

In the Name of GOD



Classification of Guidance and Navigation Systems

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Basic Navigation Systems



- Inertial Navigation
 - Strapdown
 - Stable Platform
- Radio Navigation Systems
- Vision-based Navigation
 - Terrestrial
 - Celestial
- Magnetic Navigation

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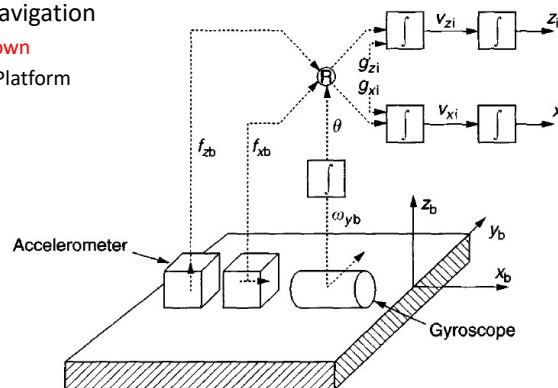
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Basic Navigation Systems



- Inertial Navigation
 - Strapdown
 - Stable Platform

IMU?



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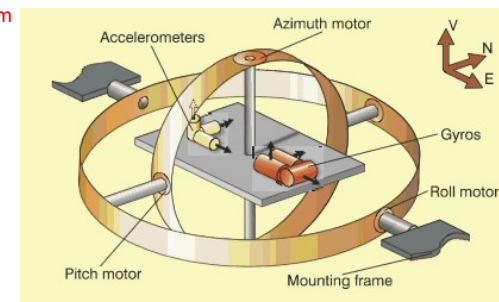
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Basic Navigation Systems



- Inertial Navigation
 - Strapdown
 - Stable Platform



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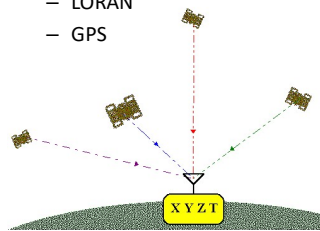
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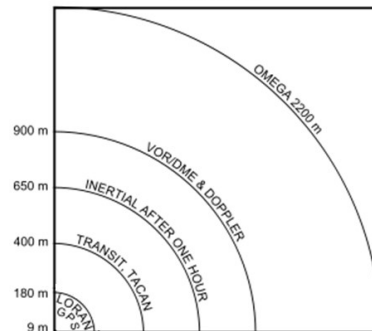
Basic Navigation Systems

- Radio Navigation

- OMEGA
- VOR/DME
- TACAN
- LORAN
- GPS



ACCURACY OF NAVIGATION SYSTEMS
(2-dimensional)



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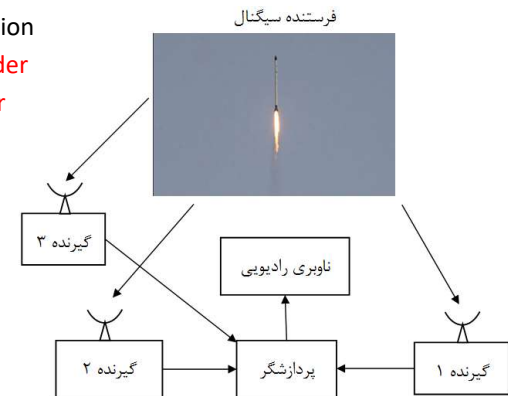
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Basic Navigation Systems

- Radio Navigation

- Single Transponder
- Multiple receiver



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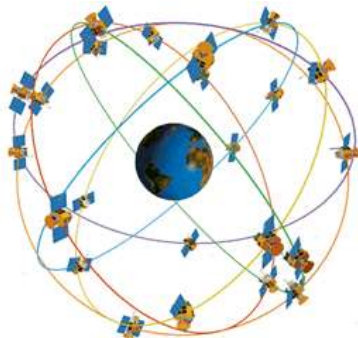
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Basic Navigation Systems

- Radio Navigation (Multiple Transponder, Single Receiver)

- GPS
- GLONASS
- GALILIO
- BeiDou



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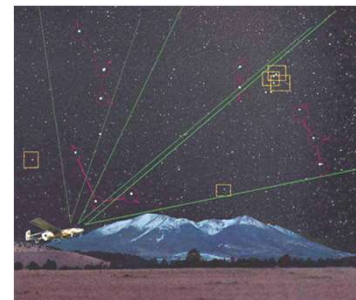
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Basic Navigation Systems

