UAV, a threat to Photogrammetry?

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No. Definitely not! Lately, I have justified this answer several times. While discussing this answer with a friend of mine in one of the last events I've been to, I was questioned why "photogrammetrists" and aerial survey companies have publically exposed so little on UAVs. After that episode I decided I should write something on the subject. Before that, I need to make it clear that, although commonplace, the question which makes up the title of this article has been misformulated on purpose, since UAV is the vehicle and Photogrammetry is the employed technique; therefore, there is no way one can be a threat to the other. It might call less attention, but, technically, the best title would be: ***Is Photogrammetry obtained by means of UAV a threat to Traditional Photogrammetry?*** In such case, my answer would still be: no, I mean, Not yet!

Mapping that has been made through UAV is pure photogrammetry itself, whether it is of medium, small, or, even more common, of "micro" or very small format. What we have been witnessing is mere technological evolution associated with miniaturization. Aerial photogrammetry remains very active and present in the discussions scenario since its onset in the beginning of the 19th century. In its nearly 200 years of existence, it has been constantly tested and, all of the time, it has been proven the best mapping tool already invented. Photogrammetry had its first significant boost when it was set aboard balloons, and, ever since, it has been used in several and varied platforms: aircrafts, satellites, submarines, space and terrestrial vehicles, and so on. The opening lecture of the 54th Photogrammetric Week, Stuttgart-Germany, September, 2013, was given by Mercedes-Benz. Two of their most sophisticated automobile models already have onboard photogrammetry, which is an important ally in assisted driving, significantly improving safety when driving. Now it is time for photogrammetry to be "commercially" aboard unmanned aircrafts.

Drone, ROA, RPA, UAS, UVS and other acronyms have been used as synonyms for UAV – Unmanned Aerial Vehicle. The acronym RPAS – **Remotely Piloted Aircraft Systems** – is currently preferred by the community. Just like aerial photogrammetry, RPAS have existed for a long time. Their existence is registered in the history of aviation since the second decade of the last century; however, so far, RPAS have been used little and in very specific fields. Due to their stage of evolution and popularization, they have now been leading a revolution in aerial industry. Today, there are many available RPAS: they vary in category, airframe type, class and size. Regarding weight, they can vary from a few grams to several tons and with different load

capacities, known as *payload*. Cost may vary from a few dozen up to millions of dollars. Their application range is also very wide. In the scope of photogrammetry or mapping, most RPAS

Two RPAS of military use, one with 15 grams (Prox Dynamics) and the other with 15 tons (Northrop Grumman).

used have a payload which varies from half a kilogram up to no more than 40 kilograms, whether they have fixed wings (most common), rotary wings, or other kinds.

Ever since they appeared, aerial cameras have been constantly improved. Today, the state-of-the-art photogrammetric sensors are represented by the large format ones, such as ADS, DMC, and UltraCam, which rely on numerous technological resources, but weigh much more than one hundred kilograms (220 lb.) and need over 50 ampere of energy, which is enough to keep a house with over 150 square meters (1,615 sq. ft.) RPAS comprising such payload and such capacity for energy supply currently present extremely high costs and it will take some time until they do have competitive prices as compared to aircrafts which are currently used in large format photogrammetric applications. Nonetheless, there is no technological restriction in order for the best airborne sensors – the ones of large format – to be operated in remotely piloted aerial platforms. Their little or almost inexistent use is mainly due to economic issues and the large risks still involved in such operations.

Just like Google, which has been of great assistance, RPAS have also made photogrammetry more popular and even more widely known and accessible, even though few people understand,

Swiss Drones RPAS with 35-kg *payload* and LEICA RCD30 medium format sensor.

SIMEPAR / ESTEIO RPAS with 2-kg *payload* and small format sensor.

or even know, that photogrammetry – even if miniaturized – lies behind every photographic mapping RPAS. It is already possible to obtain a small "photogrammetric" RPAS through the Internet with home delivery. Some believe that, in not such a faraway future, such delivery will also be performed by an RPAS. Those small systems already contain a great deal of technology

onboard, such as GPS, radio, inertial system, digital camera, control via smartphone, etc.

