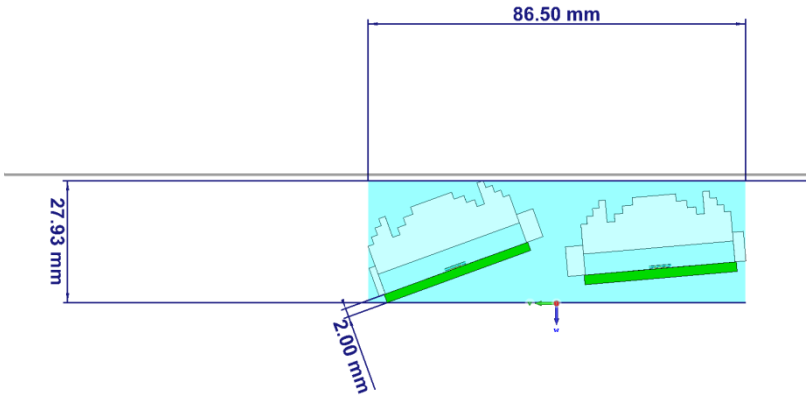
Fan

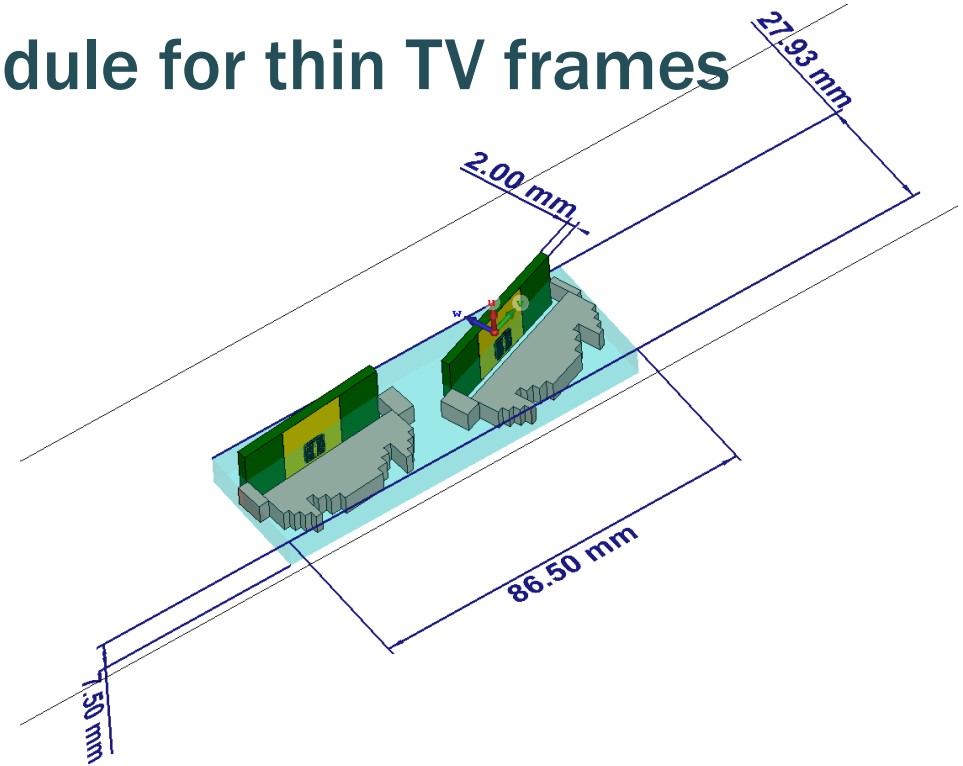


Radar Lens prototype module for thin TV frames

Lenses are angled according to product requirements

Height under LCD (lens)	7.5 mm
Width	86.5 mm
Depth	27.93mm

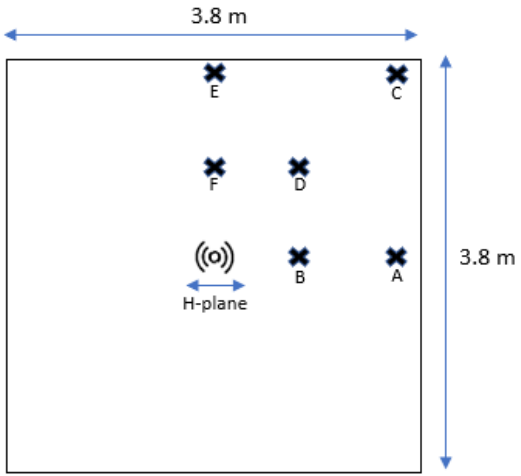




Proof-of-concept
Presence with sensors mounted in ceiling

- Positions tested in a room of size 3.8x3.8x2.4 m
- Tests done with a sitting person (position A to F in picture)
- One sensor mounted in the middle of the ceiling
- Running high power mode and low power mode (< 1mW)

