

SMART RADAR SYSTEM

mmWave Radar Sensor

2021. JULY



**SMART
RADAR
SYSTEM**

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 - : RETINA-4ST (RETINA-4SN)
 - IRIS c/t
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SMART RADAR SYSTEM

To See the Unseen

Company Overview

Company	SMART RADAR SYSTEM Inc.
Established	October, 2021
CEO	Paul Kim
# Employee	51
Business Area	mmWave Radar Sensor Solution for Automotive, Industrial Safety, Healthcare, Traffic Monitoring & Logistic Automation
Location	Headquarter) Pangyo, Gyeonggi-do, Korea R&D 2) Seoul National University Siheung Campus USA Branch) Irvine, California, USA
Website	www.smartradarsystem.com

Business Area



Automotive



In-Cabin



Industrial Vehicle



Smart Factory



Smart Office



Smart Traffic



Healthcare



Weapon Detection



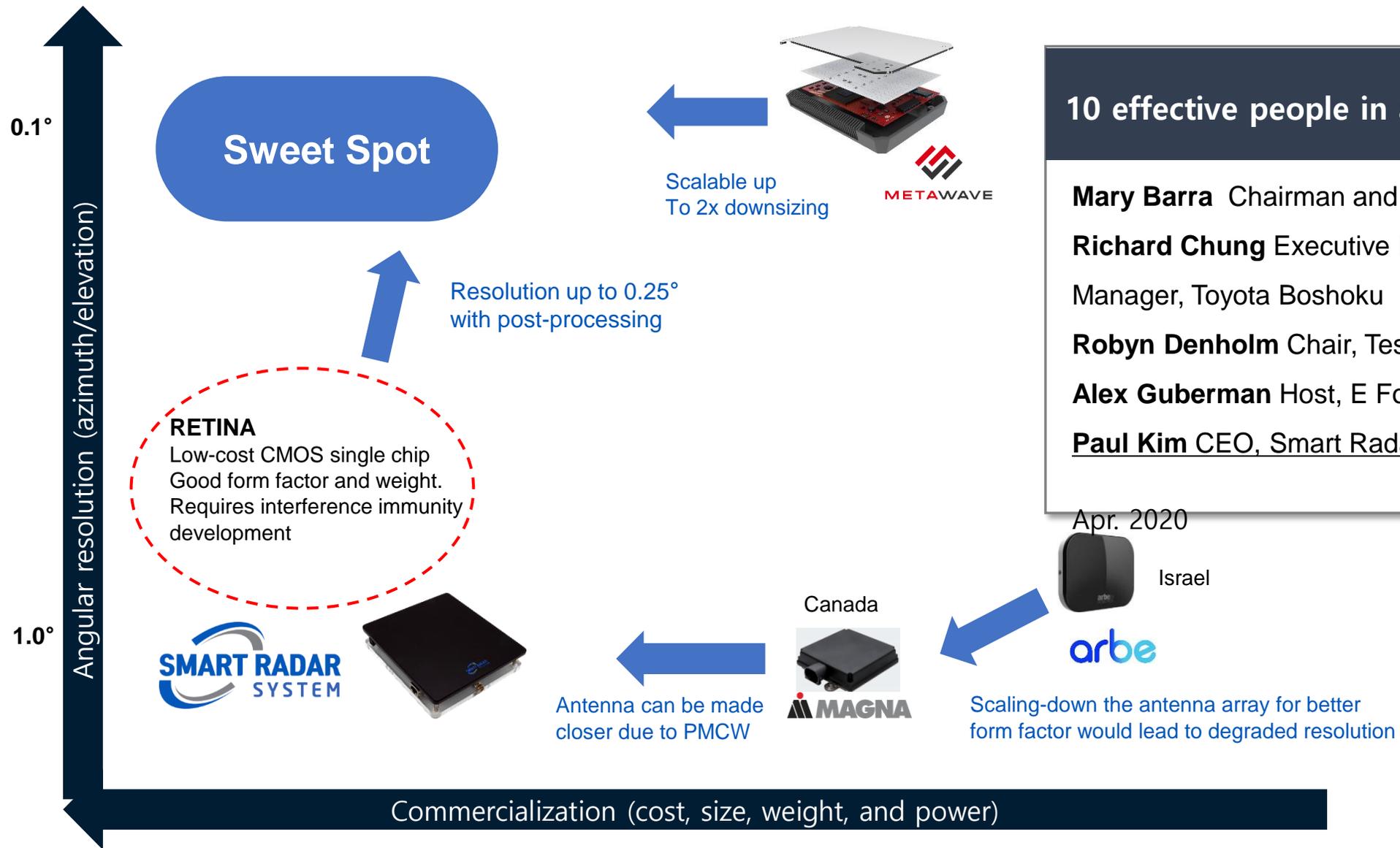
Drones



Robotics

POWERFUL PLAYER in AUTOMOTIVE INDUSTRY

To See the Unseen



10 effective people in automotive industry

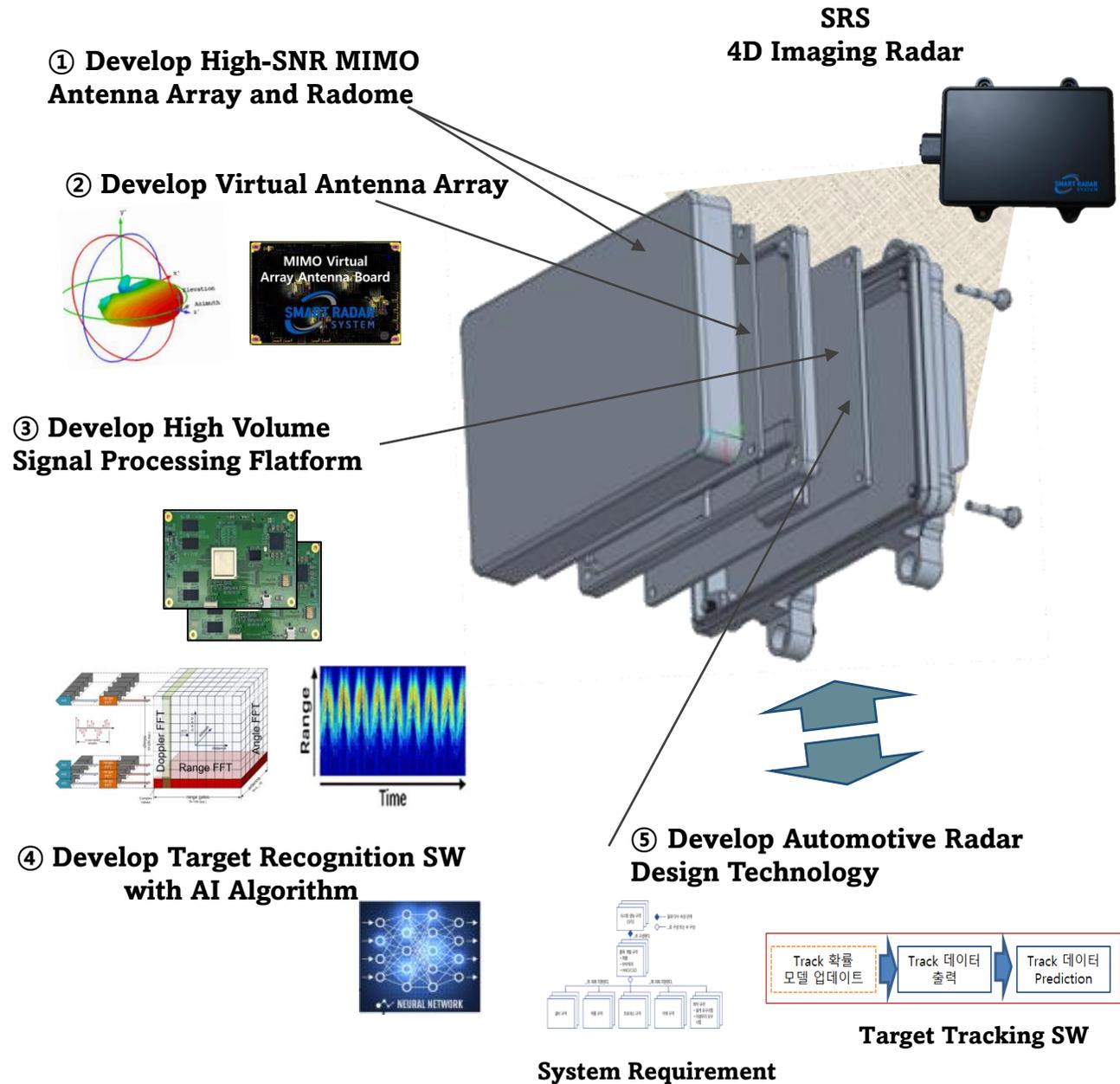
- Mary Barra** Chairman and CEO, General Motors
 - Richard Chung** Executive Product Program Manager, Toyota Boshoku
 - Robyn Denholm** Chair, Tesla
 - Alex Guberman** Host, E For Electric
 - Paul Kim** CEO, Smart Radar System
- LinkedIn,

