Docket #: S19-154

A System for Remote Parametric Detection, Localization, and Identification of Passive Tags using Radio Frequency and Ultrasound Waves

Researchers in the Arbabian Lab have developed a system that uses a combination of radio frequency (RF) electromagnetic and ultrasound (US) waves to detect, localize, and identify multiple battery-free tags. The system consists of any number of small (centimeter- or millimeter-sized) battery-free tags to be localized, as well as one or several readers capable of providing tag location and velocity estimates at high frame rate for tags up to several meters away from the reader(s). Each reader transmits continuous-wave (CW) RF and pulsed US to regions of interest; a tag in that region reradiates RF waves that are modulated by the pulsed US incident on the tag. The reader detects this modulation in the returning RF waves and uses it to detect, localize, and identify that tag. Each tag consists at least of an RF antenna connected to an US transducer by a passive electrical network, which ideally is a network that matches the impedance of the transducer to that of the antenna at the RF frequency of operation. Each reader consists at least of an US transmitter combined with an RF transceiver, and may include any or all of the following parts: a pulsed US transmitter, an array of US transducers, a CW RF transmitter, an array of RF antennas, an RF self-interference cancellation system, an RF demodulation system, and firmware/software to stitch together location and velocity estimates of tags into continuous tag paths through space.

Stage of Research

- Proof of concept

Applications

- **Motion capture**
  - Entertainment – movie and video game development, AR/VR/gaming
  - Engineering – equipment control, sensor validation, robotics development and tracking
  - Medicine, sports, and physical therapy – surgical navigation, swing/gait analysis
- **Tagging**
  - Supply chain and delivery management
  - Consumer items – electronics, small valuables (e.g., jewelry), apparel, pharmaceuticals
  - Insects and animals – pest control, scientific studies
  - Security/authentication driven by location information
- **Long-term distributed sensing**
  - Environmental monitoring – fine-grained weather tracking, scientific studies
  - Industrial monitoring – oil and gas extraction, factory condition monitoring
  - Quality control for consumer products during manufacturing and shipping

Advantages

- Tags can be centimeter-sized or smaller
- Tag location estimates with sub-centimeter accuracy
- Tag location and velocity estimates at high frame rate for tags up to several meters away from the reader(s)
- Works with an arbitrary number of tags
- Tags are completely battery-free (no battery anxiety, no maintenance required)
- No expensive high-res high-speed optical cameras required on the reader (unlike existing state of the art motion capture technology)

Publications

- A. S. Rekhi, E. So, A. Gural, and A. Arbabian, "CRADLE: Combined RF/Acoustic Detection and Localization of Passive Tags," in preparation.

Patents

- Published Application: WO2021097214
- Published Application: 20220385375
- Issued: 12,763,857 (USA)

Innovators

- Angad Rekhi
- Mohammad Arbabian
- Chun-Ming So
- Albert Gural

Licensing Contact

Evan Elder

Associate Director, Licensing and Strategic Alliances, Physica

Email