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Guidance Control and Tracking of a Missile

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Abstract: -- The scope of Guidance and Tracking and Classification encompasses many disciplines, including infrared, far infrared, millimeter wave, microwave, radar, and synthetic aperture radar sensors as well as the very dynamic topics of signal processing, computer vision, and pattern recognition. It is a fertile area for growth in both analysis and experimentation in military applications. The availability of ever improving computer resources and continuing improvement in sensor performance has given great impetus to this field of research. This technology "push" has been balanced by a technology "pull" resulting from increasing demand from potential users of this technology including both military and civilian entities as well as needs arising from the growing field of Homeland Security.

The original tentative of guidance control has been focused mostly on the development of target detection, tracking, and classification associated with visible range sensors in day and in other hostile environments. In the last decade, infrared, thermal and other non-visible imaging sensors were used in special areas like military. That lower interest level in heat sensors was due in part to the high cost of non-visible range sensors, low image resolution, high image noise, lack of widely available data sets, and lack of consideration of the potential advantages of non-visible lights. These historical objections are becoming less relevant as infrared imaging technology advances and their cost is dropping dramatically. Image sensing devices with high dynamic range and high IR sensitivity have started to appear in a growing number of applications ranging from military and automotive domains to home and office security applications. In order to develop robust guidance and tracking system and accurate systems that operate in and beyond the radar frequency range, not only existing methods and algorithms originally developed for the existing range should be improved and adapted, but also entirely new systems that consider the potential advantages of frequency ranges are certainly required. The fusion of visible and non-visible ranges, like radar and IR images, or thermal and visible spectrum images, is another dimension to explore for a higher performance of vision-and-signal based systems. The tracking system is widely employed in vision-based systems, and many detection and recognition systems available today are relying on physiological phenomena produced by IR and thermal wavelengths..

It has to be noted that this paper is the result of the seminar report of the UG BE curriculum of the 8th semester that was undertaken by Mr. Naveen under the guidance of the faculty & the HOD.

Keywords: GPS, INS, GOT, GOLIS

1. INTRODUCTION

1.1 In common military parlance, the word missile describes a powered, guided munition, whilst the word "rocket" describes a powered, unguided munition. Unpowered, guided munitions are known as guided bombs. A common further sub-division is to consider ballistic missile to mean a munition that follows a ballistic trajectory and cruise missile to describe a munition that generates lift.

1.2 Technology

Guided missiles have a number of different system components:

- targeting and/or guidance
- flight system
- engine
- warhead

1.2.1 Guidance Systems

Missiles may be targeted in a number of ways. The most common method is to use some form of radiation, such as infra-red, lasers or radio waves, to guide the missile onto its target. This radiation may emanate from the target (such as the heat of an engine or the radio waves from an enemy radar), it may be provided by the missile itself (such as a radar) or it may be provided by a friendly third party (such as the radar of the launch vehicle/platform, or a laser designator operated by friendly infantry). The first two are often known as fire and forget as they need no further support or control from the launch vehicle/platform in order to function. Another method is to use a TV camera - using either visible light or infra-red - in order to see the target. The picture may be used either by a human operator who steers the missile onto its target, or by a computer doing much the same job. Many missiles use a combination of two or more of the above methods, to improve accuracy and the chances of a successful engagement.

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1.2.2 Targeting Systems

Another method is to target the missile by knowing the location of the target, and using a guidance system such as INS, TERCOM or GPS. This guidance system guides the missile by knowing the missile's current position and the position of the target, and then calculating a course between them. This job can also be performed somewhat crudely by a human operator who can see the target and the missile, and guides it using either cable or radio based remote-control.

1.2.3 Flight System

Whether a guided missile uses a targeting system, a guidance system or both, it needs a flight system. The flight system uses the data from the targeting or guidance system to maneuver the missile in flight, allowing it to counter inaccuracies in the missile or to follow a moving target. There are two main systems: vectored thrust (for missiles that are powered throughout the guidance phase of their flight) and aerodynamic maneuvering (wings, fins, canards, etc).

Fig 1 - Exocet missile in flight

2. GPS/INS refers to the use of GPS satellite signals to correct or calibrate a solution from an Inertial Navigation System (INS). Inertial navigation systems usually can only provide an accurate solution for a short period of time. The INS accelerometers will produce an unknown gives an absolute drift-free position bias signal that appears as a genuine specific force. This is integrated to produce an error in position. Additionally, the INS software must use an estimate of the angular position of the accelerometers when conducting this integration. Typically, the angular position is of the unit. The GPS value that can be used tracked through an integration of the angular rate from the gyro sensors. These to reset the INS solution or may be blended also produce unknown biases that affect the integration to get the position with it by use of a mathematical algorithm such as a **Kalman Filter**. The angular orientation of the unit may be inferred from the series of position updates from the GPS. The change in the error in position relative to the GPS may be used to estimate the unknown angle error.

The benefits of using GPS with an INS are that the INS may be calibrated by the GPS signals and that the INS can provide position and angle updates between the 1 second GPS updates. For high dynamic vehicles such as missiles and aircraft, the 1 second delay is unacceptable for guidance and control; the INS fills in the gap. Additionally, GPS may lose its signal and the INS can continue to compute the position and angle during the period of lost GPS signal. The two systems are complementary and are often employed together.