Apr. 2020

*RETINA (Radar Enabled True Imaging by Neural Analysis): 4D image radar developed by Smart Radar System, Inc.

THINK DIFFERENT and ADVANCED RADAR SOLUTION

To See the Unseen



Item	Advanced Features and Technologies
Radar Chipset	Using Globally Field Proven Radar (Reliable Chipset Supply)
Antenna Array	Unique Antenna Array - Achieved the same leveled performance with smaller numbers of antennas (70% less than competitor)
Radar Signal Processing	Core Technology (converting the data acquired by uniquely arrayed antennas to uniformed data)

READY FOR SMART CITY

To See the Unseen



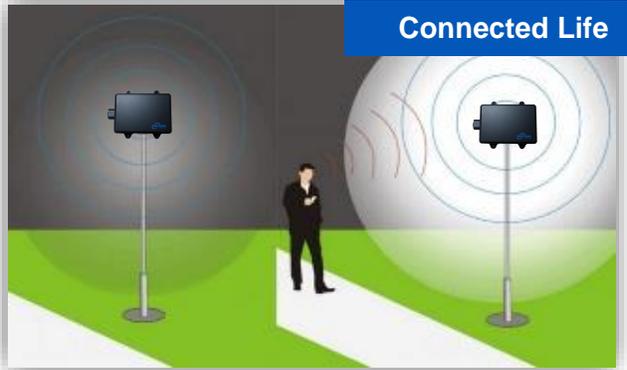
FMTC (Future Mobility Technical Center)
Seoul National University



서울대학교
SEOUL NATIONAL UNIVERSITY



Autonomous Driving



Connected Life



V2C Infrastructure



Public Safety



Public Healthcare



School zone

Smart Radar System Inc.

4D IMAGING RADAR for AUTONOMOUS

To See the Unseen

Building up autonomous driving data with 4D imaging radar under the cooperation with Seoul National University and Siheung City.

SRS 4D Imaging Radar



Autonomous driving route in Siheung City



IONIQ (BEV) with 5 pcs of 4D Imaging Radar (LRR, SRR)



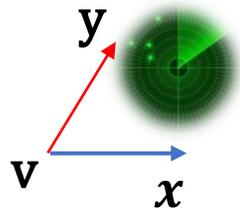
Autonomous Driving Bus with 7 pcs of 4D Imaging Radar