- Vision based Navigation: Celestial

- Finding your way by the sun, moon, stars, and planets

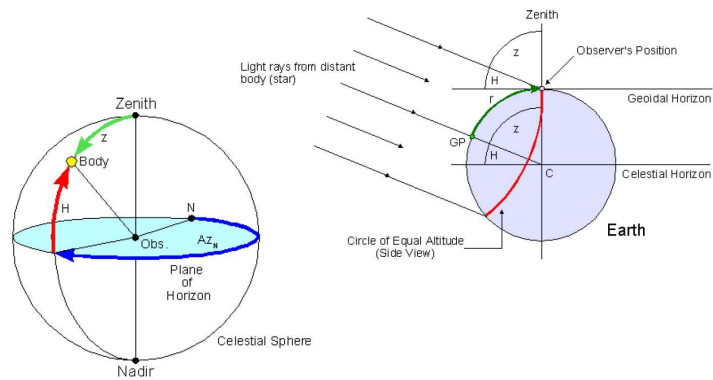


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Celestial Navigation

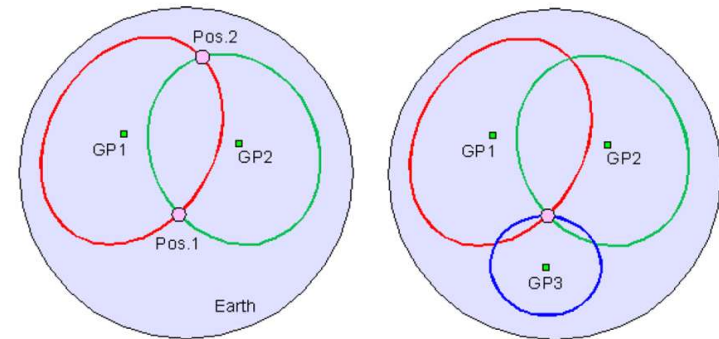


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Celestial Navigation



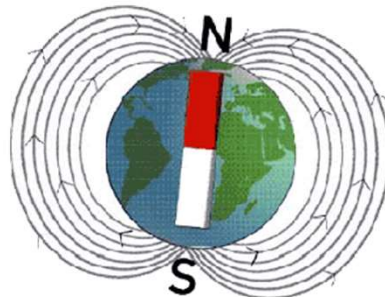
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Basic Navigation Systems

- Magnetic Navigation
 - Finding the north direction using the Earth's magnetic field (geomagnetic field)



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Basic Navigation Systems

- Inertial Navigation
 - robust to external disturbances
 - Non-detectable
 - All weather applicable
 - High rate
 - Increasing error with time
 - Expensive in case of high accuracy
 - Initial Alignment
- Radio Navigation
 - Sensitive to jamming
 - Difficulties in determining attitudes
 - Low rate
 - Constant error with time
 - Low cost

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Basic Navigation Systems



- Vision-based Navigation
 - CPU time
 - Can not be used in **bad weather** condition
 - Low rate
 - Constant error with time
- Magnetic Navigation
 - Error due to **local magnetic fields**
 - Only directions
 - Low accuracy
 - High rate
 - Constant error with time

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Combined Navigation Systems



- Inertial+Radio
- Inertial+Terrain aided
- Inertial+Vision (Terrestrial, Celestial)
- Inertial+Magnetic
- Inertial+Magnetic+Radio



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Classification of Guidance Systems



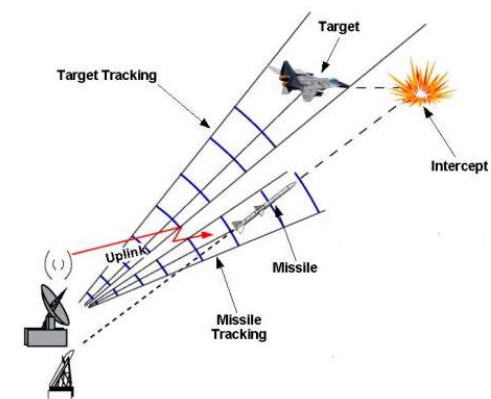
- Command Guidance System
- Beam Rider Guidance System
- Homing Guidance System
- Inertial Guidance System
- Combined Guidance Systems
- Guidance Systems based on Combined Navigation