Positions



Set up

Detection performance, in room sitting still

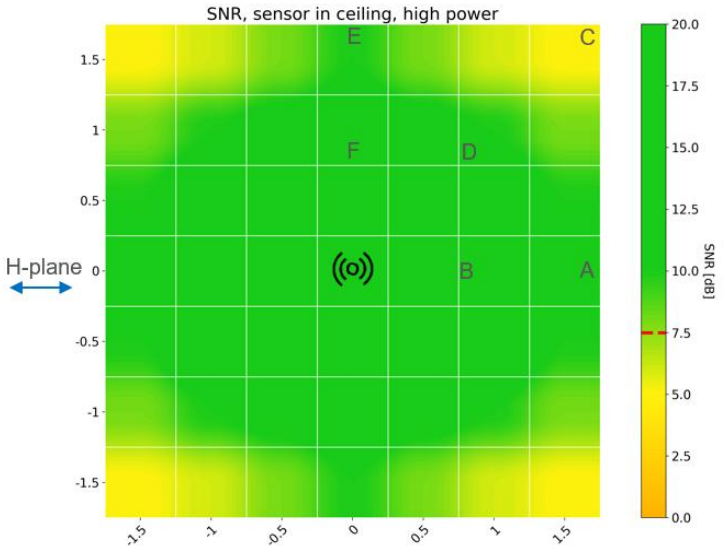
1 sensor mounted in ceiling

Good detection

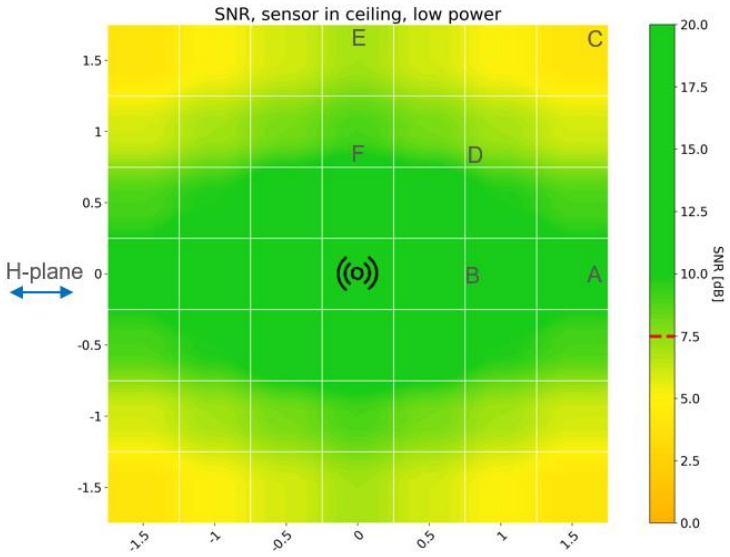
Moderate detection

Poor detection

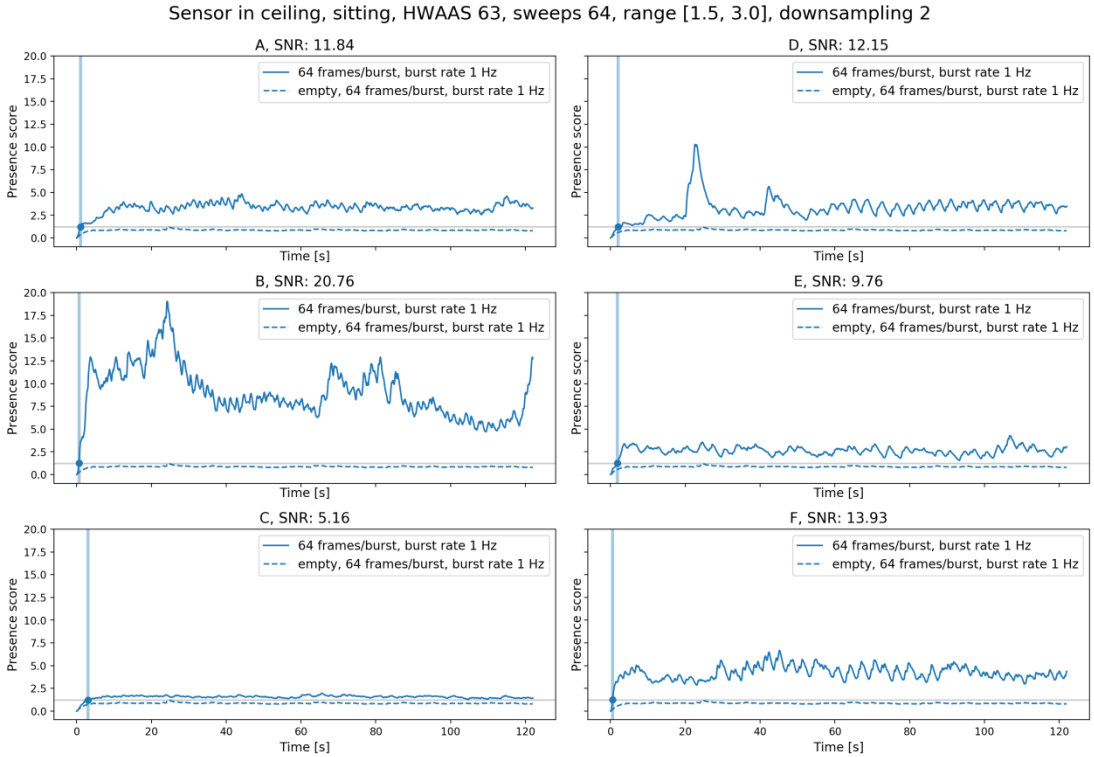
High power