3D & 4D RADAR SOLUTION

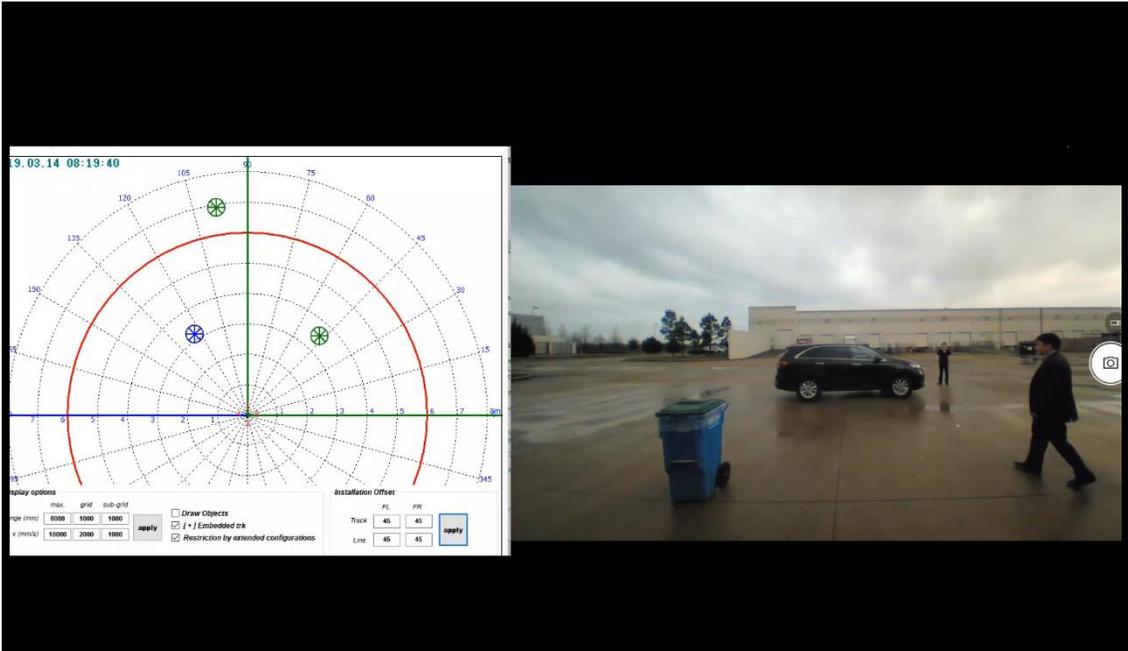
To See the Unseen

From Points to Images, and adding Deep Learning Algorithm

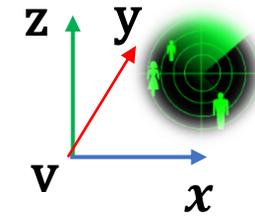
3D Point



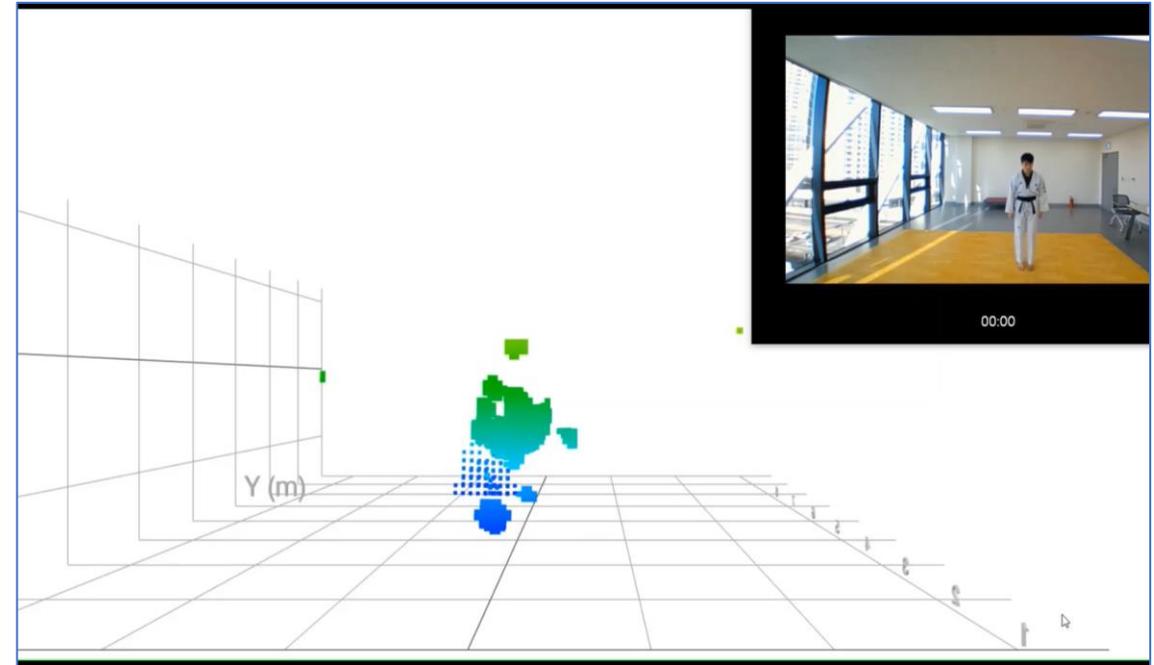
Traditional Radar : X, Y value + Velocity



4D Point Cloud



4D Image Radar : X,Y,Z value + Velocity



Smart Radar System Inc.

2. APPLICATION

- Healthcare**
- Industrial Safety**
- Smart Places**
- Automotive**
- Others**

Improve Patients Safety and Health

To See the Unseen



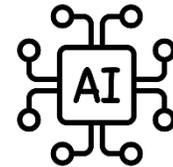
No Invasion of Privacy



No Need of Light



No Need to Wear



Deep Learning



Continuous Working (24/7)



Patient Monitoring



Fall Detect

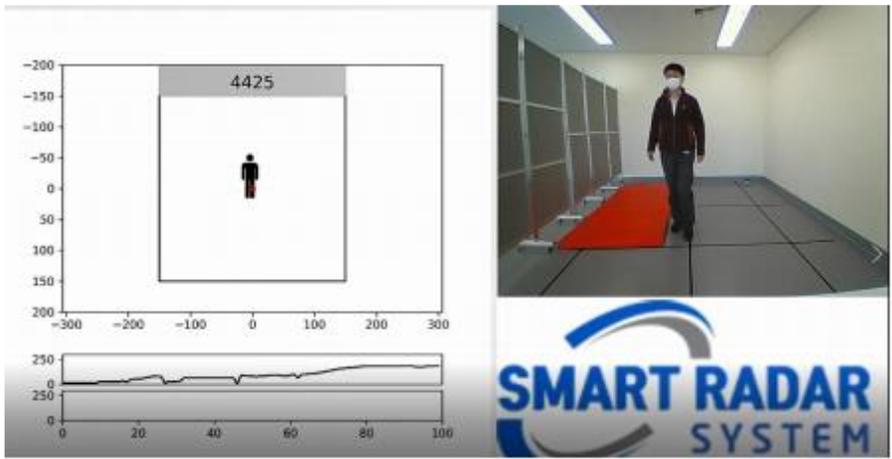
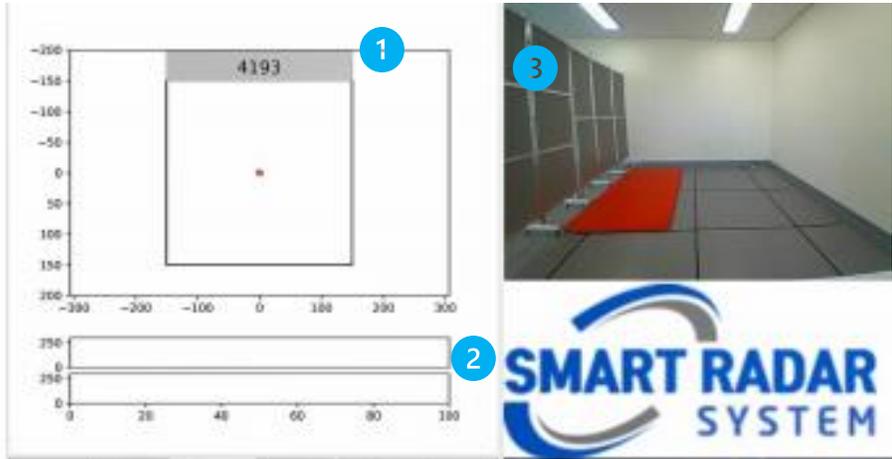


Patient Presence



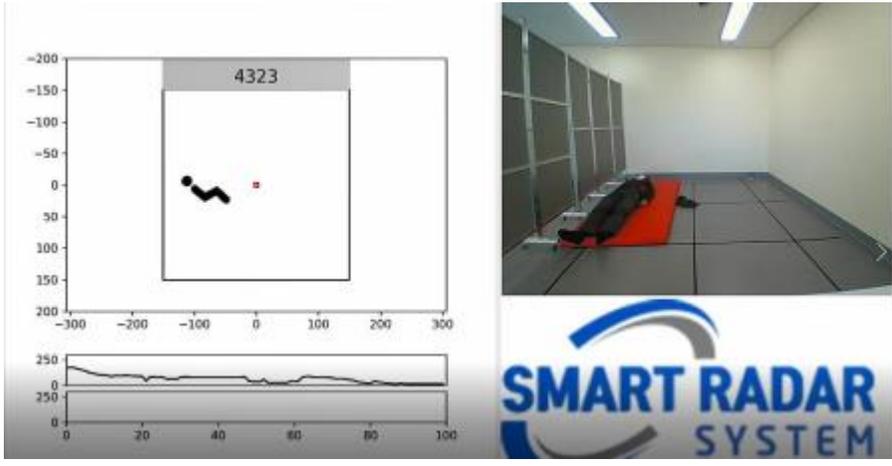
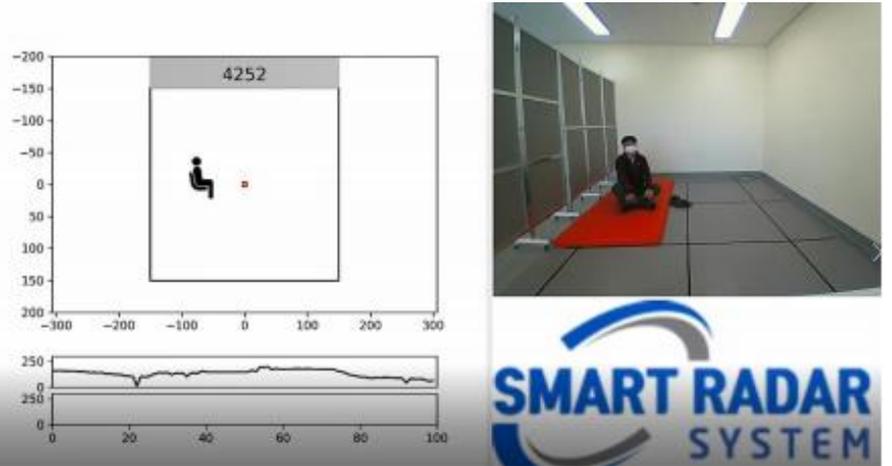
Movement at Night

