Elderly-care Monitoring Sensor Using Stepped-FM UWB Scheme

M. Otsu, R. Nakamura, A. Kajiwara

Graduate School of Environmental Engineering,
The University of Kitakyushu, Japan

Overview

- Background
- Advantages/Challenges of UWB-IR
- Stepped-FM scheme
  - Stepped-FM scheme
  - Detect and Avoid technology
- Elderly-care monitoring sensor
  - Experimental overview
  - Demonstration video of state detection
- Conclusions

Background

- Arrival of increasingly aging society
  - Accidents of the elderly in care facilities are increasing
  - Limited number of nursing staffs

Increased requirements for monitoring their activities

Monitoring systems

Video camera ⇒ Privacy invasion

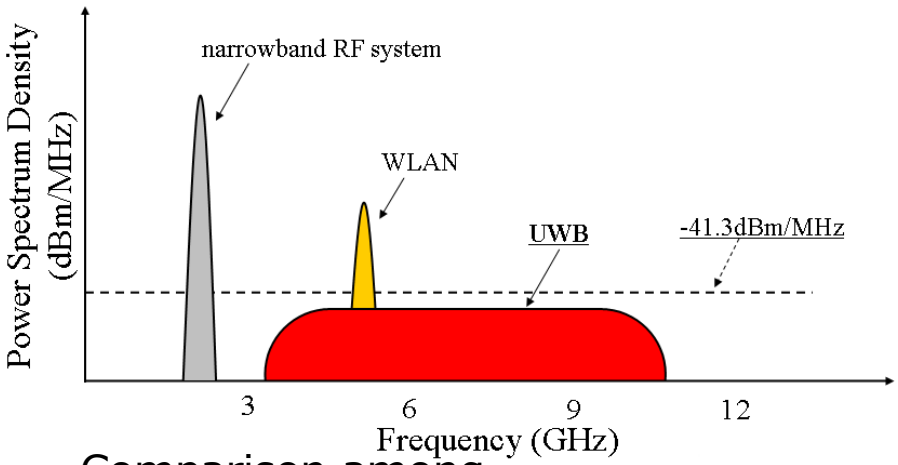
Infra-red ⇒ Small detection area

RFID tag ⇒ Coming off devices

⇒ Ultra-wideband impulse-radio has lately attracted

UWB-IR

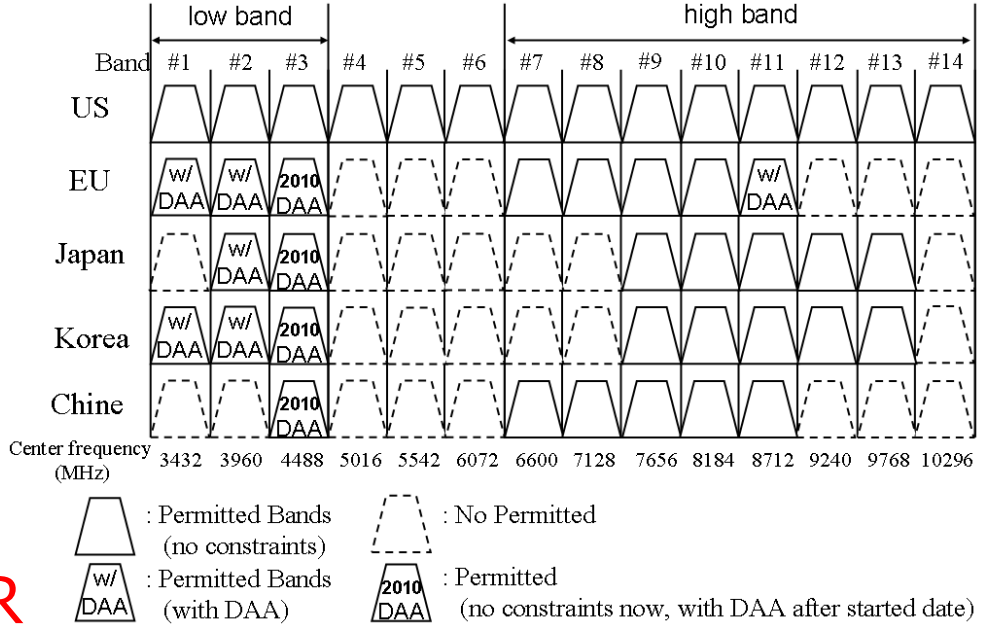
- Advantages
  - High range-resolution
  - Low power emission
  - Penetration agaist clothes and blanket



