

Basic Navigation and Guidance

Introduction

The discipline of Navigation and Guidance is concerned primarily with the movement of living beings / objects from one place to another. The subject involves methodologies and mechanisms that help in determining the position and strategies for reaching the desired destination. Living beings, (land, sea, air & space based), have a continuous requirement of moving from one place to another, with specific motion objectives. Any motion scenario involves answering the following questions.

Where am I currently?

How should I move to reach the desired destination?

Navigation & Guidance involve different mechanisms to find answers to the above questions.

Definitions of Navigation and Guidance

As per the dictionary, To navigate means, “to direct the way a craft will travel” OR “to find a direction across, along or over an area of land, sea etc.”. In living beings, the navigation is born out of homing instinct. Typically, Navigation starts at the beginning of the journey and ends when the journey ends. Navigation, in a broader sense, can refer to any skill or study that involves the determination of position and direction in relation to the time.

Guidance is the process of calculating the changes in position, velocity, attitude, and/or rotation rates of a moving object required to follow a certain trajectory and/or attitude profile. Guidance takes input from the navigation system (where am I) and uses targeting information (where do I want to go) to send signals to a control system that will allow the vehicle to reach its destination (within the operating constraints of the vehicle). Therefore, Guidance is the “*driver*” to next location, with Navigation as the current “*location finder*”.

Course Objectives

To provide exposure to basic concepts in Navigation, Guidance and related topics.

To present tools & processes to aid in the determination of parameters of Navigation and Guidance.

Course Contents

Fundamentals of Navigation, Historical Perspective and Navigation Process. Basic Navigation Strategies: Stellar or Celestial Navigation, Radio & Radar based Navigation methods. Dead Reckoning (DR) Based Systems: Ranging and Bearing based methods, Inertial Navigation System (INS) as a special case of DR Strategy. Satellite Based Navigation Methods: GNSS based Navigation.

Fundamentals of Guidance, Route and Path Planning, Map based guidance. Basic Guidance Strategies: Intercept Geometry, Line of Sight and Collision Triangle. Proportional Navigation & Guidance (PNG) and Determination of Miss Distance, Augmented PNG and its comparison with PNG. Advanced Guidance Methods: Command to LOS & Beam Rider Guidance, Lambert’s Guidance.

Pre-requisites

Course does not have any formal pre-requisites. However, good familiarity with basic Kinematics and concept of rotating frames of reference is useful. Also, exposure to numerical techniques for solving differential equations is desirable.

Text/References

Anderson, 'The Principles of Navigation', Hollis & Carter, London, 1966.

Kayton & Fried, ‘Avionics Navigation Systems’, 2nd Ed, Wiley-India, 1997.

Hofmann-Wellenhoff, ‘Navigation: Principles of Positioning and Guidance’, Springer-Wien, 2003.

Zarchan, 'Tactical & Strategic Missile Guidance', Progress In Aeronautics and Astronautics Series, 5th Ed., Vol. 219, AIAA Publication, 2007.

Groves, ‘Principles of GNSS, Inertial and Multisensor Integrated Navigation Systems’, Artech House, 2008.