SENSOR SOLUTIONS PLAY CRITICAL ROLES IN ENABLING INNOVATION IN DRONES

In today's fast growing drone market segment, sensor technologies are often the unheralded secret sauce inside. In this article, we discuss the current state of drones and the sensor technology that empowers them.

Industrial drones are a substantial growth industry. The market research firm Tractica estimates that annual worldwide shipments of commercial drones will reach 2.7 million units in 2025. Services enabled by these drones could generate annual revenue of $8.2 billion.

In the past, innovations in drone technology extensively focused on military applications. However, recently the trend has instead started to focus on the commercial market. Here are some important industry verticals where growth is expected:

Cargo Transport and Delivery

Drones can be used to transport medicines and smaller utility items to and from areas that are remote or not readily accessible by conventional means. They can also play a role in delivering supplies to disaster stricken areas such as those that have experienced earthquakes, floods, and disease outbreaks. For commercial delivery, Amazon and Google also announced in 2013 that they are planning to use drones as part of their delivery service to deliver orders to their customers within a couple of hours. One critical hurdle is FAA flight rules. Although drones are currently limited to line of site from the operator, further modification of FAA rules may allow beyond visual range deliveries to commence. The FAA currently has a committee of 27 companies and trade associations currently investigating and recommending flight rules for commercial drones based on drone size and flight paths over people. We expect continued focus on defining tests and flight rules, with the ultimate goal of allowing autonomous drones to become a part of everyday commerce.

Monitoring and Surveying

Surveying and monitoring are also a substantial growth sector. Some examples include geomagnetic surveying, which can be used to predict the location of mineral deposits, gas and oil pipeline monitoring, disaster area inspection, and wildfire detection and prevention. Other used include investigation and data collection such as archaeology. Archaeologists can use drone technology to create three-dimensional models of sites, which can save months of time for the researchers.

Conservation and Animal Rights

Conservation groups and animal rights organizations are using drones to good effect in their efforts to curb abuse. For example, The World Wildlife Fund for Nature (WWF) started to use drones in 2012 to help aid conservation efforts in Nepal. They were used to monitor the populations of rhinos, tigers, elephants and deer. The WWF has also worked with the Namibian government, using drones to help reduce rhino poaching. Anti-whaling activists such as Sea Shepherd have used drones to monitor Japanese whaling ships.

Law Enforcement

For the last several years, police in many countries have used drones to monitor suspects and public places. Drones may be equipped with non-lethal tools such as Tasers to identify criminals and facilitate arrest. An example of this is being tested in North Dakota, with Taser-armed drones known as Predators. Other drones are equipped with sensors to identify chemical, biological, radiological and/or nuclear materials.

Commercial Filmmaking

The media and filmmakers make use of drones to capture images and video, which would otherwise be taken by a helicopter or expensive crane gear. Drones reduce costs dramatically, and can also improve the process by being more agile and maneuverable, offering the director more flexibility to get the right shot. Drones are also used to capture sporting events to get a dynamic, close-up look at the athletes or game in progress. These drones capture the excitement of a moving image that precedes or follows a fast moving athlete. Accelerometer sensors work with the guidance system of the drone to make that possible.

An example of a commercially available drone for filmmaking is DJI's Phantom 3, which is extensively used for filmmaking, and with a price of only $999, is one of the lower cost drones available in the market. Recently, GoPro has announced that it will be investing in a drone, which uses its camera for video recording.

Agriculture

Drones use in agriculture has increase substantially over the last several years. Farmers use drones to monitor and improve crop health and irrigation, livestock location and gazing patterns. Given issues such as dealing with severe drought, drones will become increasingly important as a useful tool for the agriculture industry. According to a Bank of America Merrill Lynch global research report, the agricultural drone market has the potential to generate more than 100,000 jobs in the U.S and $82 billion in economic activity between 2015 and 2025.

Healthcare

The use of drones in healthcare is also gaining attention. Small drones can be used inside of medical facilities to efficiently and autonomously carry and deliver medicine to the bedside of a patient. They can also be used to deliver critical items such as blood for analysis and medical supplies.

Ambulance drones are also being tested. These drones can be used to deliver automatic external defibrillators increasing the survival rates with cases of cardiac arrests. Prototypes have been conceived and developed by TU Delft University in the Netherlands.

The Technology That Makes Drones Work

Given the current growth trends for drones, what are the underlying sensor technologies that make them work?