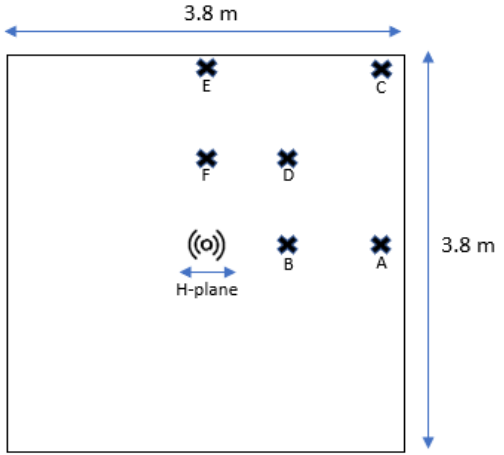


Low power

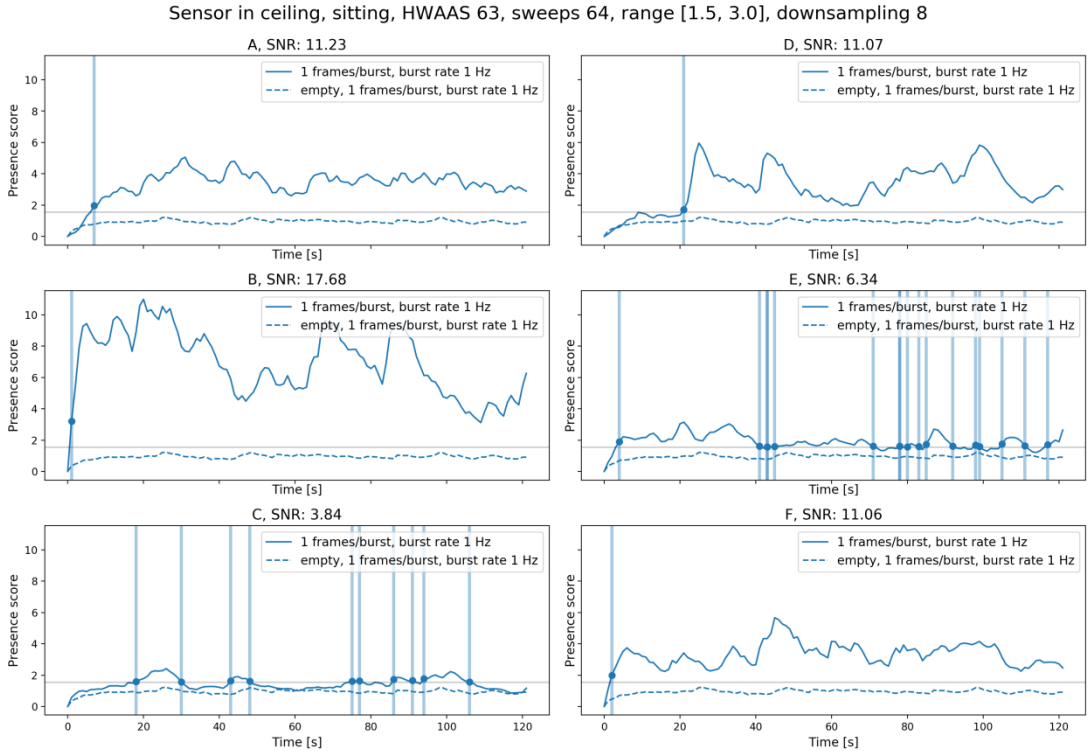


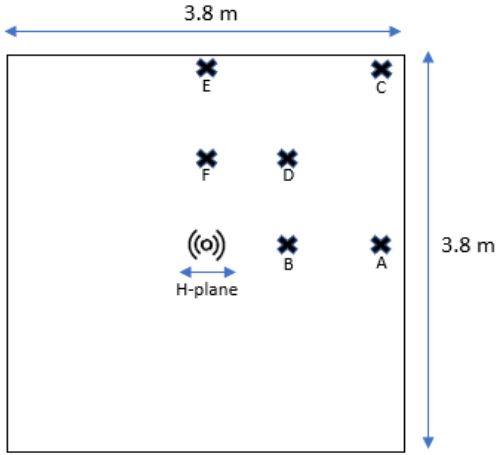
Sparse presence, 1 sensor in ceiling, high power





Sparse presence, 1 sensor in ceiling, low power





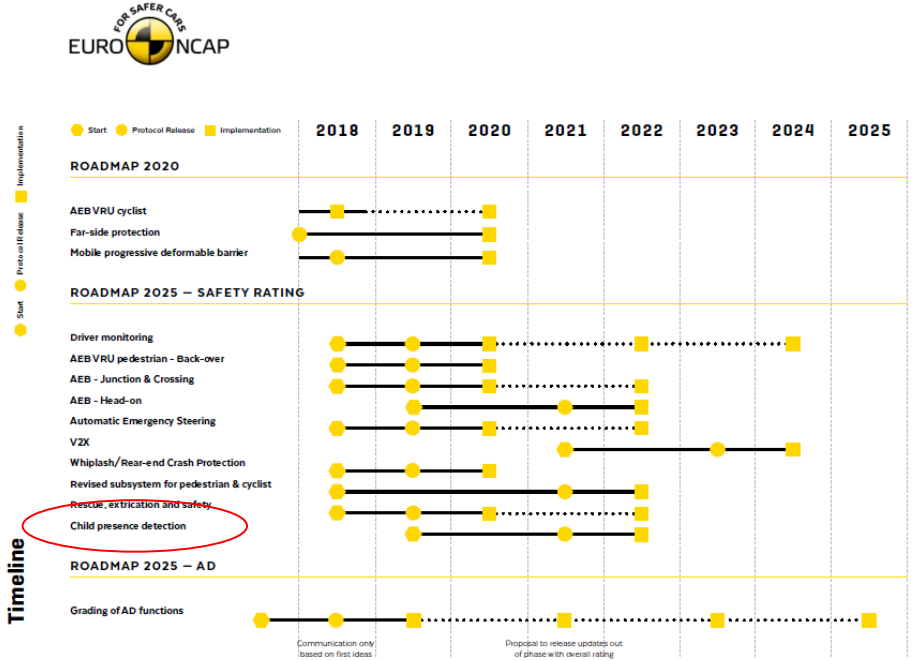
In-car passenger detection

…becoming a critical safety feature [Euro NCAP] requiring **high accuracy robust detection** and **flexible integration** not interfering in interrail design:

- Detection human vs objects
- Preventing leaving child or pet in car
- Seatbelt reminder

