drones

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*Editorial*

# *Drones*—An Open Access Journal

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Since the beginning of aviation, unmanned aerial systems have been a challenge for scientists and engineers. The first automatic airplane developed by the Wright brothers in 1916 and the drone used by the British Royal Navy for gunnery practice in 1933 serve as examples. The possibility of controlling an aircraft without a pilot has been a challenge, both from the civil and military point of view. Nowadays, the proliferation of unmanned aerial systems, popularly known as "drones", is a reality for local policy makers, regulatory bodies, mapping authorities, start-ups and consolidated companies. The number of developed drones has increased threefold from 2005 to present and, additionally, a relevant increase has been observed in the civil/commercial type of platforms, especially in 2012 and 2013 [1]. There are many uses and benefits of drones based on their own pilot system (autonomous or remotely controlled) and sensory to achieve accurate positioning and to acquire a great variety of data. By this binomial, drones are an efficient solution for the observation, inspection, measurement and monitoring of territory; ensuring better spatial, radiometric, spectral and temporal resolutions than any manned aerial vehicle and satellite.

Drones have caused an unprecedented impact on society and the economy. According to recent market research [2], the global drones market revenue is worth $6,800 M United States Dollars (USD) as of 2016 and is expected to grow up to $36,900 M USD by 2022. The low-cost of the sensors integrated in aerial platforms of different designs has launched its application and proliferation more than its military origin, offering new applications and leading to more clients in the civil sector. It is in this last sector where more progress by drones is expected. For instance, new developments in robotics, computer vision and geomatic technologies, together with more research and development supported by technological centres and universities, allow the improvement of technology transfer with an important insight into new markets. While it is true that these civil-drones are still far from the systems used in military applications, studies and advances in the development of technology can offer professional systems with new, improved and promising features.

In this sense, it is expected that the main advances of drones may occur in the following lines: (1) the emergence of **new sensors** that allow the improvement of the geometric and radiometric resolution, as well as the spectral range; (2) the evolution of **new platforms** that improve robustness and increase autonomy; (3) the **development of software**, from the navigation and communication with the platform to the processing and analysis of the images captured; (4) **new applications** in emerging sectors: logistics, disaster assistance, security and surveillance, health and marine science, among others.

The emergence of **new sensors**, thanks to advances in microelectronics and nanotechnology [3–5] will be crucial in the coming years. In fact, the evolution of integrated circuitry and radio-controlled systems in the late twentieth century was key in the advent of modern drones. At present, improvements in miniaturization and the development of new sensors (e.g., computer boards, Global Navigation Satellite System (GNSS) receivers and antennas, Inertial Measurement Systems (IMU), cameras, etc.) has entailed a very important evolution for drones [6–8]. These advances have appeared in the range of existing sensors both active (e.g., Light Detection and Ranging (LiDAR) and Synthetic aperture radar (SAR)) and passive (e.g., multispectral, hyperspectral and thermographic cameras).

Specifically for drones, many imaging and ranging sensors are identified in [9], including active and passive, as well as optical systems—from the visible band and the Near Infrared (NIR) to the Thermal Infrared (TIR)—and microwave systems. The possibilities offered by these new sensors have created new opportunities for research and study. For instance, RGB sensors have improved their capabilities, including multiple-head RGB cameras and wide-angle lens [10,11]. For its part, multispectral sensors have improved their dynamic range and sensitivity [12], including geometric and radiometric calibration procedures [13,14]. In parallel, hyperspectral cameras provide more detailed information than multispectral sensors because an entire spectrum is acquired at each pixel [15]. There has been remarkable progress in thermographic cameras miniaturization in recent years. Thermographical sensors have also been improved in weight and quality, being applied to inspect or monitor structures or pathologies, which otherwise would not be visible to the human eye [16]. They have also been applied in the military context for remote reconnaissance [17] and in applications such as forest fire monitoring [18].

The **new platforms** have also undergone a great evolution; since the beginning of the first captive unmanned vehicles, such as kites [19], balloons [20] and zeppelins [21], to the modern drones based on multi-rotors [22], fixed-wing [23] and hybrid platforms (fixed-wing hybrid vertical take-off and landing) [24], without forgetting the nano-drones [25]. Some characteristics of these new platforms, which in many cases make them unique, can be heights of flight below the limits of aerial navigation with a consequent increase in spatial resolution; low flight speed which can reach zero while maintaining a static flight (multi-rotors); the possibility of flight in complex environments, for example, between buildings or even flights for indoor mapping [26]; the addition of durable and lightweight materials such as carbon fiber. These platforms have been made possible thanks to advances in electronics that have allowed inertial measurement units (IMU) for navigation and stabilization of the drones; the use of global navigation satellite systems for positioning and navigation; or the use of stations and control systems which have allowed us to operate drones in an efficient way. However, most civil drones are small vehicles, sensitive to wind and of limited autonomy, which restricts the effective usability of the platform in terms of coverage area, payload and mission time. This is a hot topic for the Scientific Community, which is looking to improve the power storage system. Some of these efforts are focused on the employment of photovoltaic cells, in the quest for the perpetual flight [27]. Alternative research lines are focused on the use of fuel cells (hydrogen) [28] or the use of new materials, such as graphene, to improve the energy density storage and conversion to electrical current [29].

Advances in **algorithms** supported by mathematics and computer science have allowed new achievements in the field of navigation and images processing either from active or passive sensors. Without these advances in processing algorithms, it would be unthinkable to deal with the enormous amount of information obtained by the sensors. This information must be processed in the shortest time possible whilst guarantying quality. Therefore, the advances in the treatment of large volumes of information (big-data) have also led to a significant advance in the technology of drones [30]. On the other hand, these algorithms have been automated so that they can provide final products guaranteeing an almost total automation of the process: from automatic flight planning [31] and autonomous navigation (autopilot), even under complicated environments [32], to the generation of quality cartographic products, mainly digital surface models and orthoimages [33–35]. Another important aspect to consider is the fusion of sensors, which presents a twofold purpose: on the one hand offering robust approaches to obtain data fusion from different sensors (visible, near infrared, middle infrared, thermographic) [36–38] and on the other hand, attempting approaches for data fusion using different sensors in different platforms [39–41].

Last but not least, **new applications** will define new market niches in the coming years. Regarding logistics, the integration of drones into commercial delivery networks is already being tested to optimize the trade-off between the mission time and range, and the security and profit [42,43]. Moreover, medical applications could benefit from a rapid response in a cardiac arrest scenario [44] or for the delivery and transportation of laboratory specimens [45]. Regarding disaster assistance, security and surveillance applications, the automatic recognition based on semantic attributes using images or videos will be crucial to provide a real-time response [46]. In addition, nanotechnology could be used to create nano-drones that are very promising for indoor navigation and inspections [47]. Regarding monitoring, some complex infrastructures (e.g., high and medium voltage lines, oil and gas pipe lines, roads, railways, etc.) could be monitored based on drones [48].

*Drones* Open Access Journal (ISSN 2504-446X) aims to be a central forum for researchers engaged in drones research and applications. *Drones* encourages researchers worldwide to contribute original research and technical manuscripts on the topics described above, and take the opportunity to share their findings and contributions on these topics with the Scientific Community. The cooperation of everyone involved will result in the success of this interdisciplinary journal. Let us wish *Drones* a bright future.

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