The **Kalman filter** is an efficient recursive filter that estimates the state of a linear dynamic system from a series of noisy measurements. It is used in a wide range of engineering applications from radar to computer vision, and is an important topic in control theory and control systems engineering. Together with the linear-quadratic regulator (LQR), the Kalman filter solves the linear-quadratic-Gaussian control problem (LQG). The Kalman filter, the linear-quadratic regulator and the linear-quadratic-Gaussian controller are theory solutions to what probably are the most fundamental problems in control.

An **Inertial Navigation System** (INS) is a navigation aid that uses a computer and motion sensors to continuously track the position, orientation, and velocity (direction and speed of movement) of a moving object without the need for external references. Other terms used to refer to inertial navigation systems or closely related devices include inertial guidance system, inertial reference platform, and many other variations.

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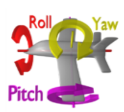


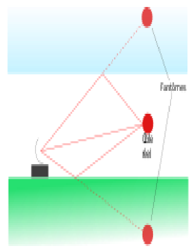

4 RADAR TRACKING OF A MISSILE

A radar system has a transmitter that emits either microwaves or radio waves that are reflected by the target and detected by a receiver, typically in the same location as the transmitter. Although the signal returned is usually very weak, the signal can be amplified. This enables radar to detect objects at ranges where other emissions, such as sound or visible light, would be too weak to detect.

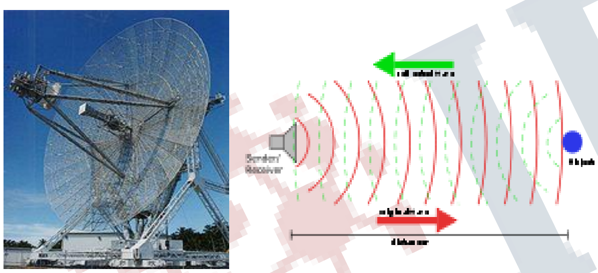

Fig- Long range radar & for Radar Operation

A. 4.1 Principles

A radar dish or antenna, sends out pulses of radio waves or microwaves. These waves bounce off any object in their path, and return to the dish, which detects them.

- Clutter
- Clutter refers to actual radio frequency (RF) echoes returned from targets which are by definition uninteresting to the radar operators in general.
- Jamming
- Radar jamming refers to radio frequency signals originating from sources outside the radar, transmitting in the radar's frequency and thereby masking targets of interest.
- Speed measurement
- Speed is the change in distance to an object with respect to time.
- Reduction of interference effects
- Signal processing is employed in radar systems to reduce the radar interference effects.
- Plot And Track Extraction
- Radar video returns on aircraft can be subjected to a plot extraction process whereby spurious and interfering signals are discarded.

Radar equation : The amount of power Pr returning to the receiving antenna is given by the radar equation:

$$P_r = \frac{P_t G_t A_r \sigma F^4}{(4\pi)^2 R_t^2 R_r^2}$$

where

- Pt = transmitter power
- Gt = gain of the transmitting antenna
- Ar = effective aperture (area) of the receiving antenna
- σ = radar cross section, or scattering coefficient, of the target
- F = pattern propagation factor
- Rt = distance from the transmitter to the target
- Rr = distance from the target to the receiver.

In the common case where the transmitter and the receiver are at the same location, Rt = Rr and the term Rt^2 Rr^2 can be replaced by R4, where R is the range. This yields:

$$P_r = \frac{P_t G_t A_r \sigma F^4}{(4\pi)^2 R^4}$$

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This shows that the received power declines as the fourth power of the range, which means that the reflected power from distant targets is very, very small. The equation above with F = 1 is a simplification for vacuum without interference. The propagation factor accounts for the effects of multipath and shadowing and depends on the details of the environment. In a real-world situation, pathloss effects should also be considered. Other mathematical developments in radar signal processing include time-frequency analysis (Weyl Heisenberg or wavelet), as well as the chirplet transform which makes use of the fact that radar returns from moving targets typically "chirp" (change their frequency as a function of time, as does the sound of a bird or bat).

CONCLUSION

In order to improve the effectiveness of guidance systems newer algorithms and systems are being developed. In this seminar report presented by the UG student, I considered the detection of moving and airborne targets. The report has details of :

- Automatic object detection
- Object tracking
- Fusion of vision & radar data
- Combining visible & non-visible signals

REFERENCES

[1]. E.D. Kapan, Understanding GPS Principles and Applications, Artech House, Norwood , MA,1997.

[2]. Timothy Pratt,Charles W. Bostian,Jeremy E. Allnutt, Sattelite Communication,Wiley Publication, 2nd Edn., 2003.

[3]. Garnell, Guided Weapon Control Systems,Pergarmon Press,1980.

[4]. Merrill I. Skolnik, Introduction to Radar Systems, Tata McGraw-Hill Publication , 3rd Edn,2001.

[5]. Song, T.L., "Target adaptive guidance for passive homing missiles," Aerospace and Electronic Systems, IEEE Transactions on, vol.33, no.1, pp.312-316, Jan. 1997