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Survey on INS

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Abstract — Here we discuss regarding the inertial navigation system (INS)and about inertial measurement unit (IMU), types of sensors used in INS. The INS is capable of providing continuous estimates of a vehicle's positioning orientation. Two types of INS systems that are strap down and gimbaled. Difference between INS and GPS is also covered.

Keywords-component: Inertial Navigation System, GPS, Inertial Measurement Unit, Accelerometer, Gyroscope.

I. INTRODUCTION

Inertial navigation is a technique in which accelerometers and gyroscopes are used to track the position and orientation of an object and velocity. Inertial measurement units (IMUs) contain three gyroscopes which are orthogonal and three accelerometers orthogonal, measuring angular velocity and linear acceleration respectively. Signals are processed with this device to track the position and orientation of a device.

We introduce inertial navigation, focusing on strap down systems based on MEMS (micro machine electromechanical system) devices [1]. For a simple inertial navigation system (INS) based on the inertial measurement unit (IMU), we show that the after 60 seconds of operation average error in position grows to over 150 m .
The propagation of orientation errors caused by noise altering gyroscope signals is the critical cause of such drift. We examine the significance of individual noise processes altering the gyroscope signals by simulation, identifying white noise as the process, This contributes most to the overall drift of the system.
Sensor fusion and domain specific constraints can be used in INS (to reduce drift).

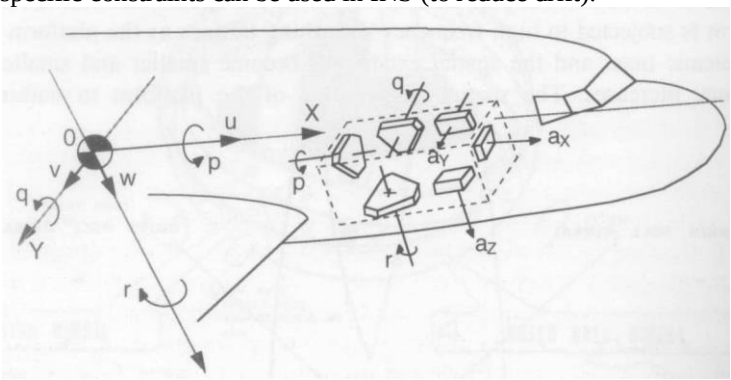

Figure 1. Orientation of axes

The INS consists of gyroscopes (3-axis) which give the system computer the roll, pitch and yaw rates about the body axes (Figure 2).The accelerations along the body axes is given by 3axis accelerometer. Usually two basic inertial mechanisms can be used to derive Euler angles from the rate gyros, viz. stable platform and strap-down INS. We would be concerned with the strap-down INS where the gyros and accelerometers are `strapped-down' to the aircraft body frame. The acceleration values from the accelerometers are then corrected for rotation of the earth and gravity to give the velocity and position of the aircraft.

Inertial navigation is used in a wide range of applications such as navigation of aircraft, tactical and strategic missiles, spacecraft, submarines and ships. Recently in the advanced construction of MEMS devices have made it possible to manufacture various such as small and light inertial navigation systems. The range of possible applications such as human and animal motion capture have been widened by these advances.

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II. TWO TECHNIQUES OF INS

There are many different design of ins with different performance characteristic but generally they fall under two categories .

1.Gimbaled or stabilized technique
2. Strap down technique

Gimbals is usually a device used for keeping an instrument in moving airspace or it is pivoted support that allows rotation of object about single axis. Stabilize here means to maintain stability by means of stabilizer, In aircraft we can say to put or keep in equilibrium by 1 or more special device. In figure roll , pitch yaw, is usually in vertical, longitudinal and latitudinal. Gimbals in an INS are mounted inside one another, and they are used to null out rotation of stable platform on which Inertial sensors are mounted

III. GIMBALED INS SYSTEM

In this system (Figure 3) integrated gyros gives an output which is proportional to angle through which they have been rotated. output of each gyro connected to servomotor so that they drive appropriate gimbals thus keeping gimbals in constant orientation in inertial space.

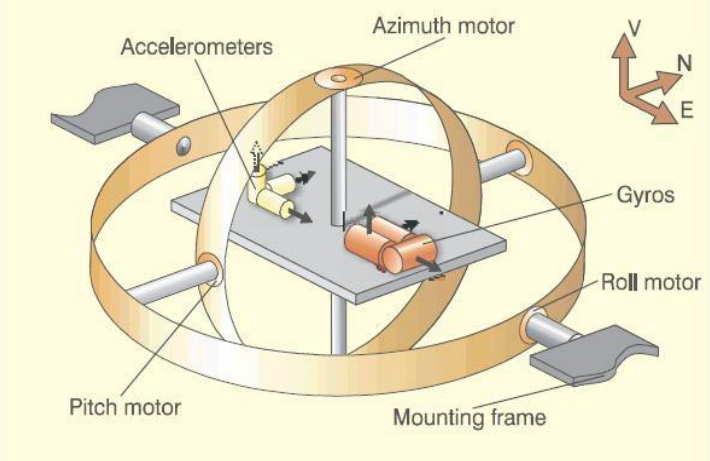

Figure 4 Gimbaled INS

The difference between stabilized and strap down INS is the frame of reference in which the rate of accelerometer and gyroscope operate .Usually two frame exist in INS and they are body frame and other is global frame. Platform which is isolated from any external rotation motion on such platform inertial sensors are mounted, rotational motion in the sense platform is held in alignment with global frame so to achieve this platform we use gimbals. To calculate position of device signals from accelerometer need to be double integrated. Before performing integration we need to subtract acceleration due to gravity.