DEMO Case with RM68 Series – Posture Detection



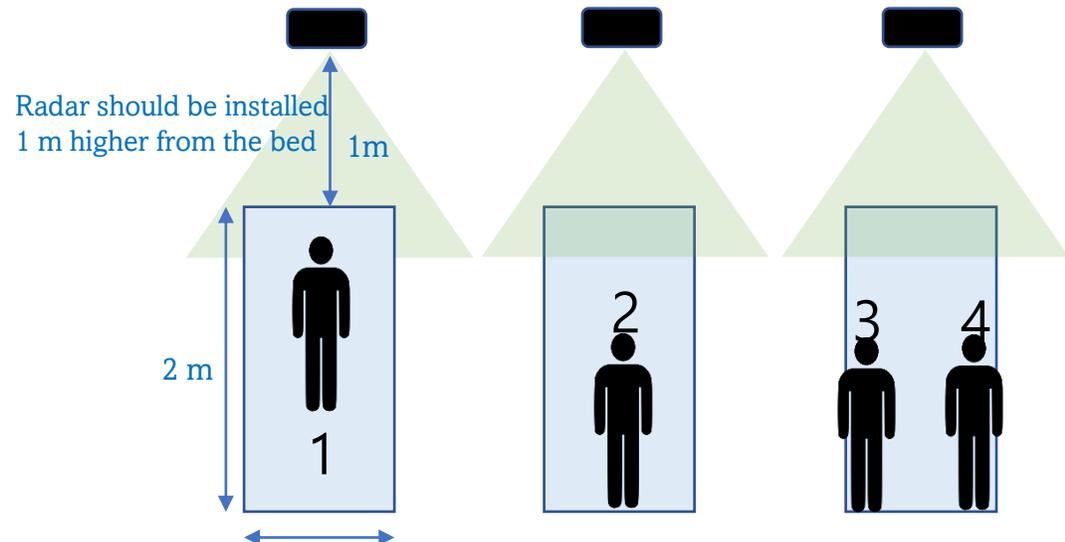
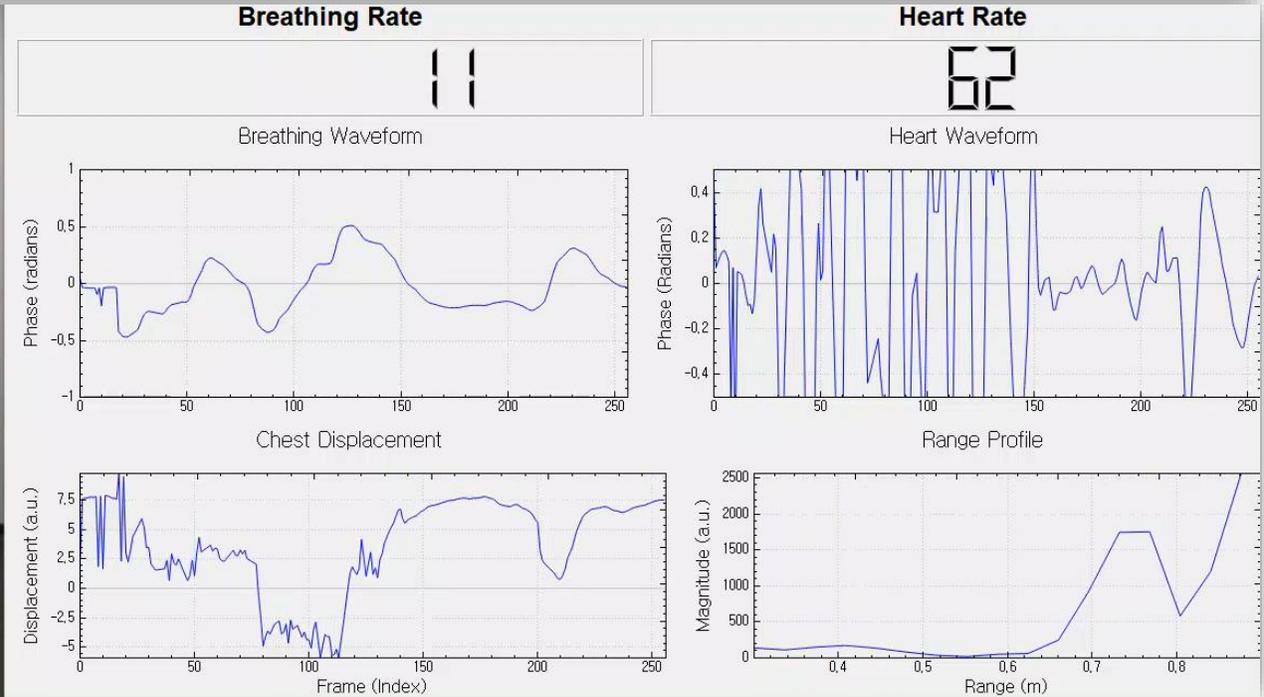
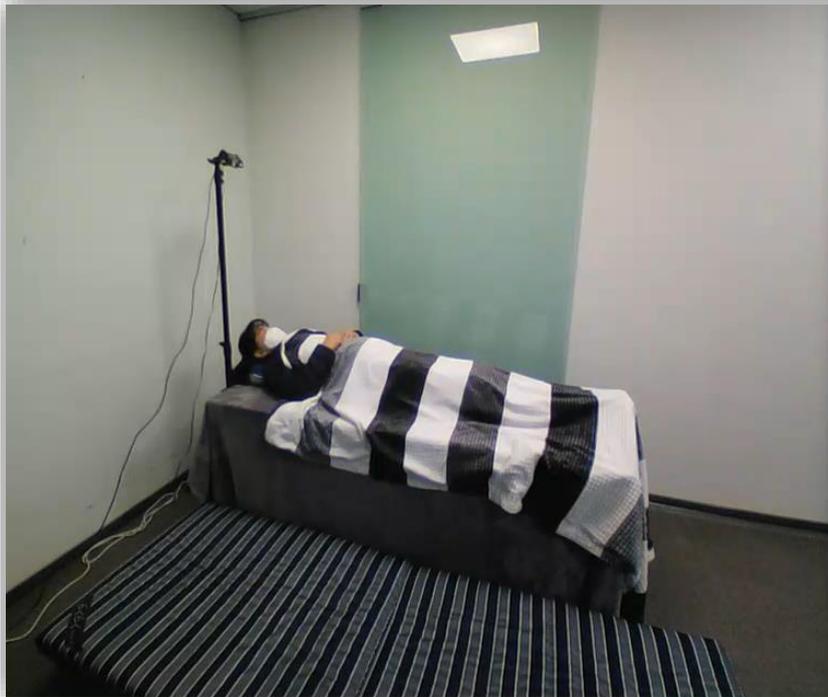
- 1 Location information plane to see the X-Y location of the target & object
- 2 Height information plane to track the object/target's height information
- 3 Camera GUI to see the test (External Camera & Viewer)