Comparison among UWB and other narrowband systems

- Challenges
  - High speed A/D devices
    ⇒ several GS/s required
  - UWB regulation
    ⇒ DAA technology required

*DAA: Detect and Avoid



UWB regulation

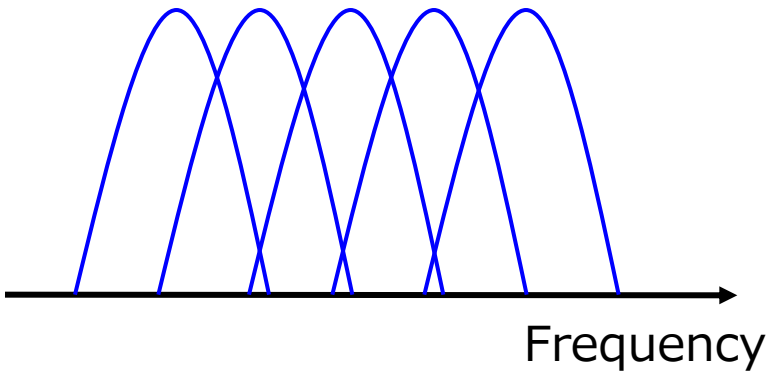
⇒ Stepped-FM scheme based UWB-IR

Stepped-FM scheme

- Transmitted signal

  Composed of monotone pulses with different frequency by Δf

  ⇒ Similar to stepped CW of VNA



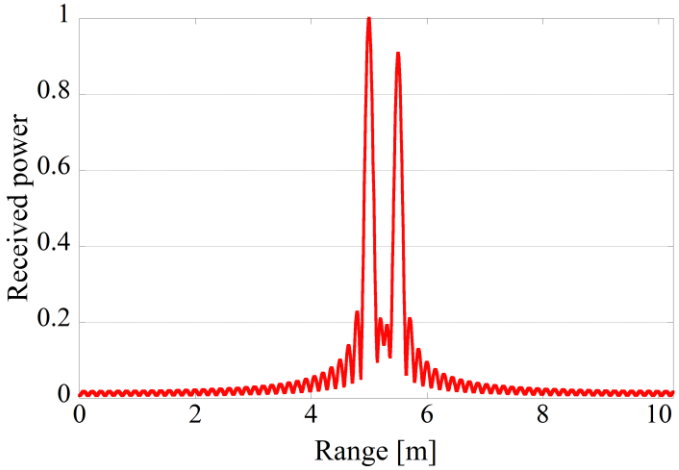
- Bandwidth

  Wider bandwidth to synthesize several monotone pulses

  ⇒ Low speed A/D devices

- Resolution

  High resolution by signal processing

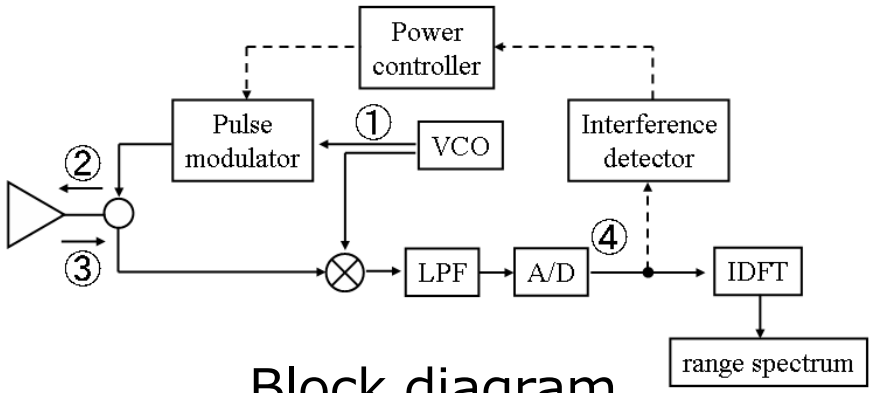


Range spectrum
(target :5m, 5.5m)

