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Simultaneous Localization and Mapping by Merging Imaging and Wireless Communications

Background

Simultaneous localization and mapping (SLAM) is the process by which a robot or system constructs a map of an undefined environment and tracks its location within it. By allowing autonomous agents to safely and independently navigate crowded settings, SLAM has found applications in virtual and augmented reality, driverless vehicles, and assisted living technologies. For many SLAM applications, providing user or device location with high spatial accuracy is critical. Because spatial resolution limits improve as the wavelength of the probing signals decreases, use of millimeter wave (mmW) electromagnetic signals has become a promising candidate for delivering high-resolution SLAM. However, current mmW localization algorithms can accommodate only one wave reflection and require an antenna array at the point of localization. As future communication base stations incorporate arrays of mmW antennas, development of an integrated mmW SLAM system would contribute substantially to infrastructure value and advancement of downstream map-based technologies.

Invention Description

Using tools from mmW imaging and mmW wireless communication, Researchers at Arizona State University have developed a new SLAM approach that would allow a base station or access point to: (1) capture a high-resolution image of both line-of-sight (LOS) and non-line-of-sight (NLOS) objects in the environment, and (2) localize users (i.e., transmitters) with centimeter accuracy, even after multipath signal reflections.

The process first captures an image of surrounding geometries. By assuming that objects are opaque at mmW frequencies, an algorithm distinguishes between LOS and NLOS objects, and corrects the image accordingly. Second, raw angle-of-arrival and time-of-arrival values are computed based on a user transmission of a pilot signal. Finally, these data sets are combined to form a complete image showing user location and surrounding objects.

Potential Applications

- Military

- Virtual and augmented reality
- Autonomous vehicles
- Assisted living
- Navigation

Benefits and Advantages

- Unprecedented – System is first to integrate localization and mapping capabilities with mmW imaging and communication
- Integrative – Technology adapts communication base station architectures for SLAM applications
- Non-Restrictive – Correction algorithm allows imaging of both line-of-sight and non-line-of-sight objects

Homepage of Professor Trichopoulos

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