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Command Guidance System



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Command Guidance System



- Commands are transmitted to the Guided Vehicle (GV) by **radio wave** or by the **wire**
- Characteristics
 - Simple and low cost missile
 - No “Fire and Forget” Capability
 - Few targets can simultaneously be serviced
 - Active tracker is in **danger**
 - Poor in **jamming**
 - Low accuracy for **far targets**
- Roll angle must be controlled
 - It is vital
 - It decouples pitch and yaw channels

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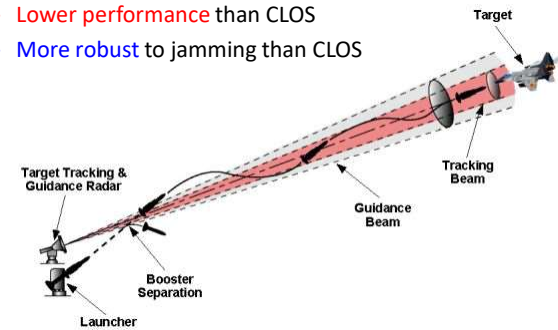
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Beam Rider Guidance System



GV guides itself through the center line of a Radar/Laser beam

- Similar characteristics as command systems
- **Lower performance** than CLOS
- **More robust** to jamming than CLOS



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Homing Guidance System



The guided vehicle detects and tracks the target using the energy emitted by the target

- passive homing
 - Target itself is the source of the energy
- Active homing
 - Target reflects the energy beamed at it by the interceptor
- semi-active homing
 - Target is illuminated by an external source

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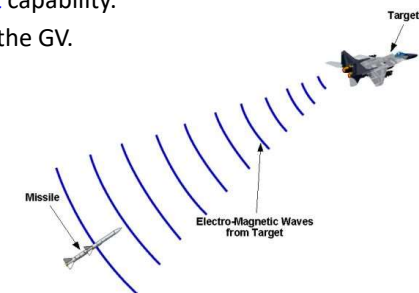
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Passive Homing Guidance System



- It **depends** to emissions reflected from the target
- Lower seeker **weight and size** than active homing
- It has a **fire-and-forget** capability.
- It is difficult to **detect** the GV.
- Lower **cost**



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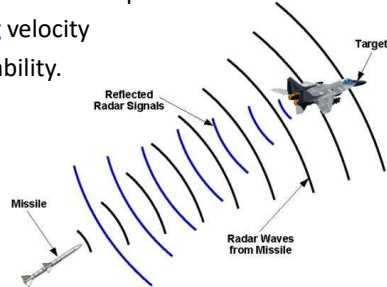
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Active Homing Guidance System



- It is **more expensive** than passive and semi-active homing.
- More **power** consumption than passive and semi-active.
- Limited **range** due to limited size and power.
- Ability to measure **closing** velocity
- It has **fire-and-forget** capability.
- It is easy to be **detected**.



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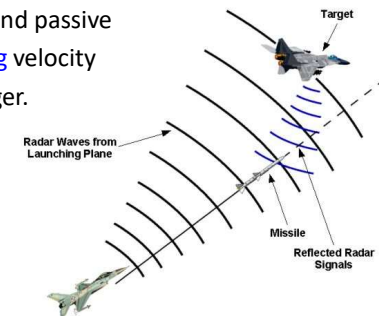
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Semi-active Homing Guidance



- Onboard Complexity: active > semi active \approx passive
- It does not have a **fire-and-forget** capability.
- More **range** than active and passive
- Ability to measure **closing** velocity
- The **illuminator** is in danger.



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Inertial Guidance



- Uses **INS** as the Navigation System
- Guidance calculations are performed in an **inertial frame**
- Guidance calculations are performed **within GV**
- GV usually follows a **predefined** trajectory
- **Applications**: Ballistic Missiles, Launch Vehicles, Airplanes, ...
- It is an **autonomous** guidance system

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Combined Guidance Systems



- Inertial+Homming
- Command+Homming
- Command+Inertial+Homming
- Guidance Systems based on Combined Navigation
 - Inertial+Radio
 - Inertial+Terrain aided
 - Inertial+Vision
 - Inertial+Celestial
 - Inertial+Magnetic
 - Inertial+Magnetic+Radio

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