Even in the case of more specific systems, miniaturization and consequent simplification of sensors and peripherals, so that they may be onboard an RPA, force the RPAS mapping user to live with problems which have long been forgotten by photogrammetrists. Common among them are: high radial distortion, high deformations caused by the terrain, excessive number of stereoscopic models and control points, low radiometric resolution, etc. RPAS, besides being currently expensive and fragile, have a service life that is too short when compared to manned aircrafts in use in traditional photogrammetry. They have, as a safe limit, a low number of landings and takeoffs – such number is specified by the manufacturers and is often below 200. In addition to those restrictions to small RPAS, there is still the low range of aircraft control, uncertainties and possible restrictions in future rules and regulations, and the great difficulty in getting insurance against loss and damage to the aircraft and equipment onboard. It is rare to find people involved in the subject who have never known of or had experience with falls and accidents involving RPAS. All of the aforementioned facts explain why "traditional" photogrammetrists are not all very fond of or open to this idea.

We can easily assert that the mapping made by means of "micro" format sensors will often present inferior quality and accuracy as compared to the one made by means of small format sensors, which will, in turn, be inferior to the one made by medium format ones, which will, yet, be inferior to the mapping carried out by means of large format sensors. Precision and quality depend on the sensor and on the technique employed, not on such sensor being onboard a manned or unmanned aircraft. Some potential users of RPAS mapping have shown disappointment regarding the obtained results in comparison to traditional photogrammetric mapping. The main reasons were little experience in photogrammetry by the executors, and the great, or sometimes unreasonable, expectation created by the industry itself, the market, and the press. There is no way to compare the product obtained by a large format digital sensor, specifically developed for aerial mapping and costing over one million US dollars, to the product obtained by a common or generic digital camera which only costs a few dozen US dollars. Taking into account the due proportions, it is like comparing a Rolls-Royce to a good old VW Beetle: they are both cars and have four wheels, but, other than that, they don't share many other features.

Radial Distortion: image obtained by ESTEIO with RPAS and small format camera on a Brazilian CEMIG power line.

UVS International has been annually publishing the *RPAS - The Global Perspective*. In the present edition, 2013/2014, the publication presents a table with about 1500 RPAS models in production or development. The United States lies ahead with the significant number of 374 units, followed by Russian Federation, with 106, and then Israel, with 96 distinct models. Brazil lies in the 21st position in this rank with 54 countries, having 16 units. With respect to safety and

regulations, everything the leaders do shall be followed or considered in principle by the other countries. The Federal Aviation Administration – FAA – has been proven very cautious and prudent in regulating such activity in the American airspace. The coexistence between piloted and remotely piloted aircrafts is on its way to being regulated. For the FAA, aviation is a global industry and, therefore, no country should act totally independently. It also states that, in the future, manned and unmanned aircrafts will certainly share the "same" airspace. Brazil has also been keenly working on such regulations. I believe that only when RPAS are equally safe or safer than manned aircrafts, or when they do not offer threats to the safety of people or other aircrafts, will the coexistence between both be completely harmonious and peaceful.

There are numerous applications for the RPAS, whether they are military or civilian, for Security, Policing, Monitoring, Border and Coast Guard, Transport, Observation, Agriculture, Fire Fighting and Control, Search & Rescue, Mapping, among many others. Commercial use of the RPAS for high precision mapping represents a tiny portion of this whole universe of activities and, certainly, it is not the noblest of its applications. I consider noble those applications in which use of the RPAS, in place of manned aircrafts, might bring fewer risks to the pilots, and whose technical, financial and operational result is equivalent or even better. Monitoring of construction sites, spraying of pesticides on agricultural fields, fire control, repetitive visual controls, supervision of great structures, and reconnaissance flights are some of the examples of what I currently consider to be noble applications for RPAS. Photogrammetry performed by current RPAS, when completely regulated, will indeed earn its place on the market and also some overlapping with little photogrammetric, topographic, and even satellite mapping; however, it cannot and should not be taken as a threat to traditional or larger formats photogrammetry, but rather as a complement to it, though in constant evolution, just like everything else with respect to technology.

Amara's law states that "we tend to overestimate the effect of a technology in the short run and underestimate the effect in the long run". In the RPAS world this law seems to be quite appropriate. Market perspective for the RPAS is vast. The development and evolution of specific photogrammetric sensors for this kind of small aircraft will bring important benefits to photogrammetry in larger sizes as well. It is extremely hard to predict when or even if RPAS will, indeed, replace piloted aircrafts in medium or large format photogrammetric operations; however, that is the trend. Enthusiasts and photogrammetrists, being supporters or not, can only follow and await the course of this dazzling and wonderful revolution.

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