Magnetic Positioning Sphere: A Single-Source 3D Positioning System using Rotating Magnetic Fields

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This study presents a 3D magnetic positioning system using a single-source Magnetic Positioning Sphere (MPS). The proposed MPS system is composed of three mutually orthogonal coils and an Arbitrary Waveform Generator (AWG) to generate the designated signals. By applying Frequency Division Multiplexing (FDM), the three coils generate two rotating magnetic fields with different frequencies of phase-quadrature current signals, which is equivalent to two mechanically rotating magnetic dipoles. To obtain the accurate position in a 3-dimensional space, the object is equipped with a magnetometer for measuring the strength of magnetic field and a micro-controller unit for signal processing. Specifically, the magnetometer is triggered by a designated pulse, and its measurement result is extracted into two signals of different frequencies. The phases of the two signals are then used to determine the elevation and azimuth angles, and the amplitudes of these signals are used to calculate the distance between the source and the object. Using a comprehensive set of experiments, we demonstrate that the proposed MPS system can achieve an accuracy within 5 cm. Compared to the existing RSSI-based indoor positioning systems, the MPS system has no need of doing site surveys, which makes it easy for quick deployment. Moreover, the MPS system is based on magnetic field, which is robust against radio interference and environment obstructions. The proposed MPS system has great potential to facilitate a wide range of applications, such as mobile systems, wearable computing, and location-based applications, where an instant and accurate indoor 3D positioning system is demanded.

Awards Won:

First Award of $5,000

NASA: Intel ISEF Best of Category Award of $5,000