Case : Standing



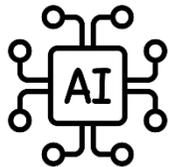
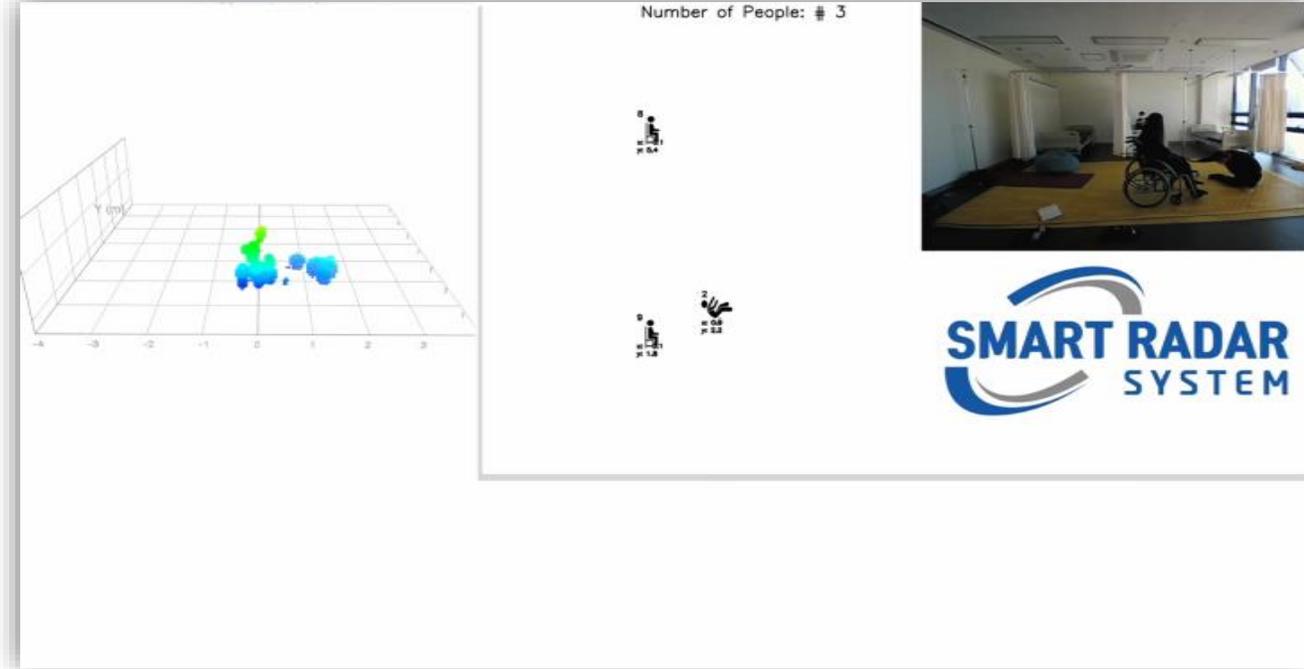
VITAL SIGN DETECTION with RADAR

To See the Unseen



FALL and POSTURE DETECTION with 4D IMAGING RADAR

To See the Unseen



Fall Detection and Bed Side Detection with 4D Imaging Radar
GUI Screen with Deep Learning Algorithms

RADAR SOLUTION for INDUSTRIAL SAFETY

To See the Unseen



Construction Vehicles

Street Sweeping Car



People safety is number one priority

IRISc and IRISr can keep workers safe around heavy machinery. Due to its unique antenna characteristics, it can make the better performance in terms monitoring blind area.

It surely works to prevent accidents and collisions which in-turn improves overall productivity and efficiency.

RADAR SOLUTION - IRISc & IRISr

To See the Unseen

Preventing unexpected accident caused by blind spots of industrial vehicles



IRISc (100° FoV)



IRISr (180° FoV)



RADAR SOLUTION for INDUSTRIAL SAFETY

To See the Unseen

Construction / Agricultural



Before using radar solution :
Too many sensors with limited coverage



Using radar solution (IRIS_t) :
2 Radars on front and backside with the coverage of
180 ° Field of View



“V” construction (US)
- Mass production started



“S” construction (JP)
- Under Discussion



“K” Agricultural (JP)
- Proposal stage
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Restroom Solution



People Detection

Home Solution



People Counting



People Tracking

Office Solution



Fall Detection

APPLICATION : PUBLIC TOILET

To See the Unseen

Protect an elderly person, handicapped and worker from any risk in public place



서울도시철도 8호선 노선도
Seoul Metro Line 8 Route



Fall Detection Safety Counting People Tracking

Toilet

RESTROOM

Smart Restroom Solution



Installed radars in Toilets of subway line #8 of Seoul metro

Smart Radar System Inc.

Application: V2C Infrastructure

To See the Unseen

Smart Radar System is already used in United States Intersections for V2C Infrastructure support

UTC Time		Local Time		Objects	Total Delay
16:13:46 PM		09:13:46 AM		1	0

Vehicles Counters																	
person		car			truck			bus			motorcycle			bicycle			
→	←	↙	↘	↖	↗	↘	↙	↗	↘	↙	↗	↘	↙	↗	↘	↙	↗
0	0	7	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0

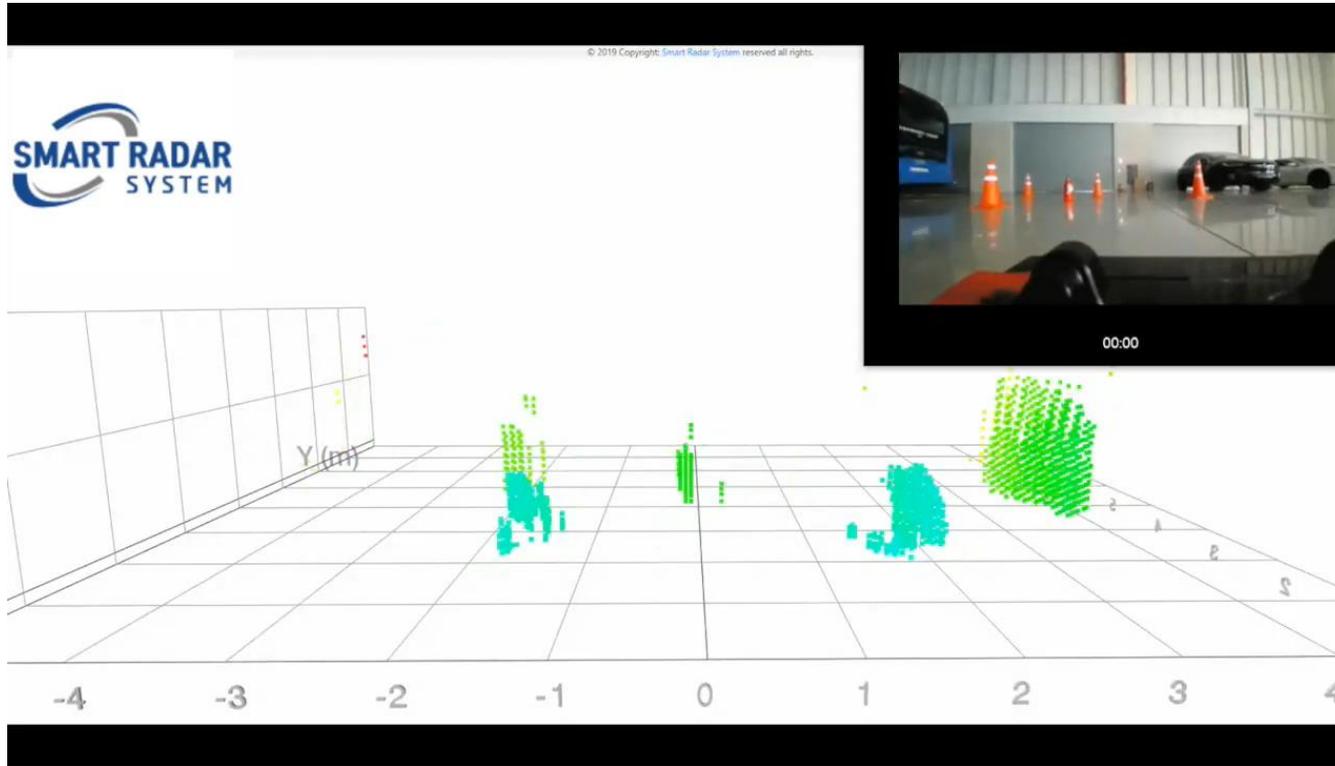
Upload to S3

Show Detections Ped Init track Track Lanes Stop line Parking Trajectories Crop(det)

