CV – Dr Muhammad Ushaq

Muhammad Ushaq completed his Electrical (Communication) Engineering from University of Engineering & Technology Peshawar during 1991~95. He did his MS and PhD in Precision Instruments & Machinery (Specializing in Navigation Sensors and Systems) from Beihang University, Beijing during 2001~2003 and 2010~2013 respectively.

He has been affiliated with a public sector R&D organization (CESAT, Pakistan) since 1996. He has been teaching (as a visiting faculty) Inertial Navigation Systems, Global Navigation Satellite Systems and GNSS/INS Integrated Navigation Systems at Institute of Space Technology (IST) Pakistan since 2005. He has supervised a number of thesis and Projects on GNSS and GNSS/INS Integrated Navigation Systems at IST and other universities of Pakistan. His research interests include inertial sensors and systems, Robotics, Position and Azimuth Determining Systems for land-based applications, Orbital Mechanics, INS/GNSS Integrated Navigation Systems, Data Fusion, Kalman Filtering & Applications, and Fault Tolerant Navigation Systems.

Title of Presentation

Comparative Analysis of Multi-position Strapdown Azimuth Determining Schemes

ABSTRACT

Determination of high precision azimuth angle is a critical requirement for accurate surveying, alignments and various navigation systems, especially Inertial Navigation Systems (INS). Azimuth is the angle between the forward direction of the object under consideration and the true North, measured from North to East, in horizontal plane.

Azimuth determination before and during navigation ensures that the navigating bodies like ships, land-vehicles and aircrafts will maintain their intended trajectories and reach destinations efficiently. In astronomy, precise azimuth measurements are essential for telescope alignment, star tracking, and the study of celestial phenomena. High precision azimuth angles are used in search and rescue operations to locate missing persons or objects. Golfers use azimuth data to analyze and improve their swings and ball trajectories. In military applications, errors in azimuth can lead to significant deviations from the intended targets. In geophysical surveying, precise azimuth measurements are essential for exploration and extraction activities. More applications include Satellite-Tracking, Tunneling, Alignment of Antenna/Solar-Panels, Mining. Drilling, Precision Farming, Civil-Works and Submarines-Navigation.

Early navigators relied on celestial bodies to determine their heading, using tools such as the astrolabe, star-trackers and sextants. Magnetic compasses have also been utilized for determining azimuth although they are highly vulnerable to the environment and magnetic interference requiring periodic calibration. A dual-antenna GNSS receiver can be used to

determine the azimuth angle by measuring the relative position between antennas. Emergence of the Inertial Sensors Technology has given new dimensions to the azimuth finding techniques. Conventional Gyrocompass (GC) tracks the true north by attempting to align the gyro-axis with the horizontal component of the Earth's spin vector by precessing or swinging around the meridian and horizontal line. GCs are immune to magnetic interferences, but their mechanical complexity and maintenance requirements calls for more robust solutions. Strapdown Azimuth Determining Systems (ADS) are gaining acceptance due to ruggedness and high accuracy. Types of gyroscopes used in ADS include Fiber Optic Gyroscopes (FOG), Ring Laser Gyros (RLG) Hemispherical Resonator Gyroscope (HRG) and high precision MEMS. In Strapdown ADS one or more gyroscopes are used to measure the component of Earth Spin Vector in the local horizontal plane. Azimuth Angle is computed from the gyroscope's readings.

This research is focused on the comparative analysis of different schemes used in strapdown Azimuth Determining Systems (ADS), including, single-position, 2-position, 4-position and multi-position north finding schemes. We have analyzed the pros and cons of these different schemes viz a viz accuracy, precision, sampling-time and total process time.