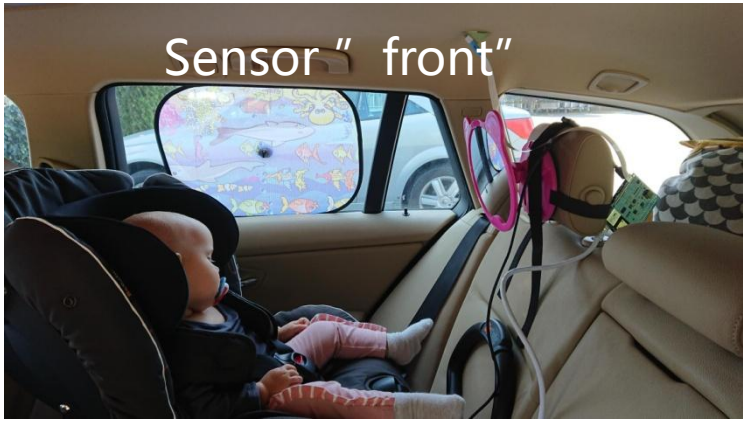
Euro NCAP – mandatory presence detection

The European New Car Assessment Program (Euro NCAP), plans to include Child presence detection for full rating in 2022

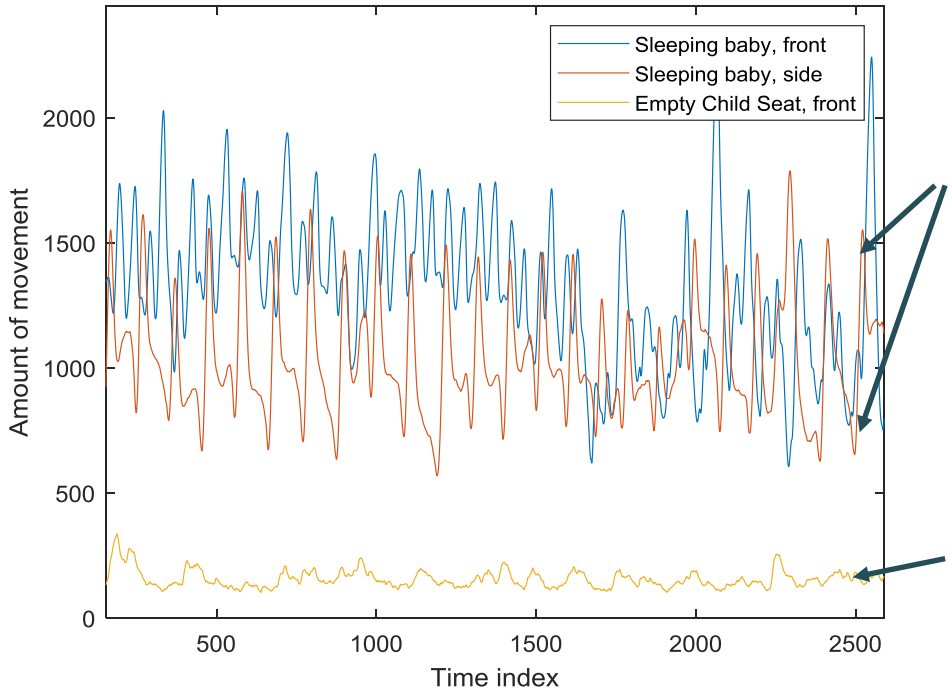


Proof-of-concept
In-car child presence detection

- 1-year-old baby sleeping in child protection seat
- Two alternative sensor mounting positions
  - In ceiling facing the baby from above rear seat neck rest position
  - In ceiling from the top of the door position