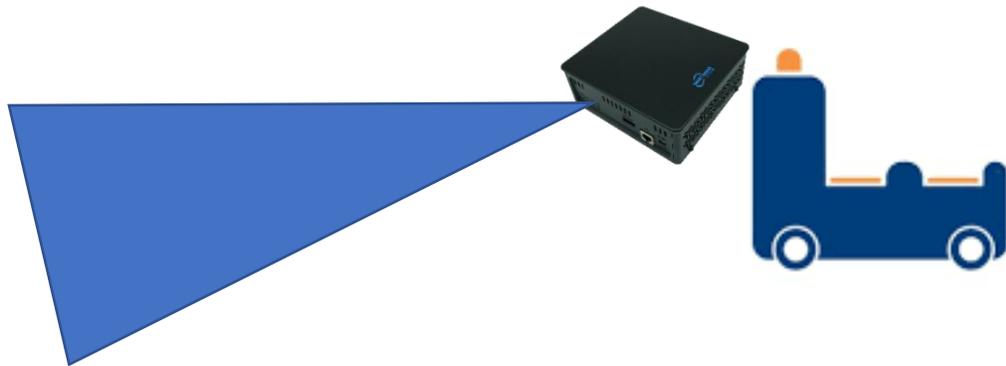


Application: Last Mile Delivery

Last Mile Delivery is Essential to Smart City Ecosystem.



REFRACTION AI



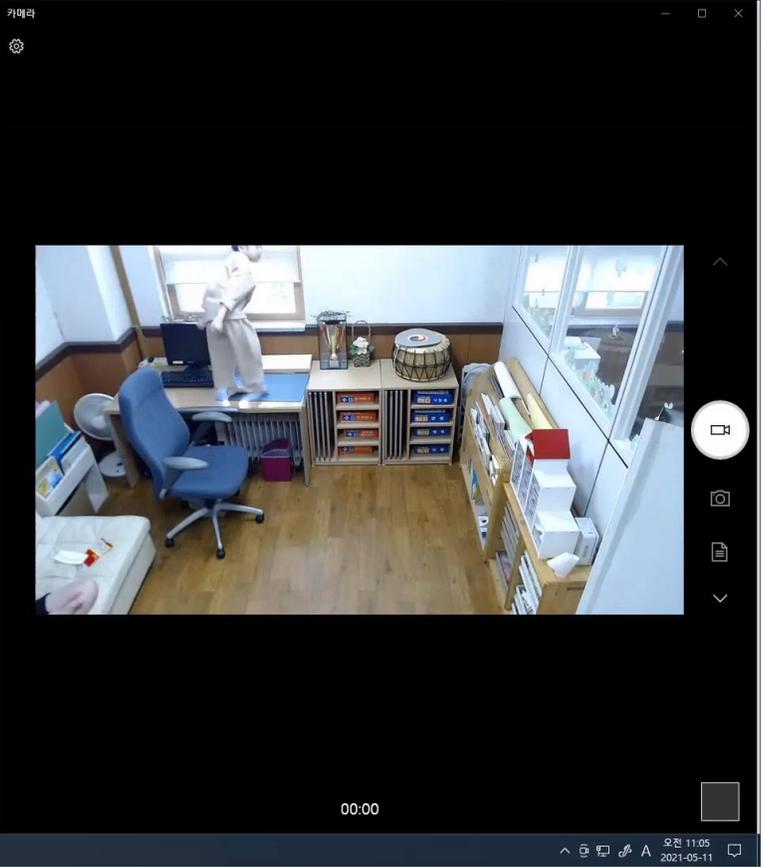
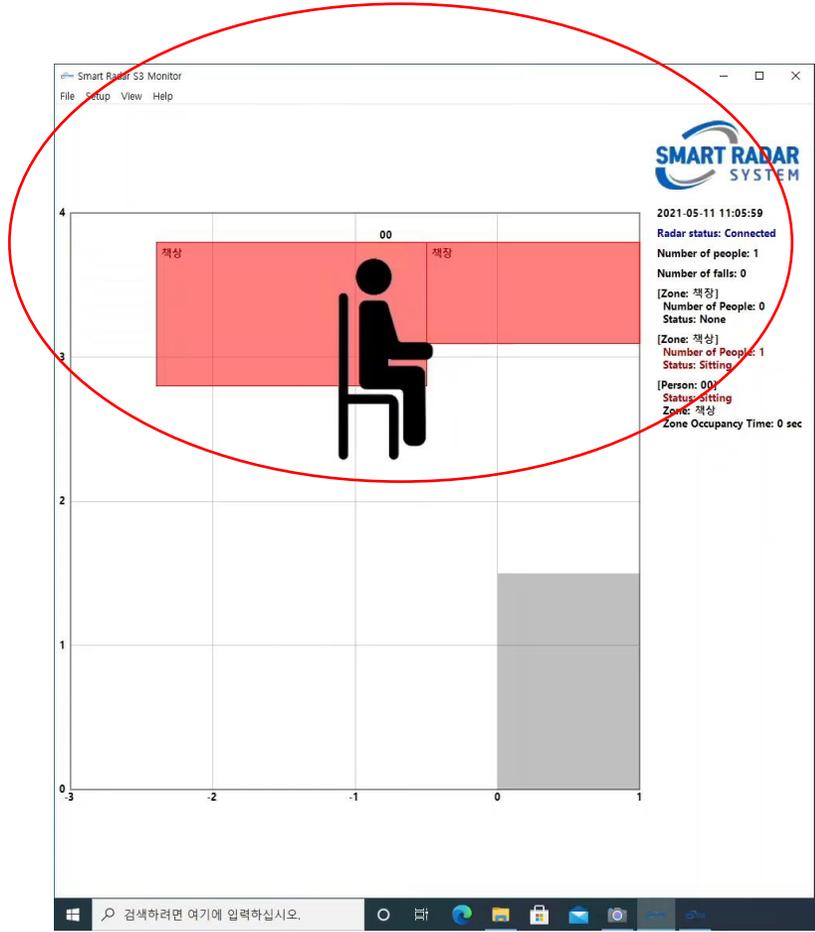
VIRTUAL FENCE FOR SURVEILLANCE AREA

To See the Unseen

- ▶ Detect People In/Out
- ▶ People Counting
- ▶ Virtue Fence for Surveillance Area



