



HUMAN VITAL SIGNS DETECTION THROUGH OBSTRUCTIVE ENVIRONMENT USING RADAR SYSTEM



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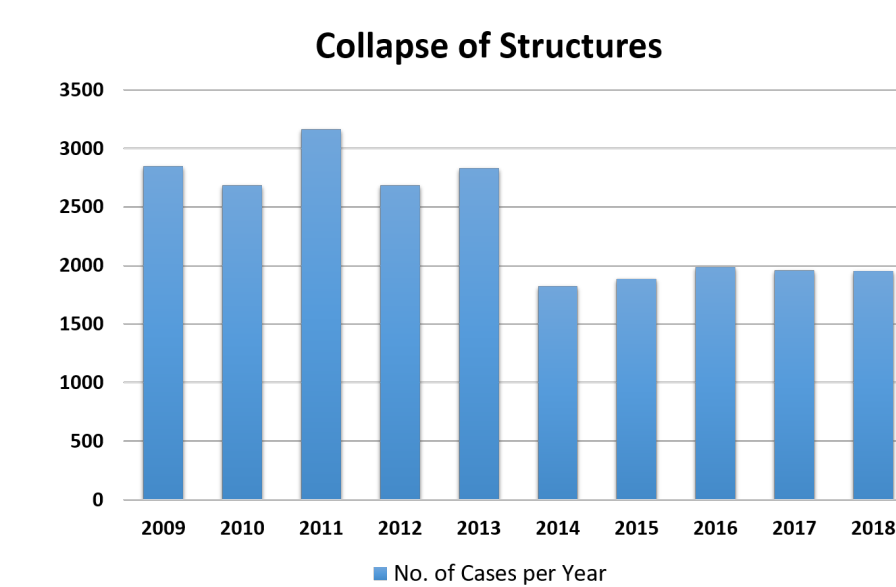
INTRODUCTION

Collapse of Man-Made Structures

- Residential buildings, bridges, etc.
- Collapse due to poor reinforcement, earthquakes, etc.



Cases of Collapse of Structures in India from 2009 to 2018



Data obtained from Accidental Deaths and Suicides in India (ADSI) report by NCRB.

Common Methods for Search and Rescue

- Call Out
- Canine Search
- Acoustic, Optical, and Motion sensors

Why Use Radar System?

- Detect unconscious people
- Non-invasive
- Time Efficient

Types of Radar system architecture

- Impulse Radar
- SFCW Radar
- FMCW Radar

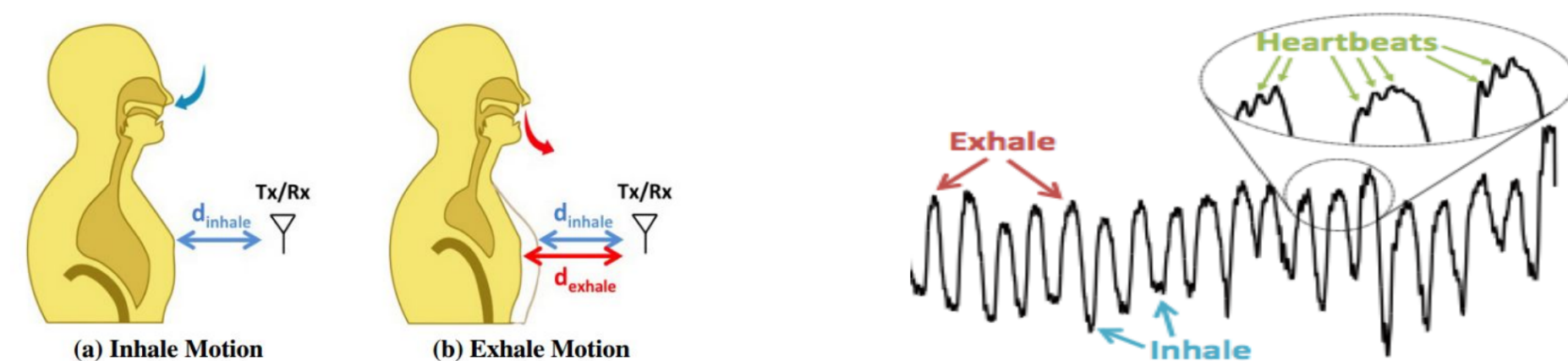
Benefits of using UWB Impulse Radar

- Low Multipath Interference
- Good separation capability of target and non-stationary clutter
- Low Power Requirements

OBJECTIVES

- Design of an UWB antenna having circular polarization, constant gain, and low cross-polarization.
- Multiple human vital sign estimation through-wall at different distances with varying postures.
- Design of a complete UWB Impulse radar system.