Sparse Sampling Presence Detection



Impossible to miss the presence of a child

Empty child seat signal

Conclusions

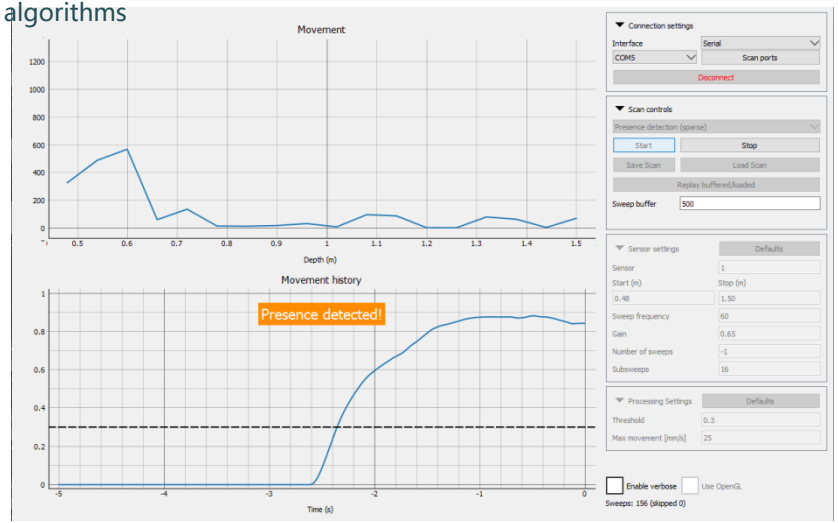
- Based on measurements on *one* sleeping 1-year-old in *one* car
  - It is **very easy to detect the presence** of the child thanks to breathing motion
  - Both tested sensor positions are very good

Get started with Acconeer Evaluation Kit

- Acconeer provides evaluation kit and ready presence algorithm to start evaluating in target environment.
- Evaluation kit including XM112 module and XB112 breakout board is available at www.beyd.com.cn
- Acconeer SDK and Module software image available at www.acconeer.com
- - Open source presence algorithm and GUI in Python available at https://github.com/acconeer/
- - Presence algorithm is described here: https://acconeer-python-exploration.readthedocs.io/en/latest/processing/presence_detection_sparse.html

Module Evaluation Kit
XM112 + XB112

Python Exploration Tool
with presence
algorithms



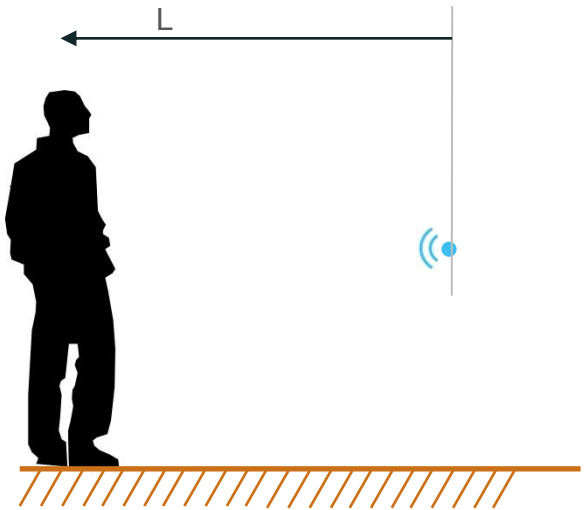
Detecting people approaching

Use Case

- A1 radar sensor pointing toward human.
- Detect human presence when walking toward or passing by
- Detection range
  - No lens up to 3 - 4 m (L) within 30° - 40° beam.
  - Lens up to 6 - 7 m (L) within 10° - 30° beam.

Benefits

- Radar allows to set area of interest
- Robust and reliable for light, temperature, sound or other disturbances.
- Easy integration and design with footprint behind plastic.



