

How to Significantly Improve the Flight Accuracy of UAVs

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The Unmanned Aerial Vehicle (UAV) Market

Commonly referred to as drones, UAVs are aircraft without a human pilot on board, and are part of a more elaborate unmanned aircraft system (UAS) that also includes a ground-based controller and a communication method for the controller to interact with the UAV. When in flight, UAVs can operate autonomously via internal electronics or be guided by a human operator at the remote controls. In either case, UAVs rely heavily on various sensors to ensure they are performing the way they are intended.

To function properly, UAVs rely on several sensors to measure various conditions and help instruct the system to adjust. Some of the sensors in UAVs include:

- 1) Gyroscopes used to determine the rate of rotation, degree of tilt and angular velocity.
- 2) Accelerometers used to determine linear movement along any axis.
- 3) Barometers used to measure air pressure and determine and maintain a stable altitude.
- 4) Pitot Tubes used to measure the air speed of winged UAV.
- 5) Angle of Attack (AOA) to measure the flow angle of winged UAVs and plays a critical role in determining the aerodynamic forces of the aircraft.
- 6) Magnetometers used to indicate the strength and direction of the magnetic field to verify heading.
- 7) GPS to determine the positioning of the UAV based on signalling from GPS satellites.
- 8) Obstacle avoidance sensors to ensure a UAV or drone does not crash into another object. These avoidance systems can include one or more of stereoscopic sensors (visual cameras to see objects), LiDAR (emit light pulses via lasers to measure distances of objects), ultrasonic sensors (ultrasonic waves to determine distance from objects) and infrared sensors (similar to ultrasonic sensors but use infrared signals instead of ultrasonic waves).

For this article, we are going to focus on the third and fourth types of sensors listed above as they require highly accurate pressure sensors: barometers and pitot tubes. Note that the first three items are sometimes fused together to create an Inertial Measurement Unit (IMU) to measure among various parameters the pitch, roll and yaw of the UAV.

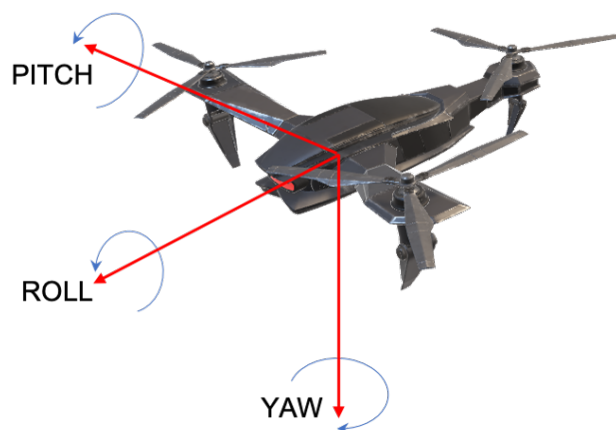


Figure 1 – UAV Roll, Pitch and Yaw

The Role of Differential Pressure Sensors in IMUs

The IMU is a critical part of UAVs, as it is used to measure altitude, acceleration and angular movement. Of these three items, differential pressure sensors can be used as a barometer to measure altitude.

Barometer

Air pressure varies by altitude – the higher you go, the lower the pressure. As a barometer is used to measure changes in altitude, a differential pressure sensor can rapidly measure changes in atmospheric pressure to help ensure the UAV is flying at the correct elevation.

Accelerometer

As an accelerometer is used to measure air speed to ensure the device maintains a stable rate of movement despite changing wind conditions and other factors.

Gyroscope

Gyroscopes are used to measure angular movement. This can apply for any axis movement – roll, pitch and yaw.

The Role of Differential Pressure Sensors in Pitot Tubes

Pitot tubes measure airspeed, which is the UAVs speed relative to the air around it. It is positioned on the exterior of the UAV and uses a differential pressure sensor to measure the difference between the pressure of still air (static pressure) and that of moving air compressed by the aircraft's forward motion (ram pressure). As speed increases, the difference between these pressures also increases.

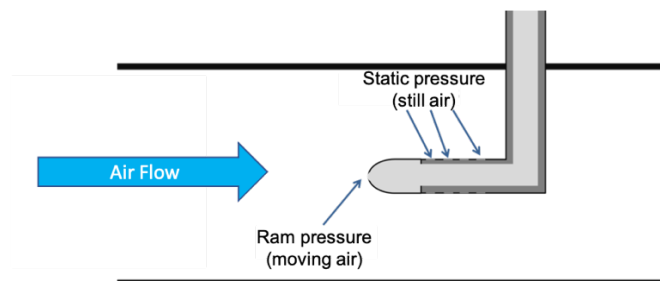


Figure 2 – Pitot Tube Diagram

Superior Sensor's Technology Advantage

Superior Sensors' proprietary [NimbleSense™](#) architecture is the industry's first System-in-a-Sensor integrated platform. It incorporates a highly differentiated advanced pressure sensing system with the ability to integrate optional building blocks to combine the highest accuracy and

reliability with lower overall system cost. This unique technology provides many advantages for UAVs and other airborne devices.

Lowest Noise Floor

One of the biggest impediments to differential pressure sensors deployed in UAVs is the noise generated by both the drone and external elements such as wind. Utilizing an integrated [advanced digital filtering](#) technology, Superior's pressure sensors eliminate the noise created by these factors prior to their reaching the sensor sub-system. Thus, the noise is eliminated before it becomes an error signal that can lead to inaccurate air pressure reading.

Highest Levels of Accuracy

With a fast moving UAV, any deviation in altitude, speed or angle of attack can have an impact on its trajectory. To minimize this potential impact, you need a differential pressure sensor with the highest levels of accuracy. Superior's sensors boast industry leading accuracy to as close as within 0.05% of the selected range and total error band (TEB) within 0.10% of FSS.

Fastest Response Times

As a complement to accuracy, the amount of time it takes the pressure sensor to update its measurement data is just as crucial for a UAV. The faster you receive updated pressure measurements, the better you can have the drone maintain its accurate positioning. While user configurable, Superior's sensors support update rates as fast as 1 msec.

Sensor Customization and Flexibility

As UAVs can utilize multiple pressure sensors, the ability to design in one sensor that is then customized for each application on the drone is a huge advantage both from a design efficiency and product cost perspective. The NimbleSense architecture allows you to deploy the same sensor for all your UAV pressure sensing needs. Depending on the application, you configure the sensor to be optimized for that specific purpose. There are many features you can customize such as pressure range, bandwidth filter and output data rate.



Figure 3 – Image of a UAV in flight

Conclusion

UAVs are sophisticated devices that require a constant stream of flight information. Pressure sensors are instrumental in providing this data, enabling drones to fly without issues. However, deviations in air pressure readings, due to slight errors in measurements, can have a larger impact on the trajectory and performance of the UAV. Thus, the most demanding products require differential pressure sensors that eliminate the effects of noise, provide extremely high accuracy, offer the fastest response times and can be customized for each specific drone function.

Based on its NimbleSense architecture, Superior Sensor Technology's differential pressure sensors offer the ultimate design flexibility with unmatched performance for more accurate and reliable UAV solutions. For detailed information about our solutions for UAVs or to learn how we can help you improve your drone products, please [contact us](#).

SuperiorTM SENSOR TECHNOLOGY

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