HOW RADAR DETECTS BREATHING?



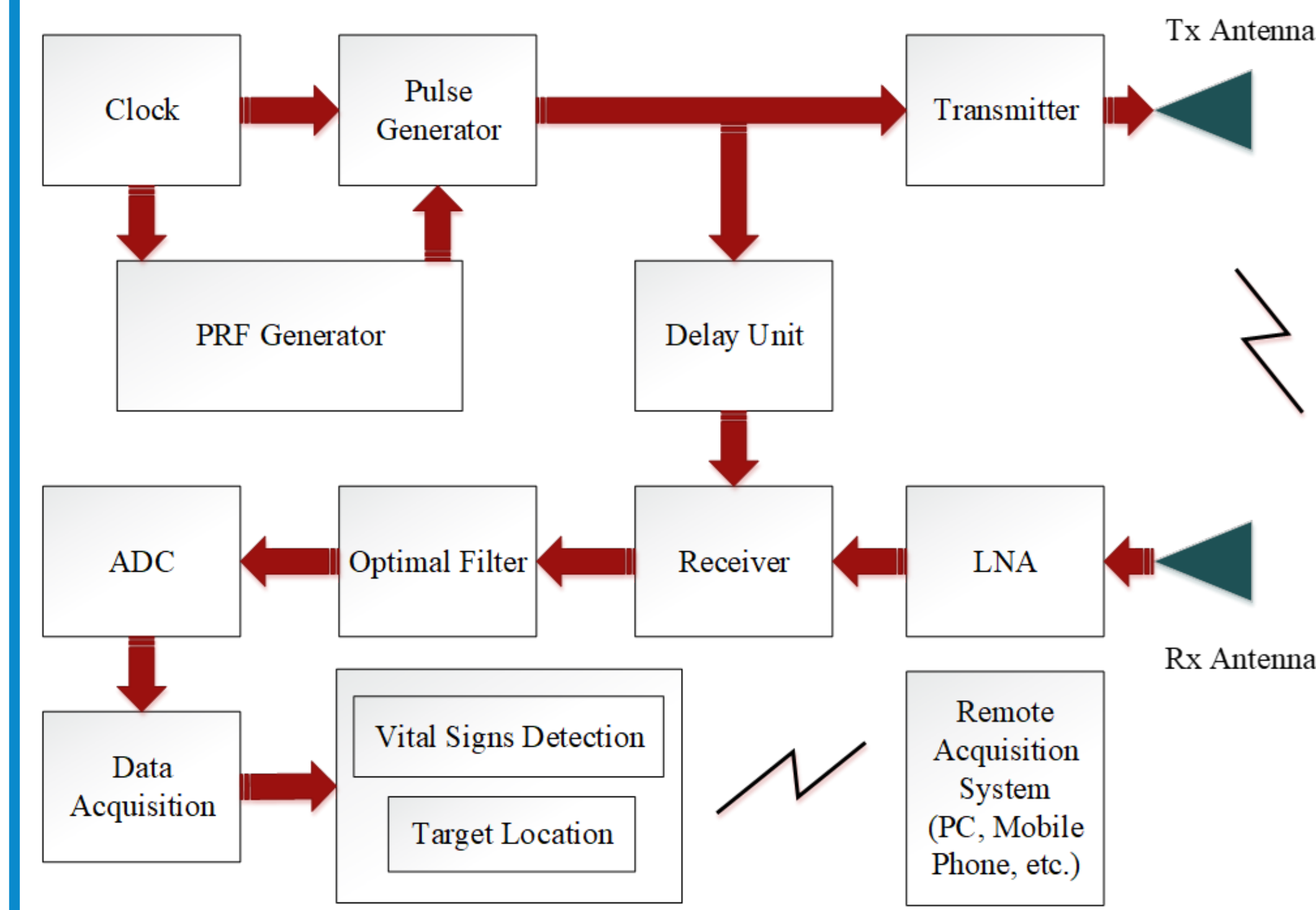
- Chest wall moves front and back during respiration.
- Phase change occurs in received signal.
- When plotted against time, these motions resemble a sinusoidal function.