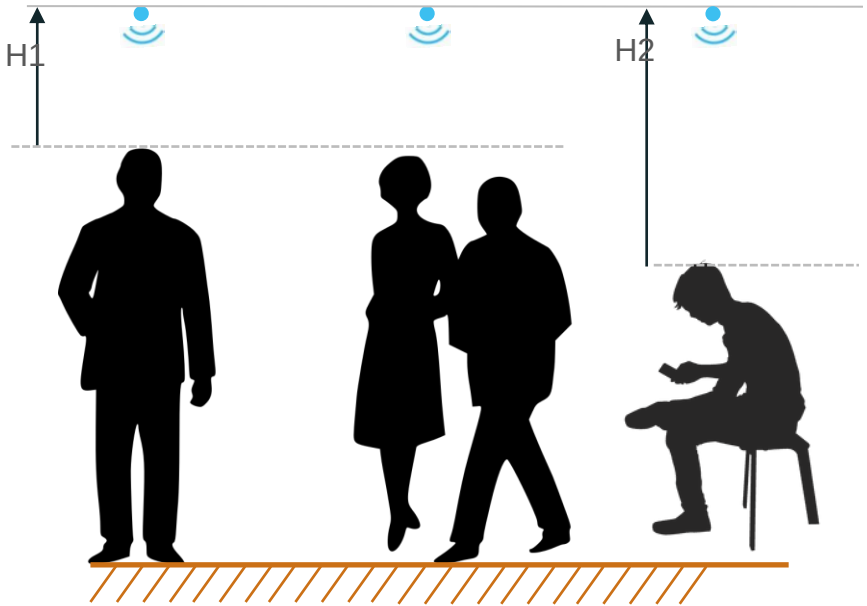
Detecting people from ceiling

Use Case

- A1 radar sensor in ceiling pointing down.
- Detect human presence passing by or standing still.
- Detection range
  - No lens up to 2 - 3 m (L) within 20° - 30° beam.
  - Lens up to 3 - 5 m (L) within 10° - 20° beam.

Benefits

- Robust and reliable for light, temperature, sound or other disturbances.
- Enable algorithms for people movement or standing still, and distance information for people standing, sitting or lying on floor.
- Easy integration and design with footprint behind plastic.



Detecting people enter and exit doors

Use Case

- One A1 radar sensor on doorframe pointing to entrance.
- Detect if human passing in or out from door opening.

Benefits

- Robust and reliable for light, temperature, sound or other disturbances.
- Easy integration and design with footprint behind plastic.

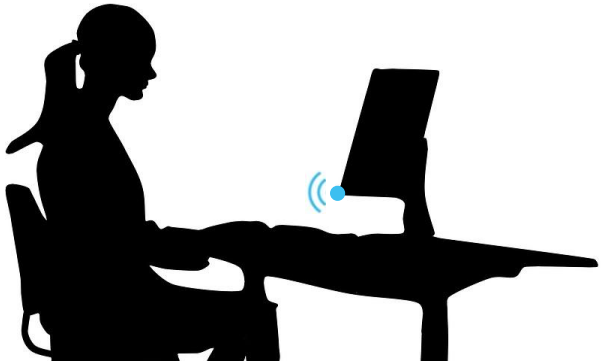
Detecting people at desk

Use Case

- One A1 radar sensor pointing toward human.
- Detect human at desk.
- Detection area of 0.3m to 1m (L) within 60° beam.

Benefits

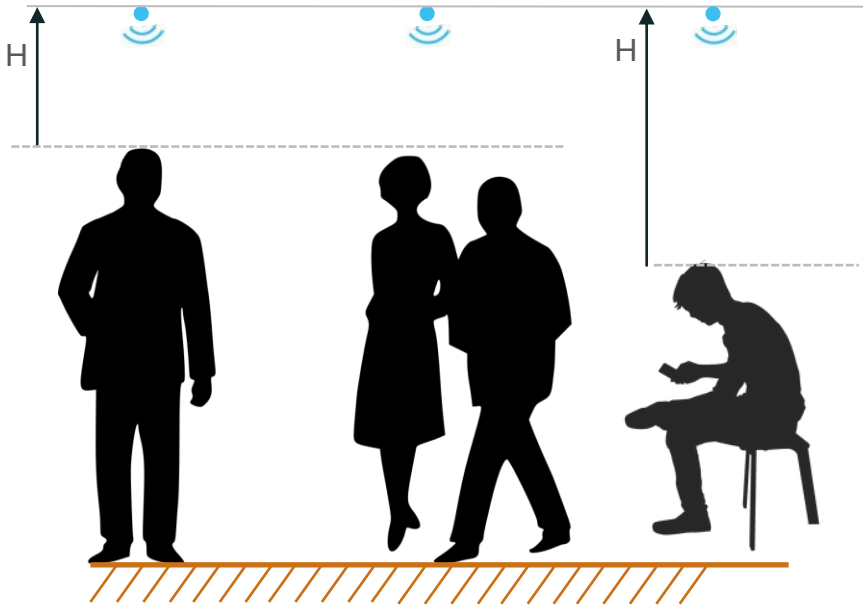
- Detect human even when sitting still due to breathing movements
- Radar allows to adjust detecting range, do not trigger on movements beyond the range.
- Robust and reliable for light, temperature, sound or other disturbances.
- Easy integration and design with footprint behind plastic.