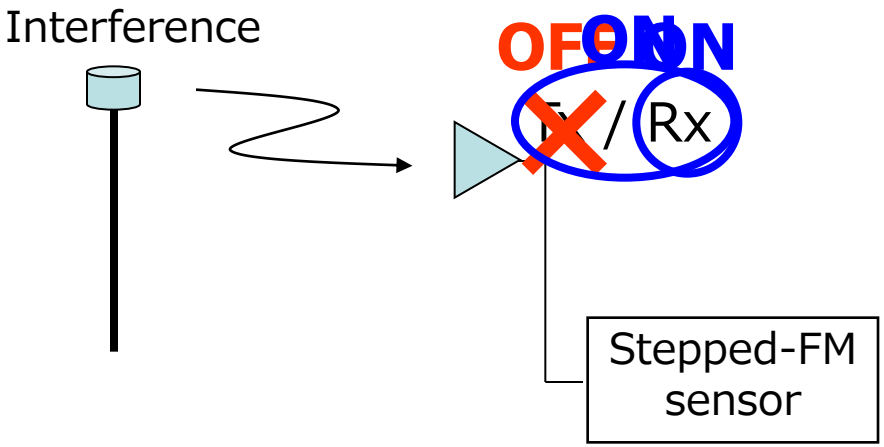
- Inherent DAA capability
  - Detection of interference
  - anti-interference

