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Differential And Non-Differential Frameworks For Submeter-Accurate UAV Navigation With Cellular Signals

Tech ID: 34258 / UC Case 2021-777-0

BRIEF DESCRIPTION

A novel framework enabling submeter-level accurate unmanned aerial vehicle (UAV) navigation using cellular carrier phase measurements with and without a base station.

FULL DESCRIPTION

This technology introduces two innovative frameworks—differential and non-differential—for achieving submeter horizontal navigation accuracy of unmanned aerial vehicles (UAVs) using cellular signal carrier phase measurements. The differential framework leverages a base station sharing carrier phase data with the UAV, employing advanced filtering and estimation techniques to guarantee position errors remain below a set threshold with high probability. The non-differential framework exploits the exceptional clock stability of cellular base transceiver stations (BTS) to enable precise navigation without the need for a base station. Both frameworks address challenges inherent in signals of opportunity navigation, delivering unprecedented accuracy.

SUGGESTED USES

- >> UAV navigation and control for package delivery, search and rescue, and inspection tasks.
- >> Mobile device location services enhancing positioning accuracy indoors and in urban areas.
- >> Automotive navigation systems requiring robust positioning in urban canyons and tunnels.
- >> Aerospace and defense applications needing secure, accurate navigation independent of GNSS.
- » GNSS augmentation providers seeking alternative or complementary navigation sources.
- » Cellular network operators aiming to expand value-added services with precise location capabilities.

ADVANTAGES

- » Achieves submeter-level horizontal navigation accuracy for UAVs.
- >> Guarantees position error remains below a predefined threshold with a desired probability in the differential framework.
- >> Enables navigation without a base station using the non-differential framework, reducing dependency on communication links.
- >> Utilizes widely available cellular signals (3G, 4G, 5G) as signals of opportunity, which are abundant and free to use.
- » Robust performance in Global Navigation Satellite System (GNSS)-denied or challenged environments such as urban canyons and indoor settings.

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OTHER INFORMATION

KEYWORDS

Autonomous Systems, Signals of Opportunity, Navigation

CATEGORIZED AS

- » Communications
 - » Wireless
- » Sensors & Instrumentation
 - >> Position sensors
- » Transportation
 - » Aerospace
 - » Automotive

RELATED CASES

2021-777-0

>> Extensive experimental validation demonstrating consistent submeter accuracy over multi-kilometer UAV trajectories.

PATENT STATUS

Patent Pending

RELATED MATERIALS

>> Khalife, J., Kassas, Z. M. (2023). Differential framework for submeter-accurate vehicular navigation with cellular signals. IEEE Trans. Intell. Veh., 8 (1). - 08/01/2022

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