IV. STRAP DOWN INS SYSTEM

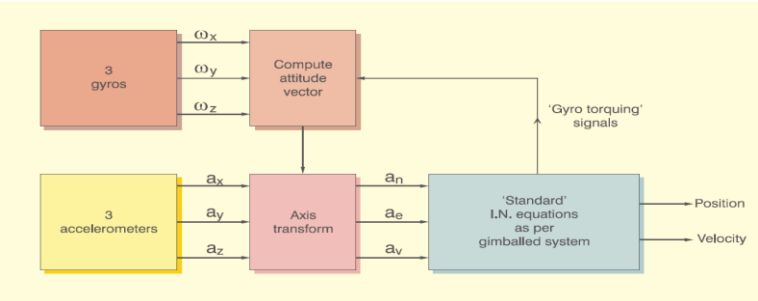

Figure 5 Block Diagram Of Strap down

Here (Figure 6) accelerometers are directly mounted to airframe and inertial are mounted on to device. Therefore in this system output quantities are measured in body frame rather than in global frame. If we integrate signal from gyroscope we get track of orientation and to get position accelerometers are resolved into global coordinates using orientation which is known.

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V. GPS AND INS DATA FUSION

IMUS are commonly used as separate tools, Usually IMUS are often used as supplying unit for positioning system for example GPS that is global positioning system, GPS is not capable for working inside the building or tunnels because there is no acceleration and orientation data. For object precise navigation GPS signal accuracy is not sufficient. All these lacking information that is required for precise navigation can be obtained from inertial measurement units. Integration of IMU and GPS into one system called as INS is implemented in three ways

1. Loosely coupled
2. Tightly coupled
3. Ultra tightly coupled

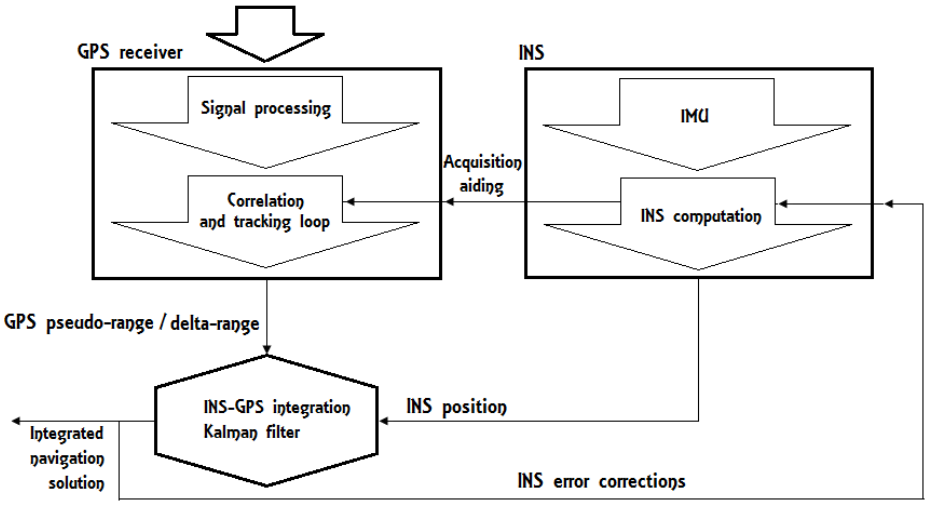

Figure 7 Tightly coupled integration type schema.[2]

GPS integration (Figure 8) has made inertial navigation platform better and it even made its(INS) cost less.INS also benefits GPS performance during loss of GPS signal by carrying navigation. Loosely coupled here INS data and GPS data like position, velocity are fused. This kind of system are usually dependent on GPS data availability and in tightly coupled GPS raw measurement fused directly with INS data ,In ultra tightly coupled INS output is used as external input to GPS receiver.

VI. ADVANTAGES

- It can operate in tunnel under water as well as anywhere else, and it is autonomous and doesn't relay on external aids.
- Derivatives of variable to be controlled (e.g., position, velocity, and attitude) are measured by its IMU.
- It is suited for integrated navigation, guidance and control of host vehicle and as no external antennas are required it is immune to jamming and neither receives nor emits radiation.

VII. DISADVANTAGES

- Heat dissipation is proportional power requirements to and is shrinking with respect to it.
- Power requirement are still higher than those for GPS receivers.
- Size and weight have been shrinking.

VIII. CONCLUSION

Following the above description we can conclude that INS is the emerging technology which will have great scope in automobile industry. We (India) have our own GPS as seventh navigation satellite was launched successfully.

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