  ⇒ without additional DAA devices

DAA of stepped-FM scheme

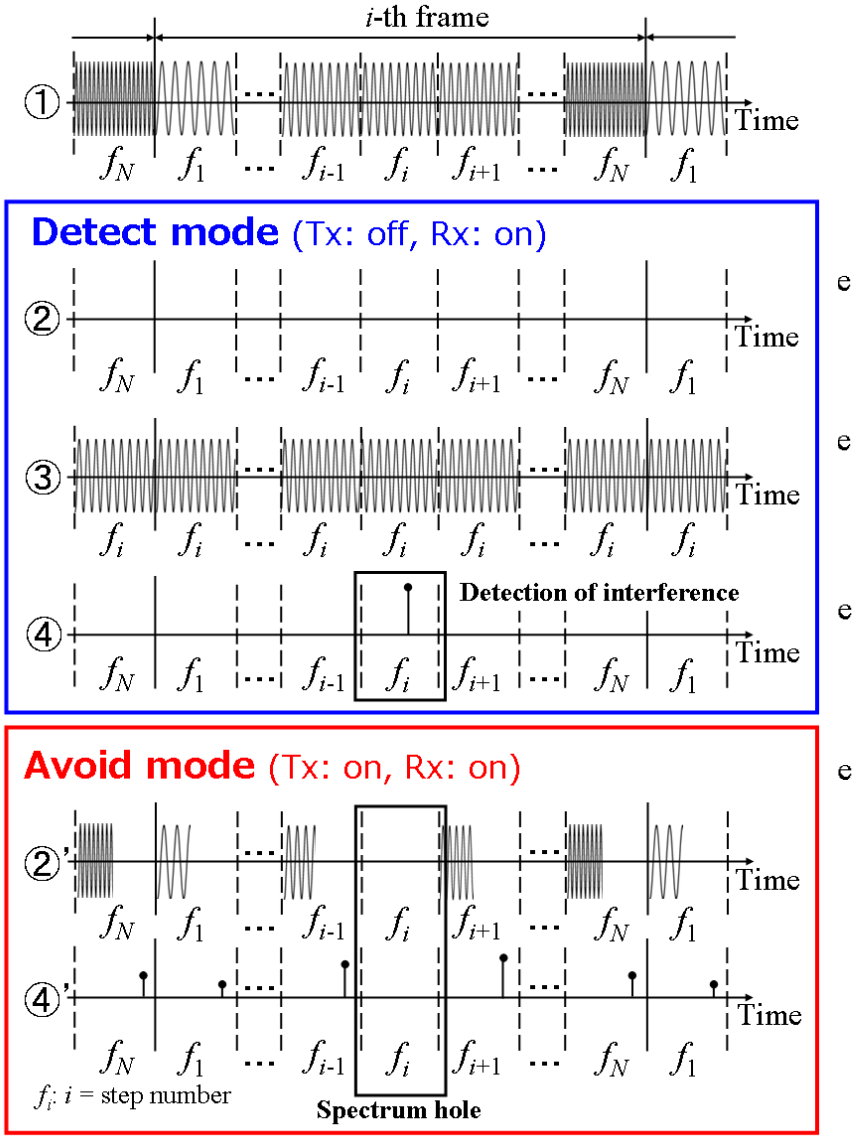


Block diagram



Schematic view

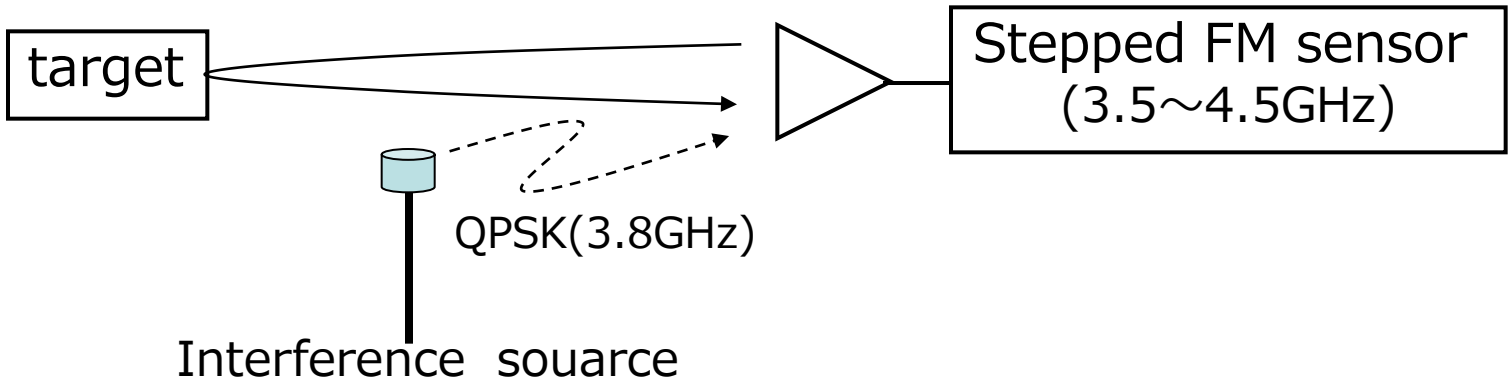
⇒ **Empirical Study**

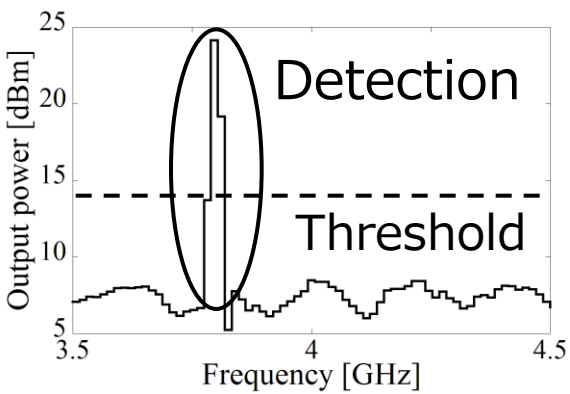


Stepped-FM scheme with DAA