REFERENCES

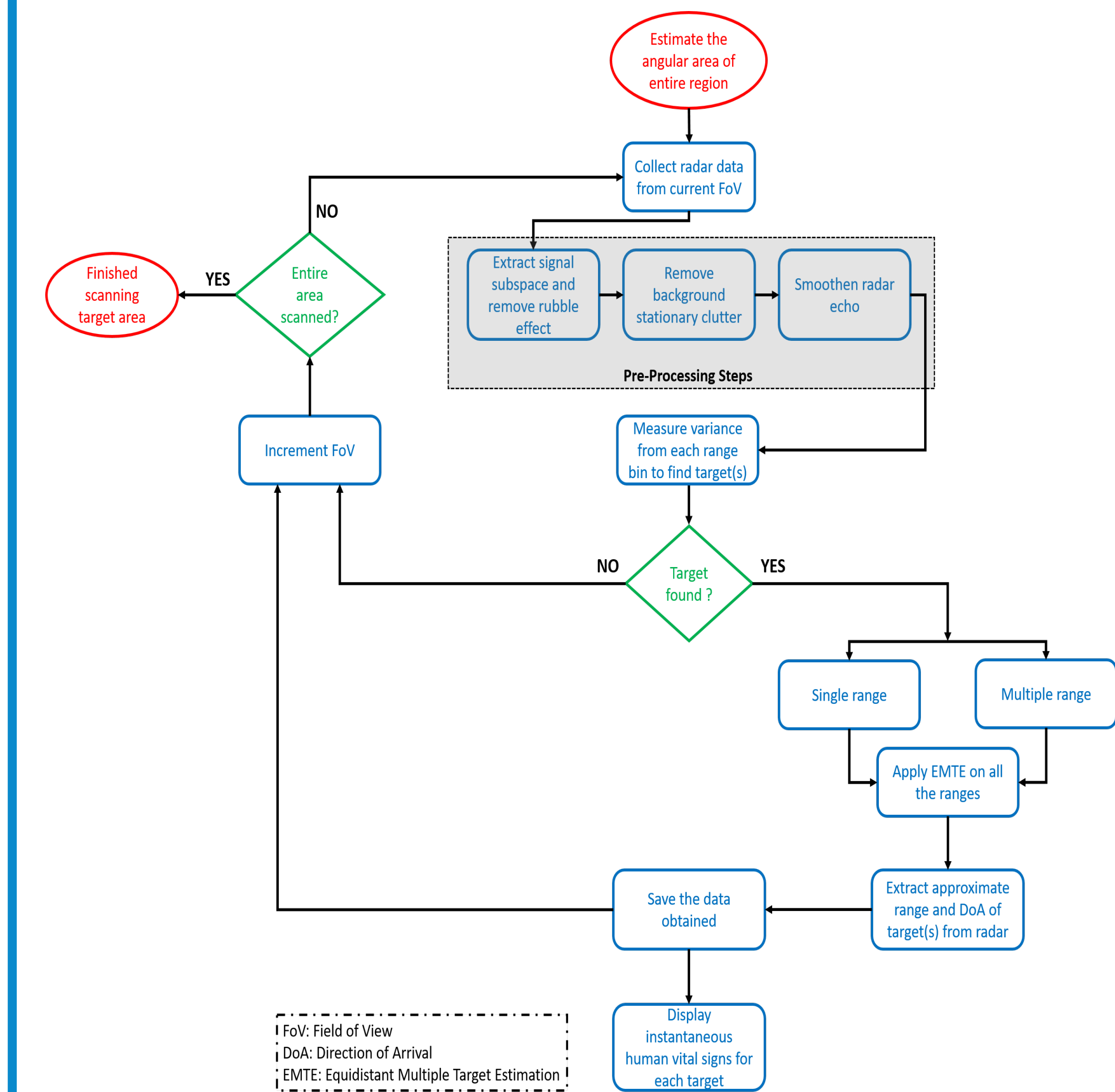
[1] A. Sarkar and D. Ghosh. Detection of multiple humans equidistant from IR-UWB SISO radar using machine learning. *IEEE Sensors Letters*, 4(1):1-4, Jan 2020.

