

Ownship Calibration for Indoor Magnetic Navigation **Adrienne Dorr**

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Zoom link: <https://wpi.zoom.us/j/92112939931> Passcode: 951690

Abstract

Precise localization is critical for numerous operations where manned and unmanned vehicles are utilized. While many autonomous systems may rely on Global Position Satellite (GPS) for localization, the GPS signal can be unavailable, degraded, and possibly jammed. To operate under these GPS-denied scenarios, alternative navigation methods are continuously developing. Among the most typical GPS-denied navigation solutions are visual-aided inertial navigation, Simultaneous Localization and Mapping (SLAM), LiDAR-inertial approaches, radar-based techniques, Earth magnetic field-based systems, or combination methods. Although these techniques have been proven effective in different scenarios, challenges remain such as relying on ideal lighting and weather conditions and visual landmarks. Magnetic Anomaly-Based Navigation, or MagNav, is one method that seeks to circumvent these challenges. This technique leverages magnetic field anomalies caused by the Earth's crustal field as a localization reference to determine and maintain an agent's estimated location. MagNav is not affected by lightning and Earth weather conditions and is nearly un-jammable. This makes MagNav very attractive for GPS-denied applications where environmental conditions are not optimal for camera or LiDAR-based solutions, i.e., flying over water at night or indoor navigation applications like warehouse automation. Successful implementation of MagNav has been deployed mainly for GPS-denied aircraft navigation. The Tolles-Lawson calibration is a standard calibration procedure for outdoor aircraft using MagNav that significantly reduces the vehicle's effect on the magnetic readings. However, as is, this calibration approach is not ideal for indoor navigation due to two main challenges of indoor environments: 1) The available space for magnetometer placement is limited due to the use of small vehicles, introducing large measurement biases due to sensor closeness to magnetic sources, and 2) surrounding electromagnetic effects from alternate currents disturb the measurements, preventing accurate magnetic field readings. We propose the augmentation of the Tolles-Lawson calibration concept for indoor navigation applications and demonstrate its use along with a navigation particle filter. Using the proposed augmented Tolles-Lawson vehicle calibration, we demonstrate that the disturbances from surrounding magnetic sources can dramatically decrease. Hardware experiments demonstrate that the calibrated measurements can enable accurate indoor MagNav.



Adrienne Dorr is a Systems Concepts Engineer specializing in Guidance, Navigation, and Control at Draper Laboratory in Cambridge, Massachusetts. A U.S. Department of Defense SMART Scholar, she earned both her Bachelor of Science and Master of Science degrees in Aerospace Engineering from the Georgia Institute of Technology.