Empirical Study of DAA

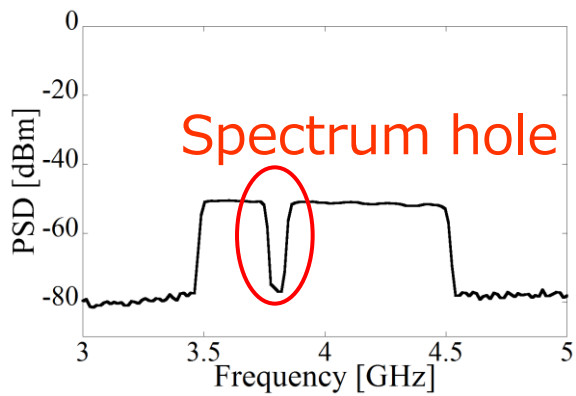
- Results





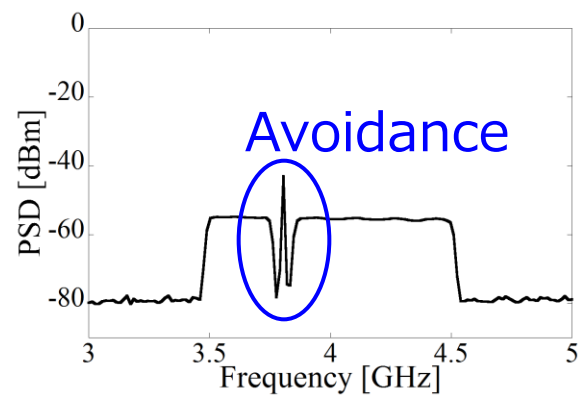
Interference output

(Detect mode)



Transmitted signal

(Avoid mode)



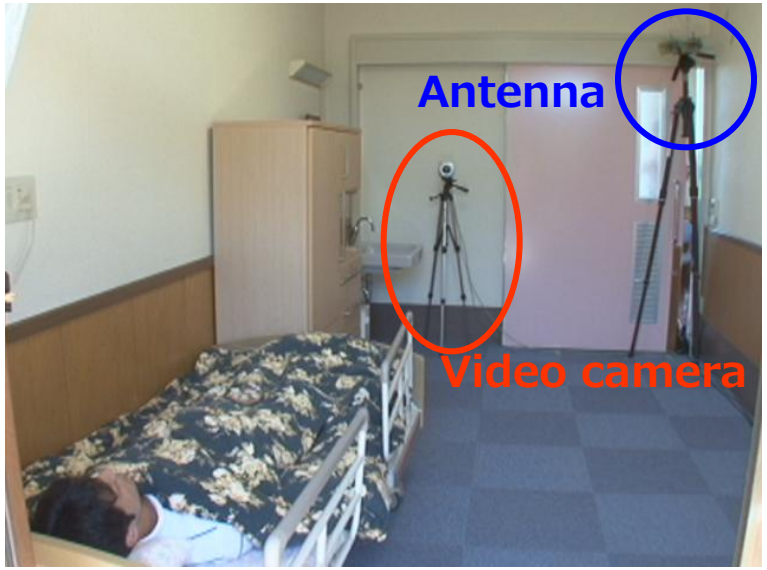
Received signal

(Co-exist mode)

