Poster Abstract: Integrated Sensing and Communication between Daily Devices and mmWave Radars

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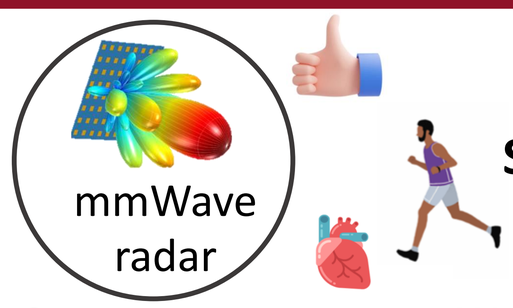
Motivation

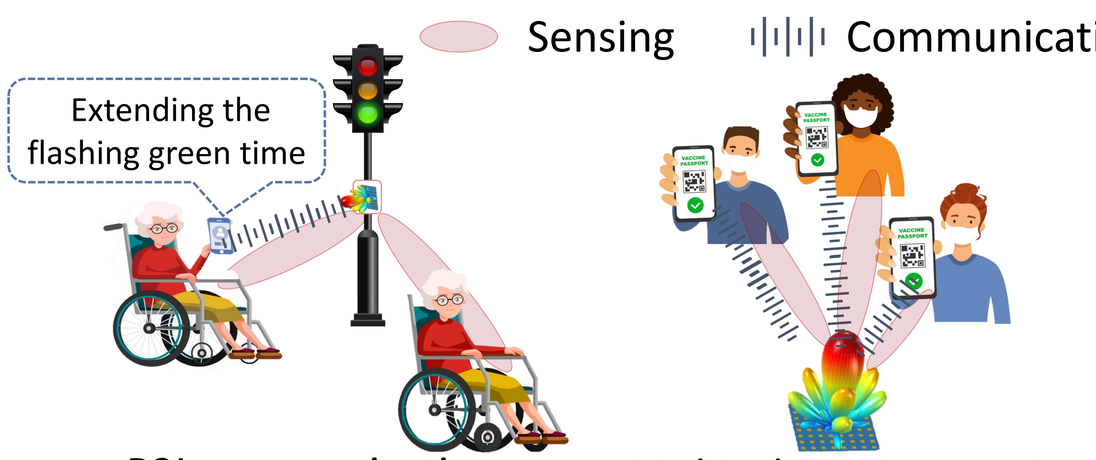


Sensing + Communication?

- **Can we empower mmWave radars with communication capability** for ISAC without any hardware modifications?
- **VibBeat** builds a communication channel, allowing daily devices to send messages to mmWave radars through vibrations.

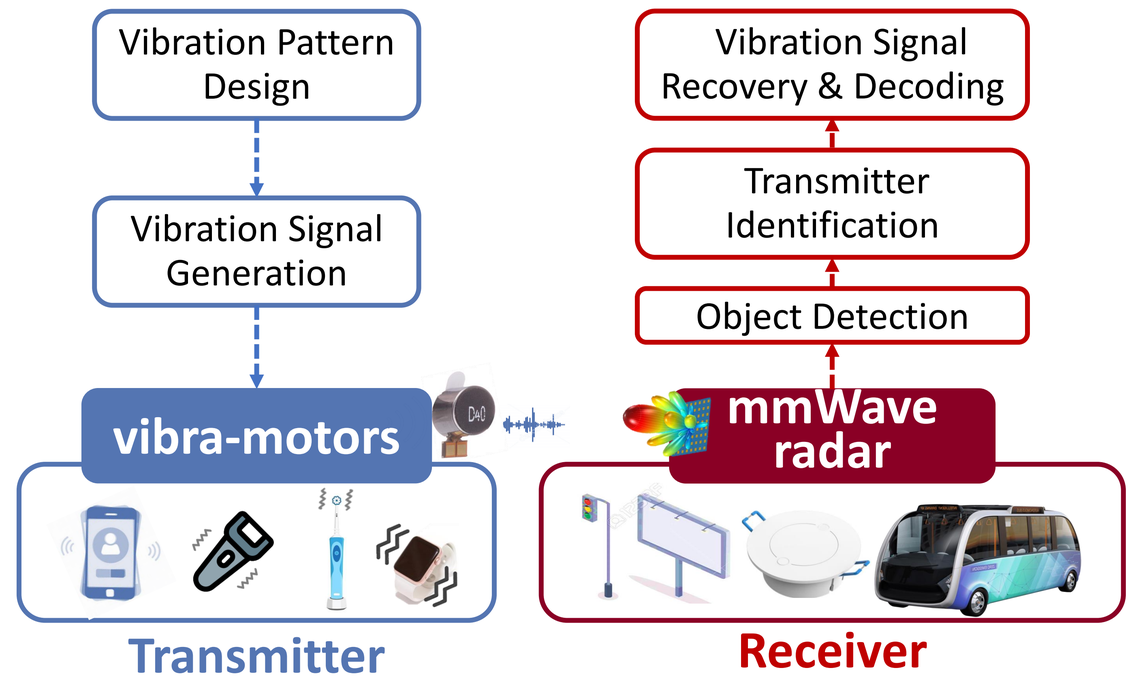
Application

- **Pedestrian-to-Infrastructure (P2I) communication.**
  After receiving the "crossing" message from an elderly's smartphone vibration, the traffic light can suitably extend the flashing green time and track her movement.
- **Multiple object interaction.**
  mmWave radar can be deployed at the entrance of a venue to monitor visitors, while checking their COVID-19 vaccine passports by decoding specific vibrations.