[2] A. Sarkar and D. Ghosh. Through-Wall heartbeat frequency detection using Ultra-Wideband impulse radar. In *2019 International Conference on Range Technology (ICORT) (ICORT 2019)*, Chandipur, India, February 2019.

UWB IMPULSE RADAR SYSTEM

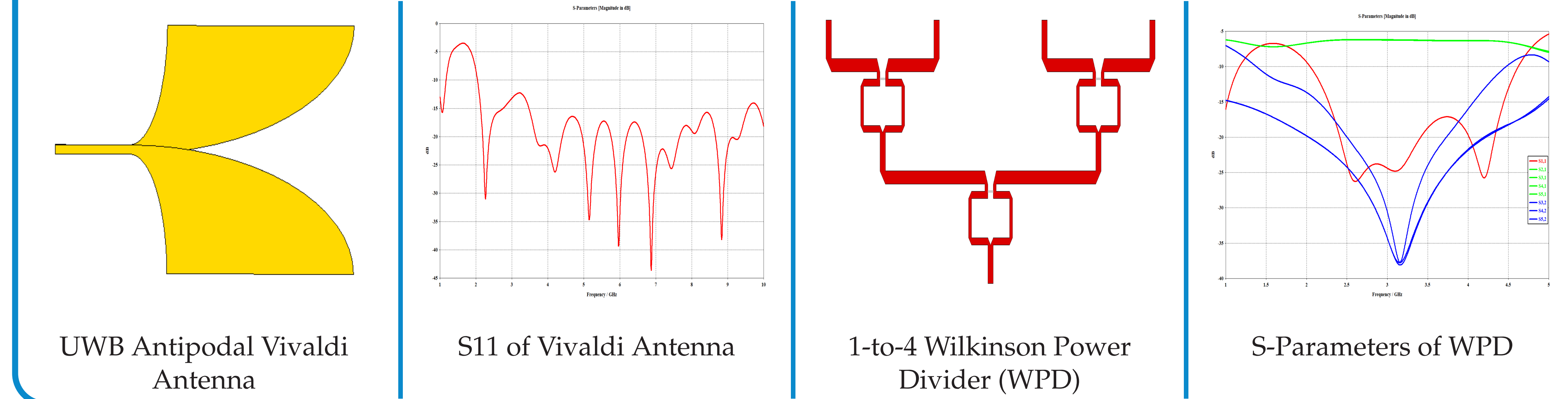


RADAR DATA COLLECTION PROCESS

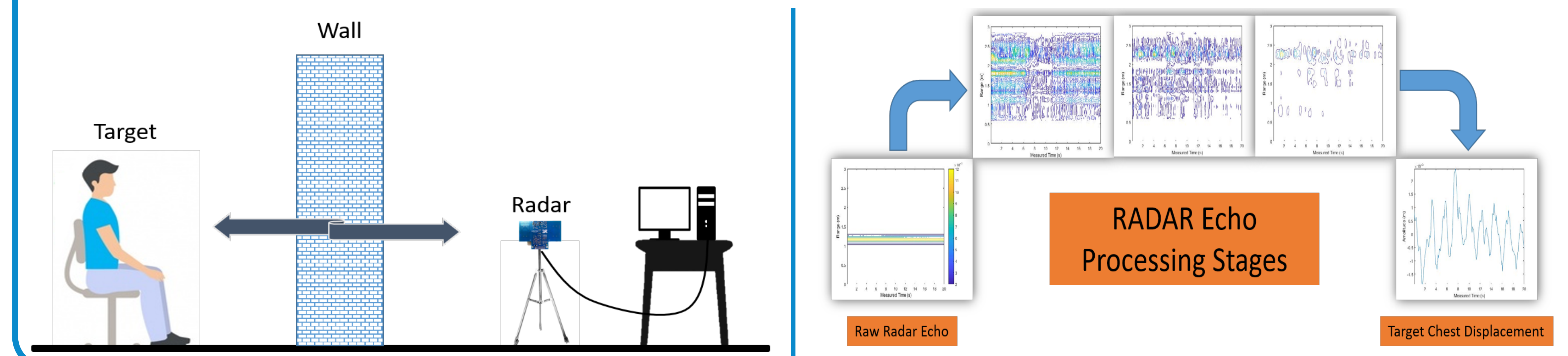


- UWB Vivaldi array antennas are employed to facilitate beamforming for scanning the target environment.
- The received signal is pre-processed and variance is measured for each range bin to locate the targets.
- Upon gathering the range and DoA information, the data will be saved and displayed on the receiver.
- The FoV will then be incremented until the entire target area gets scanned.