⇒ coexist with exiting radio systems

Elderly-care monitoring sensor

Care facility



Scene for measurement environment

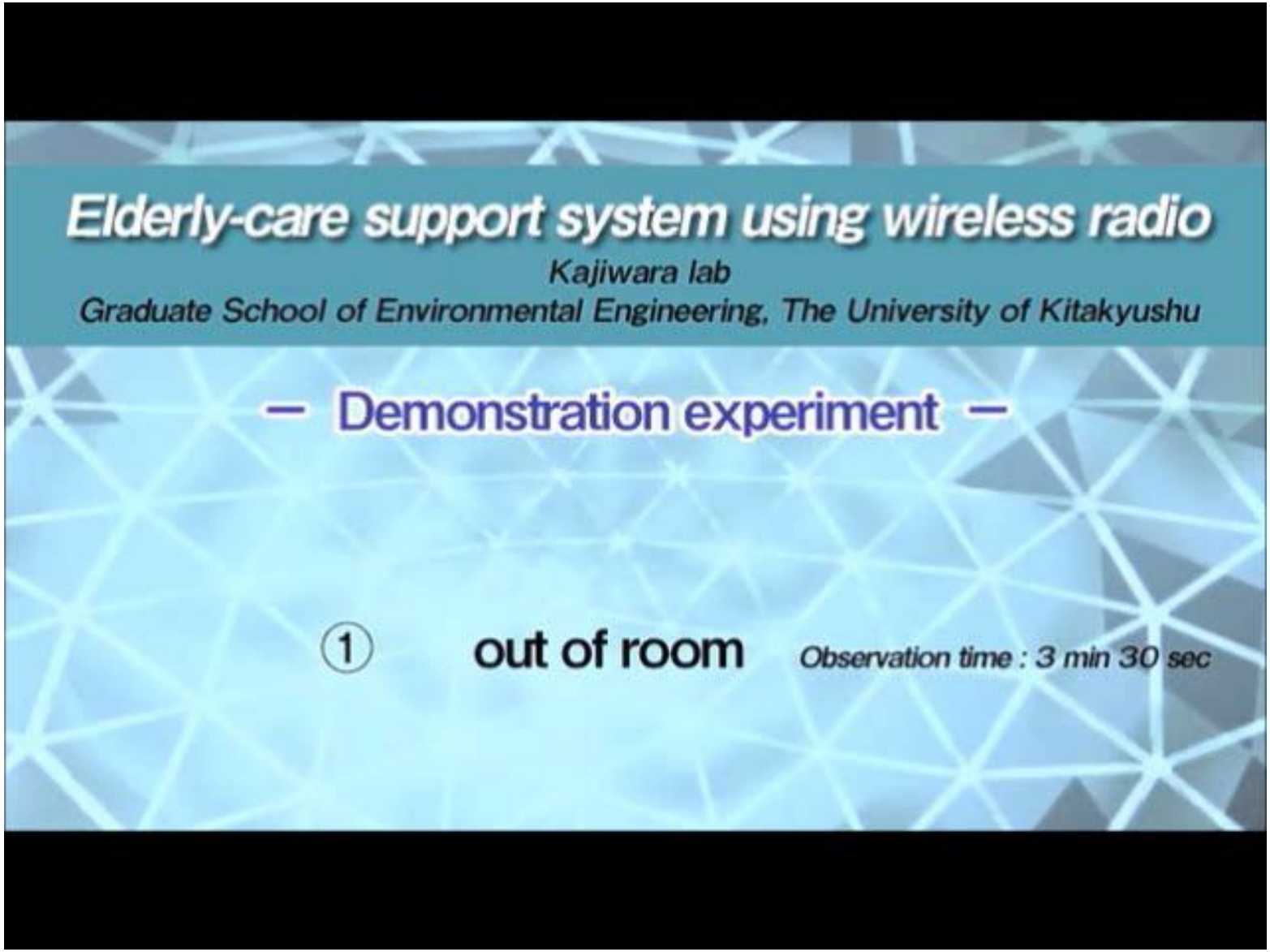
Specification

Transmitted power	-12.5dBm
Frequency band	3.5～4.5GHz
Stepped width Δf	14.5MHz
Number of step N	70
Frame period	0.2sec
A/D	70KS/s
antenna	Horn(9.88dBi)

