Sharp Senses for Industrial Drones

The built-in sensor technology is a decisive factor for the quality and application possibilities of drones.

Dirk Thümer

Unmanned aerial vehicles, also called drones, are going to be a big thing. Between drones for military reconnaissance and combat and the booming toy multicopter market is a broad range of commercial applications. A decisive factor for the quality and application possibilities of drones is the built-in sensor technology and the know-how of specialists.

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Drones can be used for a wide range of applications such as the recording of geographical information or the inspection of buildings and technical facilities.

Unmanned aerial vehicles (UAVs) are an attractive growth market: The market research company Gartner predicted that more than three million drones will be delivered worldwide in 2017. Sales of UAVs are expected to increase by 34 % to 6 billion dollars, and to 11.2 billion dollars by 2020. Market researchers expect significant growth, particularly in the field of industrial inspection (oil, gas, energy, infrastructure, transport). By 2020, this sector might account for about thirty percent of the commercial drones market. Delivery drones on the other hand, though a popular daily press news topic, will stay a mere niche with a share of probably less than one percent by 2020.

Wide Range of Requirements

Sensors are vital components of any drone. Only sensor systems with suitable performance lend commercial drones the flight characteristics they need. Sensors also determine the application possibilities of commercial UAVs. Police surveys, traffic monitoring or searches for missing persons, reconnaissance flights in disaster control, the recording of geographical information or the inspection of buildings and technical facilities: Different tasks require different sensors, or rather different sensor combinations.

While the hard price pressure in the hobby drone market does not leave much leeway for cameras or motion sensors, the sensor equipment is an important feature in professional target markets. Sensor types used in drones are:

- Lidar for collision avoidance, navigation and as a 3D scanner,
- range finders for collision avoidance and navigation,
- cameras for observation, data acquisition, navigation and collision avoidance,
- radar for collision avoidance and navigation,
- inertial measuring units (IMU) for navigation,
- pressure gauges for data collection and navigation, and
- GPS for position determination.

This listing shows that many special skills are required here. Drone manufacturers outside the defense industry rarely can offer all those on their own. Companies wanting to conquer this growth market usually rely on partnerships with sensor manufacturers that are experienced in industry and aeronautics. But these partners have to offer additional skills apart from the pure sensor know-how. Customizing capabilities are just as necessary as manufacturing according to industrial quality standards, and the ability to reliably supply samples and medium quantities at reasonable prices and over a longer period of time. Even large sensor manufacturers often fail in this regard, so that medium-sized specialists for industrial sensors such as First Sensor can score points. Here are some examples.

Long-range Lidar Systems

Detection and ranging systems with light or lasers (lidar / ladar) serve as optical systems and determine the fields of applications of commercial drones. Like the radar systems in large flight systems, they measure distance, speed and partial atmospheric parameters. In addition to the use for navigation, they are also used for three-dimensional recording of the environment as user data. The essential components are avalanche photodiode arrays (APD).

Dirk Thümer, Head of Solution Management, First Sensor AG, Peter-Behrens-Str. 15, 12459 Berlin, Dirk.Thuemer@first-sensor.com