RETINA-4ST
Ethernet or WiFi



RADAR for AUTONOMOUS DRIVING

In-Cabin Solution

Fine motion detection by a radar can monitor breathing and heart rate to help determine whether the driver is awake, providing an essential measure of safety as automated driving –and the tendency to nod off. Safety is also at issue if a baby becomes locked inside a hot car; a radar sensor

In-Cabin Application Overview



Front Side Application

Vital Sign Monitoring

AWR1843 AcP: 79GHz(77-81GHz)

IWR6843 AcP: 60GHz(60-64GHz)

RETINA-2S: 79GHz(77-81GHz)

RETINA-4S: 79GHz(77-81GHz)



Posture Detection

RETINA-2S: 79GHz(77-81GHz)



Upper Side Application

Passenger Localization

AWR1843 AcP: 79GHz(77-81GHz)

IWR6843 AcP: 60GHz(60-64GHz)

RETINA-2S: 79GHz(77-81GHz)

RETINA-4S: 79GHz(77-81GHz)



Adult / Baby Classification

RETINA-2S: 79GHz(77-81GHz)

RETINA-4S: 79GHz(77-81GHz)



- **RM-68-##**
- Vital Sign/Heart Rate/ People Count
- 60-64GHz
- Radar Module with embedded DSP
- Onboard patch antennas : 3Tx & 4Rx
- CAN interface

RADAR for AUTONOMOUS DRIVING

Autonomous Driving

mmWave radar can support ADAS (Advanced Driver Assistance System) with its highly precise sensing performance and the steady development of automatic operation. Radar's unique ability to see at night and through poor environmental conditions make mmWave a key component of the vehicle's overall sensing complex.



RETINA-4F 4D Image Radar

- 77-81GHz
- Long/Short/Ultra Short
- Azimuth FoV : 10 ° & 90 °
- Elevation FoV : 24 °
- CAN-FD, 1G Ethernet

Moving forward to advance Level 4 of autonomous driving with ultra-high resolution 4D Imaging Radar

Mando to localize ultra-high resolution 4D imaging radar by 2023

(<https://pulsenews.co.kr/view.php?year=2021&no=540191>)



Mando Corporation has partnered with startup Smart Radar System Inc. (SRS) for joint development of an ultra-high resolution 4D imaging radar (radio detection and ranging) module by 2023 to localize the key component for self-driving vehicles, the Korea-based auto parts maker announced on Friday.

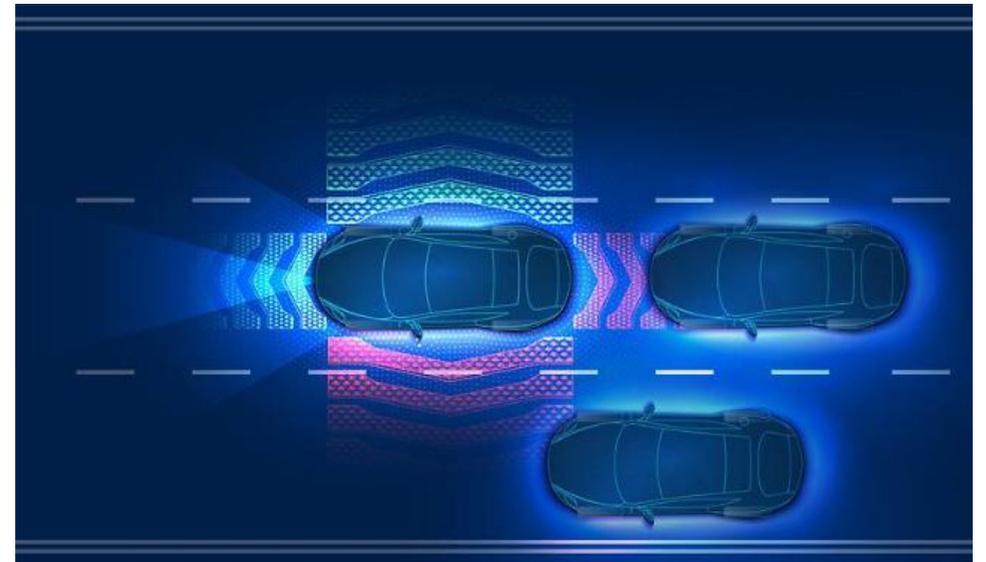
SRS is a local startup dedicated to image radar technology for automotive and industrial applications and has developed 4D image radar technology for self-driving vehicles.

A 4D imaging radar prototype to be jointly developed by the two companies will be designed with 768 channels, featuring four times higher resolution than those from global competitors.

A 4D imaging radar is created by a technology that implements a radar target using point clouds into a 4D image, making the shape clearly and accurately marked compared to 3D image radars.

Mando succeeded in localizing the `adaptive cruise control (ACC)` long-range radar for the first time in Korea in 2014, and currently has a third-generation radar lineup applicable to autonomous driving level 3, including the `automatic emergency brake (AEB)` medium-range radar. Mando said the 4D imaging radar represents the beginning in efforts to develop the industry's 4th generation radar.

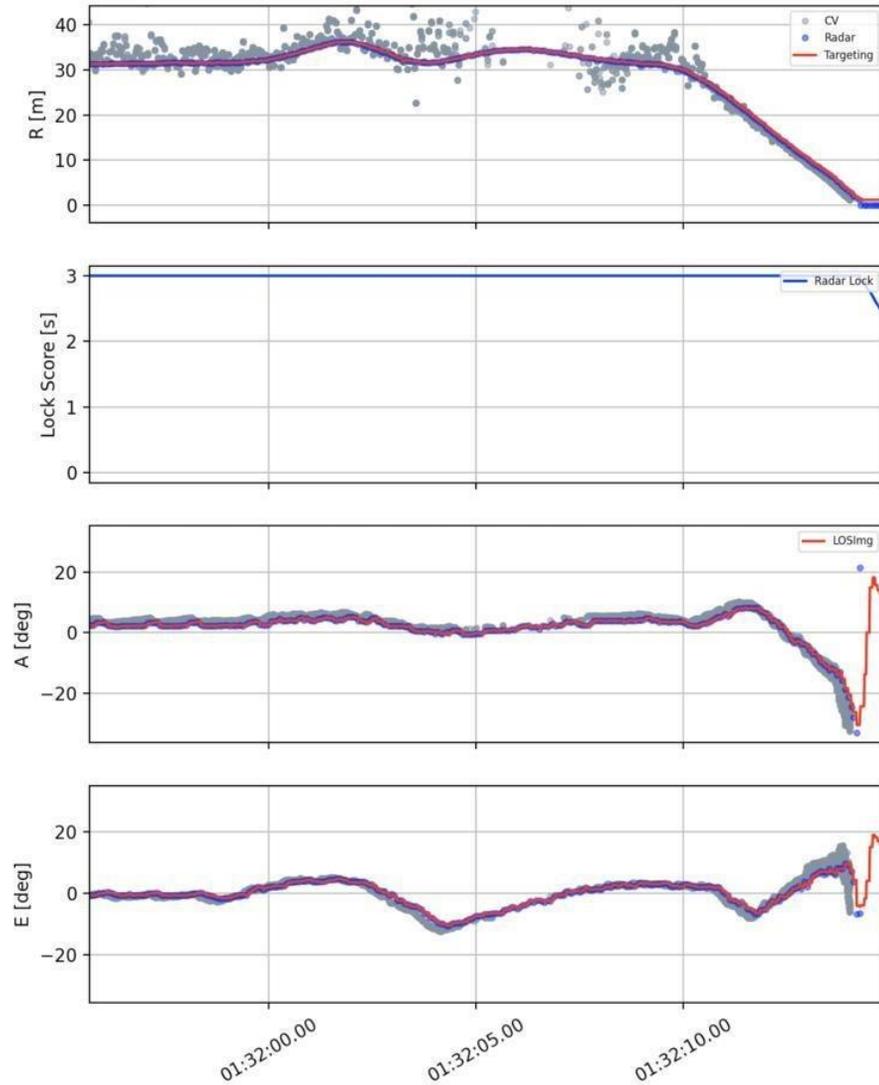
Starting with the development of 4D imaging radar modules for autonomous driving, the two companies plan to expand cooperation in various sectors such as smart city and smart factory solutions, and robots.