Next step - people counting

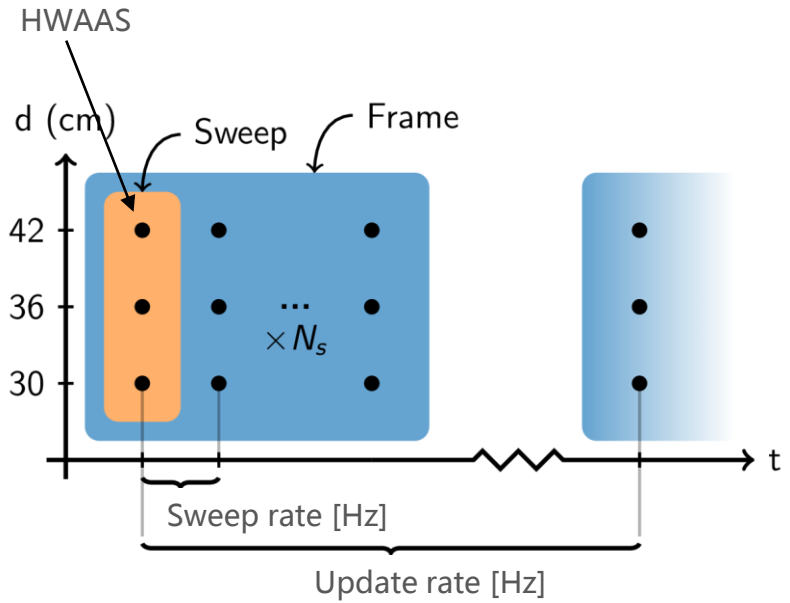
Use Case

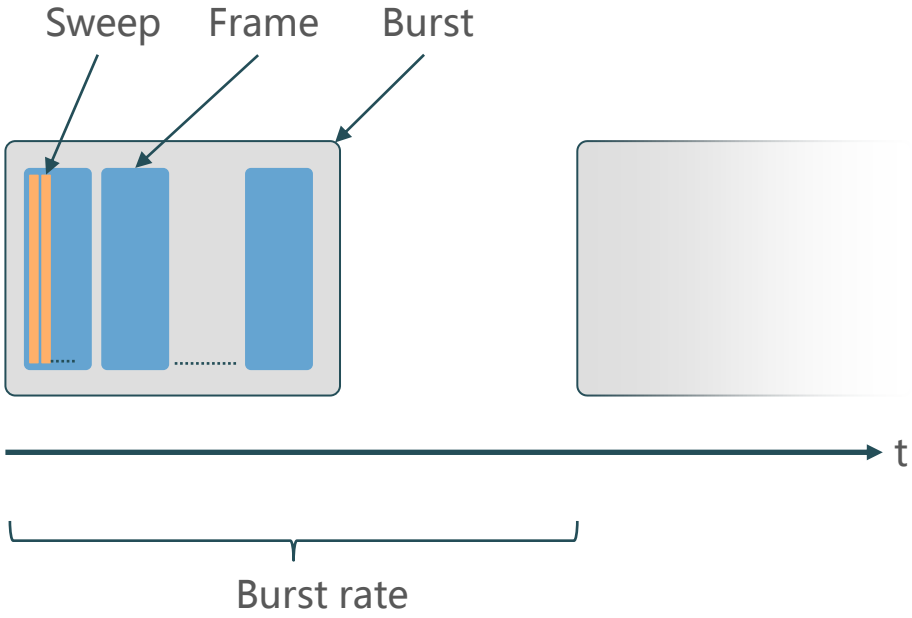
- A1 radar sensor in ceiling pointing down.
- Detect human presence passing by or standing still.
- Detection range
  - No lens up to 2 - 3 m (L) within 20° - 30° beam.
  - Lens up to 3 - 5 m (L) within 10° - 20° beam.
- Each sensor estimates number of people using machine learning algorithm.



Sparse parameter settings

- From sparse service, every received data Frame consists of a number of Sweeps
- Every Sweep consists of one or several sampling points, *HW accelerated average sample (HWAAS),* depending on range and downsampling
- Sweep rate is defined within a frame
- Frame rate is defined by the update rate of frames



Sparse with Burst mode

- A burst contains a number of Frames
- Burst rate: 1 Hz
- Maximal frames per burst: 65
- SNR and time response evaluated for both sitting and standing positions
- Evaluated in two different positions: front right and front right half