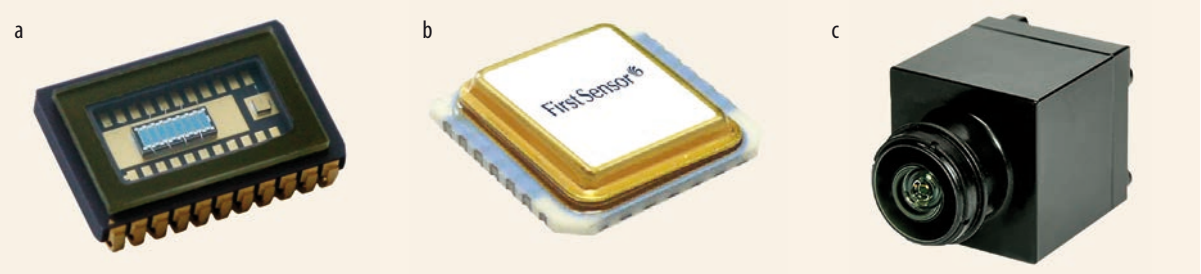

Fig. 1 For lidar systems, First Sensor offers silicon avalanche photodiodes as single elements as well as line arrays (a) or matrix arrays consisting of several active sensor areas. The inertial sensors are based on single-crystal silicon sensor elements and micromechanical manufacturing combined with ASIC signal processing in a hermetically sealed SMD package (b). The HDR CMOS cameras are designed to withstand toughest environmental conditions (c).

IR-APDs are used for long-range lidar systems. Integrating these components into the systems often requires customizing, and the APD supplier should be experienced in aerospace industry.

Movement and Location

Inertial measuring units that detect the direction of movement, the acceleration and the inclination angle are needed for controlling the UAV. These sensors are essential for the precise steering and the stabilization of the flight position for the actual measurement tasks. It is recommended to integrate high-quality microsystems with high sensitivity on the PCB of the UAV control system.

First Sensor offers a technology platform with capacitive inclinometers and accelerometers based on single-crystal silicon sensor elements. They achieve a very good signal-to-noise ratio and a high temperature stability. Even the smallest changes in position or acceleration are detected which is a precondition for the use of drones in measurement applications. The high aspect ratio microstructures (HARMS) ensure lowest cross-sensitivity. In addition, the patented AIM technology (air gap insulated microstructures) minimizes parasitic capacitances by insulating the active areas by air gaps. Furthermore, the supplier should be experienced in the aviation industry, and able to adapt the sensor measuring ranges to the requirements of the UAV and the application.

Viable Camera Solutions

Here it is necessary to distinguish between the real-time imaging which permits the remote-control operator to virtually sit in the "cockpit" of the drone, the digital imaging for automatic navigation, and optical data collection.

Robust high-quality camera systems are widely used in the field of driver assistance systems. Suppliers to the automotive industry know how to build reliable systems and, above all, how to test their suitability. Developments and trends from this sector can be used to quickly achieve viable solutions by adapting proven standard sensors. Modular systems offer the flexibility to meet various requirements in user data collection, such as infrared, different resolutions and optics.

What is more, local intelligence can be employed as it is common with sensors for autonomous safety systems. Evaluating the images via nearby subsystems reduces the data volume that has to be processed by the computer of the drone or sent to the controller. So, for example, only the result of a pattern recognition has to be transmitted without burdening the system with unnecessary image information.

Suitable Development Partners

Commercial drones with observation and analysis functions are a growth market where – in contrast to the hobby sector – price is not the primary factor. Drone suppliers who want to stand out from their competitors have to earn credits for superior functionality and reliability. The quality of the "sensory perception" of a UAV enables a safe flight and justifies the deployment and its costs.

Manufacturers can shorten their time-to-market by looking for sensor suppliers who can act as development partners. Ideal are partners who are experienced in industries with high standards in quality and functional testing, like aerospace and automotive. Such partners are better suited to contribute to engineering tailored sensor systems than mere component suppliers. Moreover, highly specialized commercial UAVs are often produced in low quantities, so manufacturers need partners who offer adequate supply flexibility.

Sensors in Drones

For lidar systems, First Sensor offers silicon avalanche photodiodes as single elements, as well as line arrays or matrix arrays consisting of several active sensor areas. Latest inertial sensors are based on single-crystal silicon-sensor elements and patented micromechanical manufacturing processes (HARMS, AIM) combined with ASIC signal processing in a hermetically sealed SMD package.

First Sensor's compact HDR CMOS cameras feature a wide range of digital interfaces for easy and flexible integration into vehicle electrical systems. The robust cameras are designed to withstand toughest environmental conditions, such as temperature changes or vibrations.