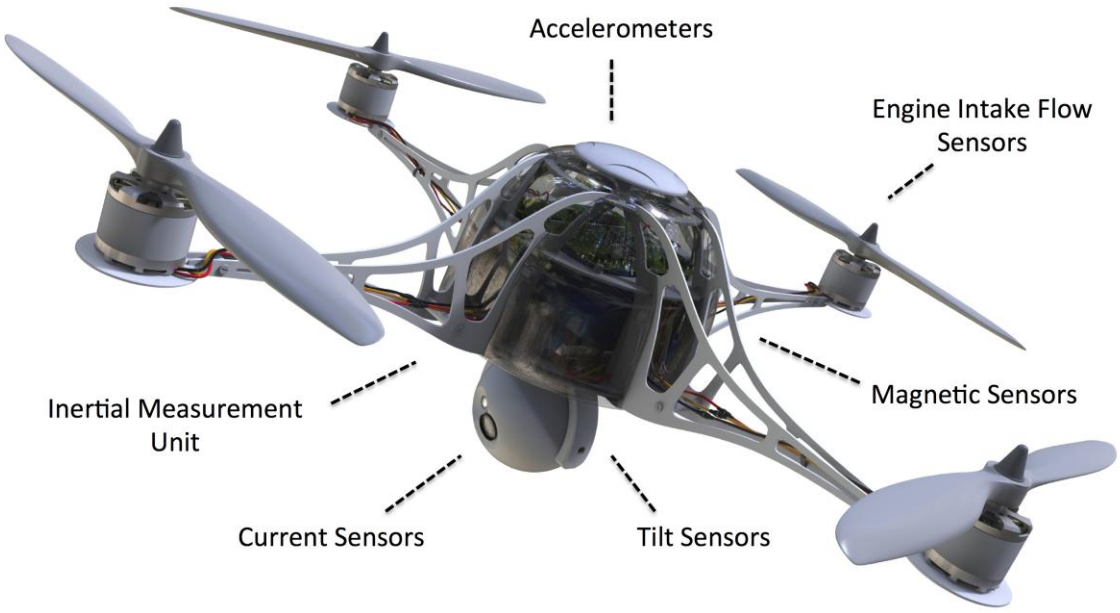

Figure 1 – Sensor technologies are used in a variety of ways in modern drone technologies and solutions.

Accelerometers

Accelerometers are used to determine position and orientation of the drone in flight. Like your Nintendo Wii controller or your iPhone screen position, these small silicon-based sensors play a key role in maintaining flight control. MEMS accelerometers sense movement in several ways. One type of technology senses the micro movement of very small structures embedded small integrated circuit. The movement of these small 'diving boards' change the amounts of electrical current moving through the structure, indicating change of position relative to gravity.

Another technology used in accelerometers is thermal sensing which offers several distinct advantages. It does not have moving parts, but instead senses changes in the movement of gas molecules passing over a small integrated circuit. Because of the sensitivity of these sensors, they play a role in stabilizing on-board cameras, which are vital for applications like filmmaking. By controlling up and down movement, as well as removing jitter and vibration, filmmakers are able to capture extremely smooth looking video. Additionally, because these sensors are more immune to vibrations than other technologies, thermal MEMS sensors are perfect in drone applications to minimize problems from the increased vibration generated by the movement of rotating propulsion fans/propellers.

Inertial Measurement Units

Inertial measurement units combined with GPS are critical for maintaining direction and flight paths. As drones become more autonomous, these are essential to maintain adherence to flight rules and air traffic control. Inertial measurement units utilize multi-axis magnetometers that are in essence small, accurate compasses. These sense changes in direction and feed data into a central processor, which ultimately indicates direction, orientation and speed.

Tilt Sensors

Tilt sensors, combined with gyros and accelerometers provide input to the flight control system in order to maintain level flight. This is extremely important for applications where stability is paramount, from surveillance to delivery of fragile goods. These types of sensors combine accelerometers with gyroscopes, allowing the detection of small variations of movement. It is the gyroscope compensation that allows these tilt sensors to be used in moving applications like motor vehicles or drones.

Current Sensors

In drones, power consumption and use are important, particularly those that are battery powered. Current sensors can be used to monitor and optimize power drain, safe charging of internal batteries, and detect fault conditions with motors or other areas of the system. Current sensors work by measuring electrical current (bi-

directional) and ideally provide electrical isolation to reduce power loss and eliminate opportunity for electrical shock or damage to the user or systems. Sensors with fast response time and high accuracy optimize the battery life and performance of drones.

Magnetic Sensors

In drones, electronic compasses provide critical directional information to inertial navigation and guidance systems. Anisotropic magnetoresistive (AMR) sensors, which have superior accuracy and response time characteristics while consuming significantly less power than alternative technologies, are well-suited to drone applications. Turnkey solutions provide drone manufacturers with quality data sensing in a very rugged and compact package.

Engine Intake Flow Sensors

Flow sensors can be used to effectively monitor air flow into small gas engines used to power some drone varieties. These help the engine CPU determine the proper fuel-to-air ratio at specified engine speed, which results in improved power and efficiency, and reduced emissions. Many gas engine mass flow sensors employ calorimetric principal utilizing a heated element and at least one temperature sensor to quantify mass flow. MEMS thermal mass air flow sensors also utilize calorimetric principal but in a micro scale, making it highly suitable for applications where reduced weight is critical.