Detected state

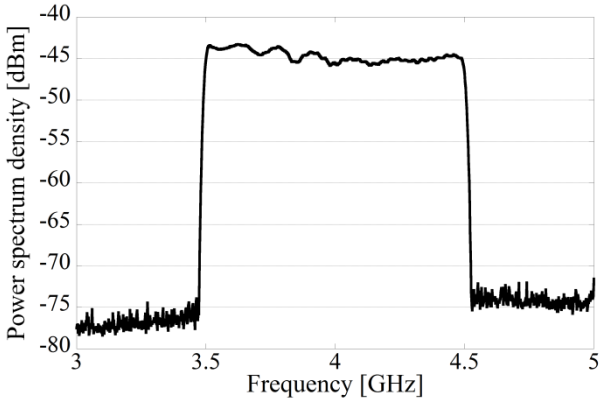
- fall
- sitting up in bed
- tossing about in bed
- sleeping in bed
- walk in room
- static
- out of room

Demonstration video



Measurement results

- Detection rate



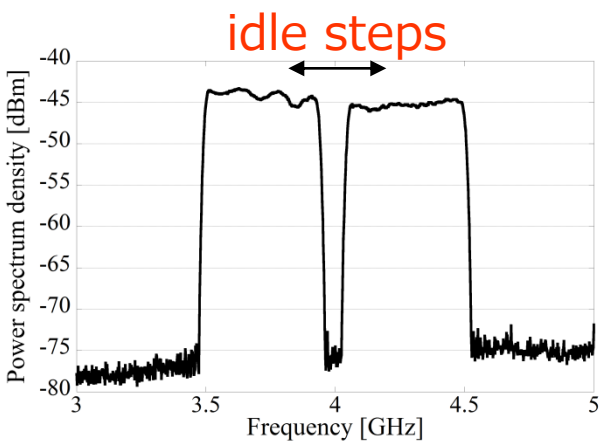
Transmitted signal

State	Detection rate [%]
out of room	100
sitting up in bed	100
fall	100
others	99.07
average	99.23

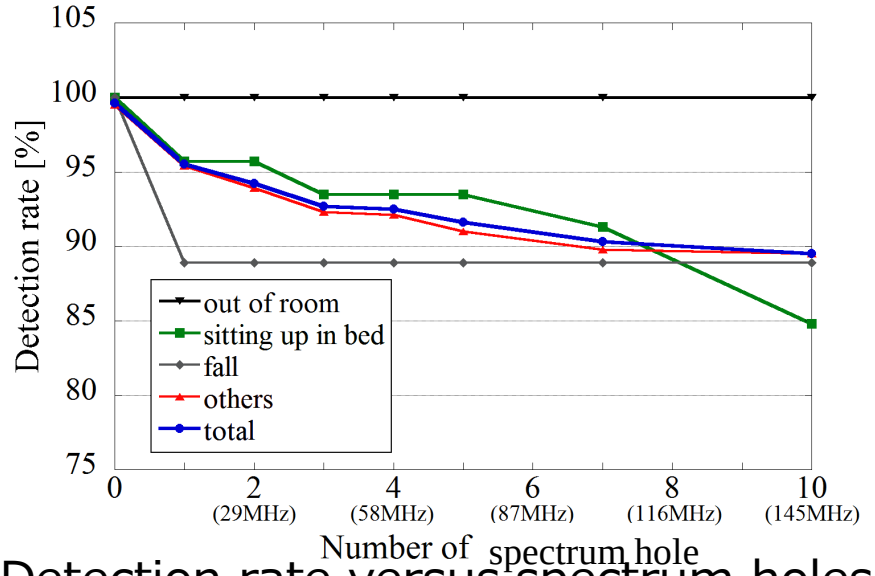
*others (tossing about in bed, sleeping in bed, walk in room, static)

*threshold : FAR = 10^{-3}

- DAA capability



Transmitted signal



Detection rate versus spectrum holes

Conclusion

- DAA of stepped-FM scheme has been proposed
  - Interference detection capability
  - Coexistence capability employing spectrum holes

- Elderly-care monitoring sensor has been suggested
  - Measurement in care house
  - Good detection performance
    - higher than 99% without hole
    - approximately 85% for a hole of 145MHz