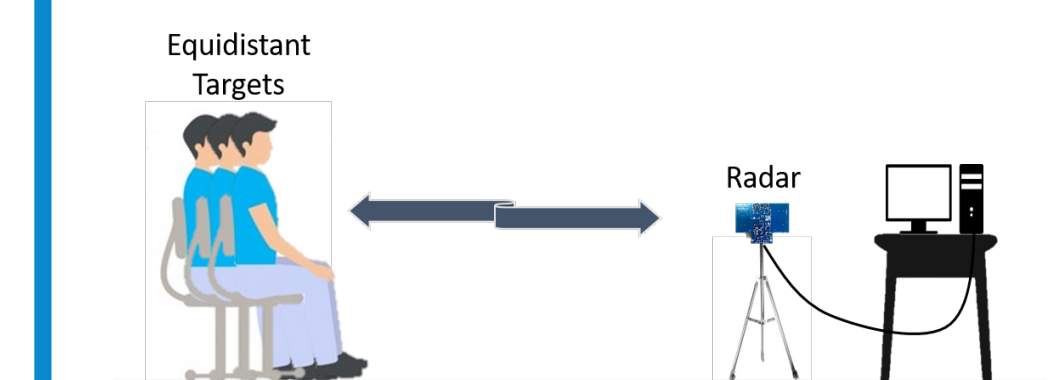
ANTENNA AND POWER DIVIDER ANALYSIS



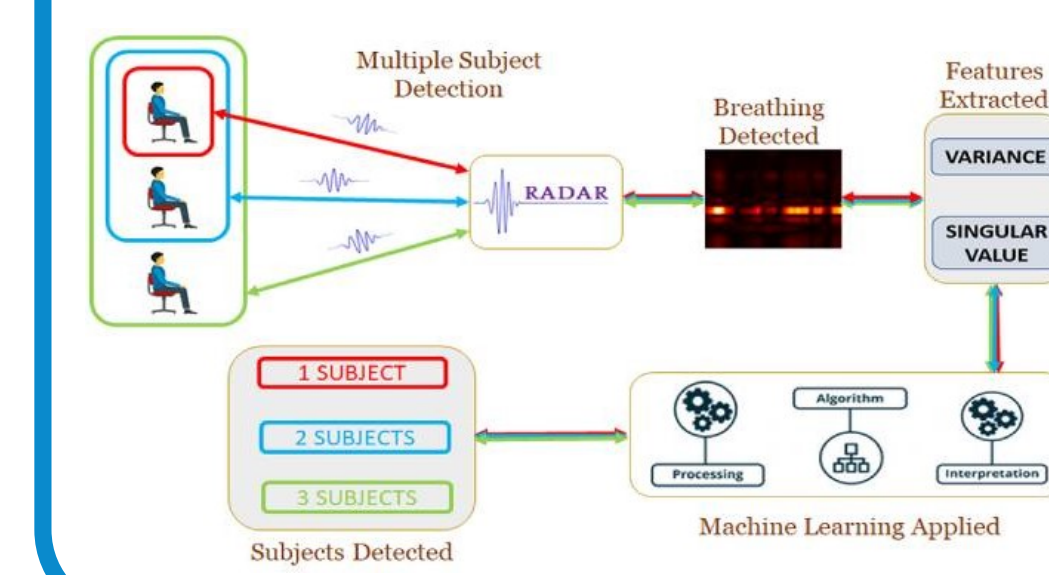
PRE-PROCESSING STEPS FOR SINGLE TARGET THROUGH-WALL



RADAR-TARGET SCENARIOS



Detection of multiple targets equidistant from radar

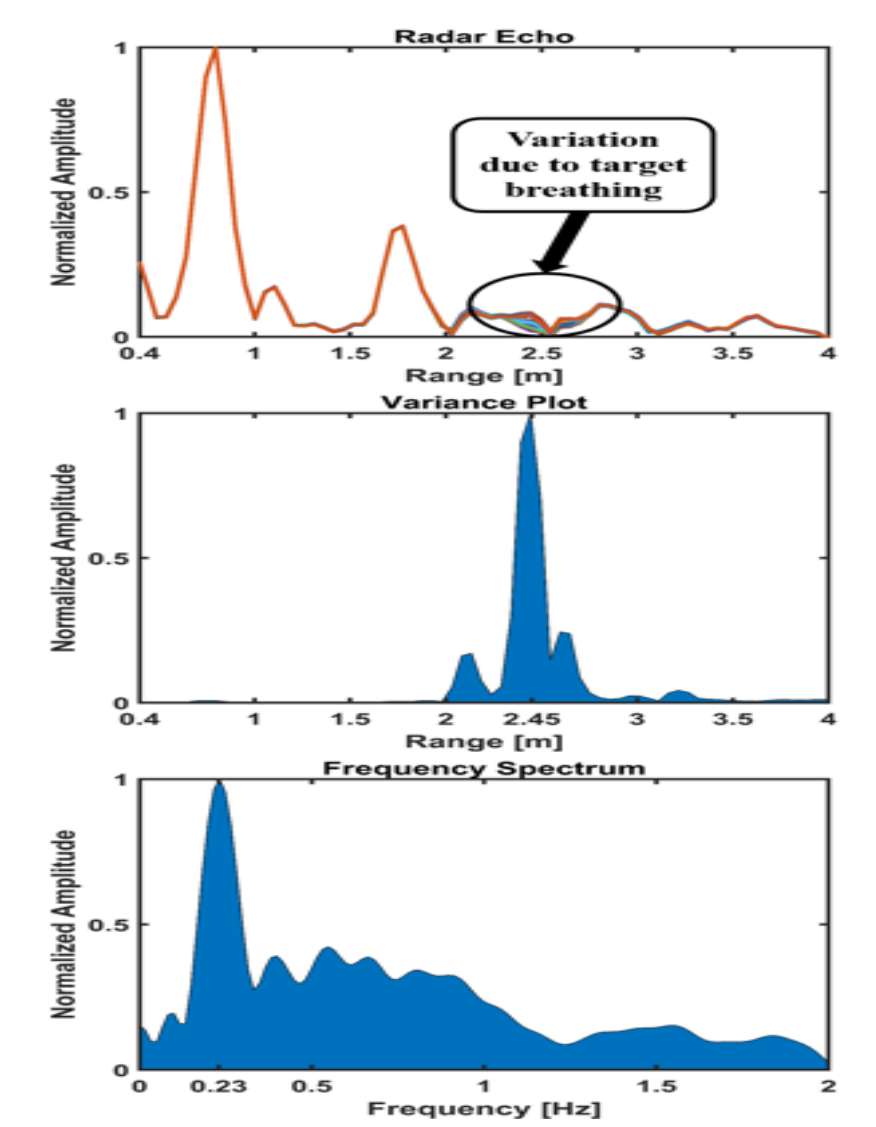


True Class \ Predicted Class	1	2	3	4
1	100.0% 40	0.0% 0	0.0% 0	0.0% 0
2	0.0% 0	95.0% 38	2.5% 1	0.0% 0
3	0.0% 0	2.5% 1	95.0% 38	0.0% 0
4	0.0% 0	2.5% 1	2.5% 1	100.0% 40

Confusion matrix for EBT classifier to classify number of targets



Target lying under a pile of rubble



Target breathing frequency analysis

CONCLUSION

- Radar is able to detect people buried under rubble by capturing their breathing movements.
- It can detect multiple targets in varied ranges by scanning through the detection zone.

FUTURE WORK

- Complete radar system development and testing under real environment.
- Detection of target posture relative to radar for efficient rescue.

MESSAGE FROM NATIONAL DISASTER RESPONSE FORCE (NDRF)

"If the location of a buried person could be found out without even touching the debris, it will be a huge help. Having a radar system at our disposal will benefit us a lot in saving human lives."

- Assistant Commandant, NDRF Cuttack