Robust Localization and Tracking Using GNSS Location Estimates, Satellite SNR Data, and 3D Maps

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BACKGROUND

The localization capabilities provided by Global Navigation Satellite Systems (GNSS), such as the Global Positioning System (GPS) and GLObalnaya NAvigatsionnaya Sputnikovaya Sistema (GLONASS), are an essential technology taken for granted in modern society. However, the accuracy of GNSS-based location is severely compromised in built-up urban environments due to blockage of satellite signals by buildings and other tall structures. Attempts to enhance GNSS localization using signals from other sources, such as cellular and WiFi, have had limited success, due to difficulties using geometric techniques for inferring location in a complex propagation environment. Three-dimensional (3D) maps of urban environments are of tremendous importance for companies and researchers, but existing methods for three-dimensional mapping of cities, such as aerial lidar, are prohibitively expensive.

DESCRIPTION

Researchers at the University of California, Santa Barbara have formulated a novel method of using crowdsourced GNSS data to create three-dimensional maps, creating a low-cost alternative to lidar and aerial photography. Furthermore, they have developed a method for using three-dimensional maps in a Bayesian localization and tracking framework to substantially improve GNSS-based localization in built-up environments. The methods developed exploit the blockage of satellite signals to enable 3D mapping and improve localization by using information already available in the GNSS receiver regarding the signal-to-noise-ratio (SNR) corresponding to each satellite it sees. If the line of sight (LoS) path from the receiver to a satellite is blocked (i.e., the receiver is in the shadow of a structure), then the SNR is likely to be small. Conversely, if the LoS path is available, the SNR is likely to be high. This observation forms the basis for a Bayesian estimation and tracking framework for “probabilistic shadow matching,” which enables both 3D map creation using crowdsourced GNSS measurements, and improved location for an individual GNSS device given a 3D map of the environment. These improved mapping and localization capabilities can be used by a myriad of organizations including telecommunication providers, mapping services, flight simulators, video game companies, and the military.

ADVANTAGES

- Improved localization data
- Ability to three-dimensionally map dense, urban environments
- Capability to three-dimensionally map unknown environments
- Improved prediction of wireless coverage

APPLICATIONS

- Telecommunications
- Three-dimensional mapping services (e.g. Google maps, Apple)
- Flight simulation
- Video games
- Military

PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Issued Patent	10,656,282	05/19/2020	2016-776

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OTHER INFORMATION

KEYWORDS

GNSS, 3D, three-dimensional, maps, 3D maps, 3D mapping, mapping services, flight simulators, telecommunication, SNR, localization, satellite signals

CATEGORIZED AS

- **Imaging**
  - 3D/Immersive
  - Other
  - Remote Sensing

RELATED CASES

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