[Gettyimages Bank]

ANTI DRONE SOLUTION : Detect Enemy Drones in the Air

Tracking, Sensor Frame



RETINA-4A*

70m ~ 100m



Can detect the Enemy Drone across all inclement weather like rain snow, fog and dust

*RETINA-4A: 4D Image Radar for drone detection



3. Our Radar Product

- 4D Imaging Radar**
 - : RETINA-4F**
 - : RETINA-4ST**
- IRIS c/t**
- RM68-03/51**

PRODUCT SPECIFICATIONS – RETINA-4ST

4D Imaging Radar

To See the Unseen

< RETINA -4ST >



< RETINA -4SN >

with WiFi
Available by Q4/2021



2020-10-13 10:42:32

Number of People: # 5

	RETINA-4ST
# Chip/ # Tx	4 / 12Tx & 16Rx
Frequency Range	77-81 GHz
Frequency Bandwidth	Max 3.8 GHz
# of Target	5 (People)
Max Detection Range	Person : 15.5m
Azimuth FoV	90° (± 45°)
Elevation FoV	90° (± 40°)
Update Rate	10FPS (100msec)
Output Data	UART

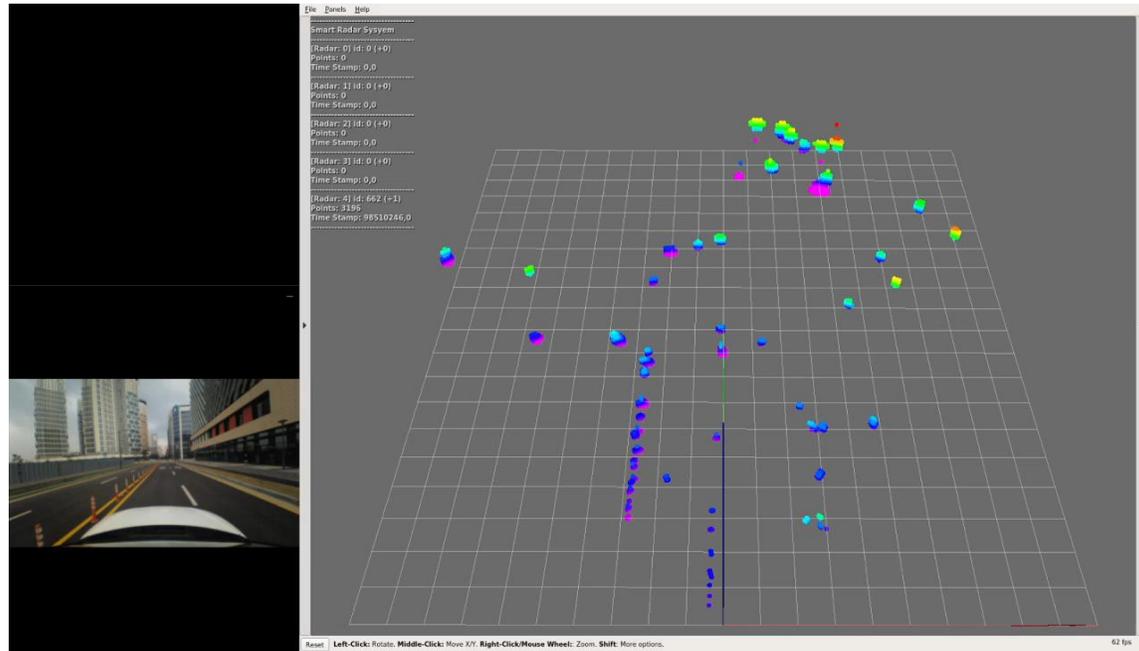
PRODUCT SPECIFICATIONS – RETINA-4F

4D Imaging Radar

To See the Unseen



- Compatible with Lidar & vision sensor
- Better Performance with Non-Uniform Antenna Array
- Can detect up to 250m
- Own developed Digital Signal Processing



	RETINA-4F (4D Imaging Radar)		
# Chip / #Tx & #Rx	4/ 12 Tx & 16 Rx		
Frequency Range	77-81GHz		
Frequency Bandwidth	Max. 4.00 GHz		
# of Target	280		
Max Detection Range	(Long Range) Vehicle : 250m Human : 80m <i>*available by end of 2021</i>	(Short Range) Vehicle : 100m Human : 40m	(Ultra-Short Range) Human : 15m
Azimuth FoV	10° (±5°)	100° (±50°)	100° (±50°)
Elevation FoV	24° (±12°)	24° (±12°)	24° (±12°)
Update Rate	100ms	125ms	125ms
Output Data	CAN-FD, 1G Ethernet (Automotive)		

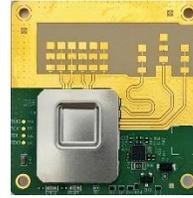
PRODUCT SPECIFICATIONS – IRISc & IRISt

To See the Unseen



	IRISc-03A	IRISSt-03A
# Chip/ # Tx	1 Single-chip / 2Tx & 4Rx	2 Single-chip / 2Tx & 4Rx
Frequency Range	77-81 GHz	77-81 GHz
Frequency Bandwidth	Max 3.95 GHz	Max 3.95 GHz
# of Target	20	20
Max Detection Range	Vehicle : 45m Human : 22m	Vehicle : 10m Human : 6m
Azimuth FoV	Vehicle: 120°@7 m, 30°@45m Human : 120°@ 3m, 40°@22m	Vehicle : 180° (±90°) @0.5~10m Human : 180°
Elevation FoV	30° (± 15°)	30° (± 15°)
Max Detection Velocity	± 54.44 km/h	± 54.44 km/h
Update Rate	10FPS (100msec)	10FPS (100msec)
Output Data	CAN	CAN

PRODUCT SPECIFICATIONS- Single Radar RM68 Series (60-64GHz)



	RM68-03	RM68-51
# Chip/ # Tx	1 / 2Tx & 4Rx	1 / 2Tx & 4Rx
Frequency Range	60-64 GHz	60-64 GHz
Frequency Bandwidth	Max 4.00 GHz	Max 4.00 GHz
# of Target	32	32
Max Detection Range (* 10dBm output power)	Vehicle : 60m Human : 40m	Vehicle : 60m Human : 40m
Azimuth FoV (* 10dBm output power)	Vehicle: 90°@13 m, 20°@60m Human : 90°@ 3m, 20°@40m	Vehicle: 90°@13 m, 20°@60m Human : 90°@ 3m, 20°@40m
Elevation FoV	60° (± 30°)	60° (± 30°)
Update Rate	10FPS (100msec)	10FPS (100msec)
Output Data	UART	UART



Thank You

Smart Radar System

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