P2I communication Multi-object interaction

System Design

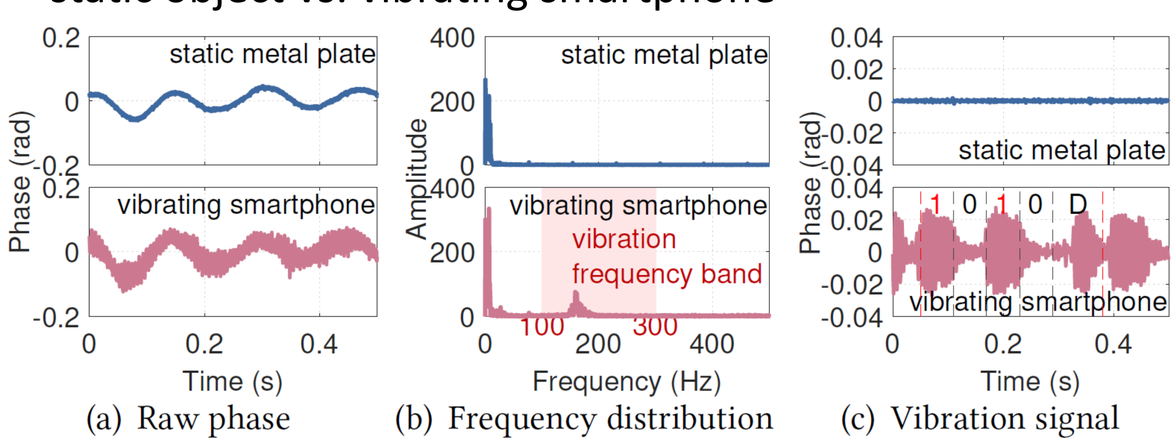


- **Transmitter (vibra-motors in daily devices).**
  We first design several orthogonal vibration patterns to convey different messages. The vibra-motor in daily devices is then programmed to generate the desired vibration signals by controlling the vibration duration and amplitude.

- **Receiver (mmWave radar).**
  A mmWave radar constantly sends FMCW signals and captures the reflected signals. By analyzing the spectrum of the received signals, we first detect candidate objects and then identify the vibration objects that vibrate in a target vibration frequency band. Next, we separate the mixed reflected signals and recover the vibration signal for each vibration object. Finally, the messages embedded in the vibrations can be decoded.

Evaluation

- **Vibration recovery.**
  static object vs. vibrating smartphone



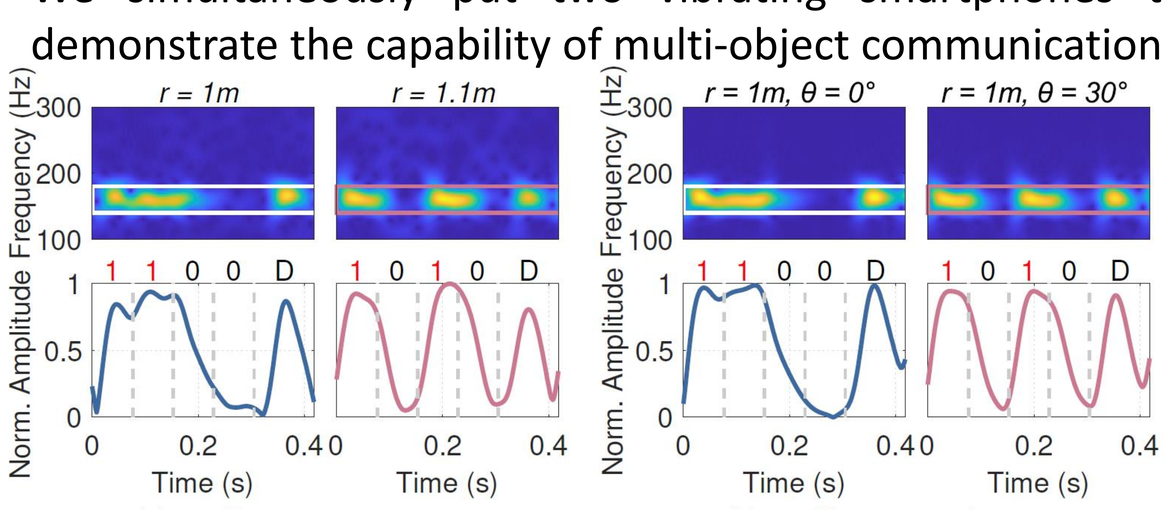
(a) Raw phase (b) Frequency distribution (c) Vibration signal

Illustration of vibration recovery.

- **Communication range.**
  We select Samsung S9+ as the transmitter to evaluate the accuracy of vibration pattern recognition at different distances.

Distance (m)	1	2	3	4	5	6	7
Accuracy (%)	100	100	100	98.33	91.67	61.67	43.33

- **Multi-object communication.**
  We simultaneously put two vibrating smartphones to demonstrate the capability of multi-object communication



(a) Different ranges (b) Different angles

Illustration of multi-object communication.

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Demo video