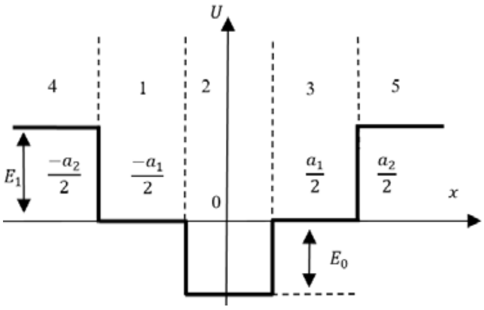

Fig. 3. Staggered QW model with two RQWs

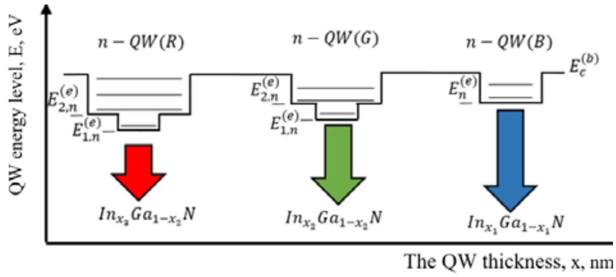

Fig. 4. Energy diagram of the RGB heterostructure with combined QWs

The QW with a staggered profile is used for QWs emitting light at the green and red wavelengths since it is assumed that these wavelengths will be «losers». In order to precisely set the dimensions of the combined profile of the quantum well, so as to balance the mixing of RGB colors, it is necessary to take the spectral characteristics of the radiation from a heterostructure with multiple rectangular QWs grown according to the given parameters.

Based on the results obtained, it is possible to determine how much the emission spectra of each wavelength differ from each other, thereby determining the parameters of the future RGB heterostructure with combined QWs, which provide the desired balance of RGB colors. The difference in the spectrum distribution depends on various factors, ranging from the choice of QW material (the use of indium (In) leads to certain difficulties in the production of QWs emitting light at a wavelength of 650 nm) to incidental defects obtained at the stage of growing the material [2]. For this reason, there can be many options for implementing such structure, but in the framework of this work, in order to clearly show how the profile of an RGB heterostructure with combined QWs looks, we use some average parameter for «lose» colors. As a result, we obtain the following structure (Fig. 4).

Conclusion

The method of obtaining white color by controlling the mixing of the RGB colors triad along with a combined profile of a quantum well, which has a denser energy spectrum, allows creating more durable and cheaper white LEDs that do not need phosphor coatings.

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Review of the use and current status of UAV technology and their capabilities

The speedy development of technology over the past ten years has allowed drones to become an important part in different sides of our life. Drones are becoming smaller, smarter and cheaper to manufacture. The market for civilian drones is growing rapidly. Thus, they have reached a level at which we can consider them as a threat. If at the beginning of their «career», drones performed auxiliary functions of reconnaissance, today they are an independent striking force, which can cause a lot of trouble, especially if they have the potential to perform dangerous, malicious, or unwanted acts. That includes the devices intended to carry out hostile missions, operated by an unsafe individual, or used for crossing into a sensitive area. This paper is aimed at identifying the drones and their current technology status, and at making a point on how these vehicles represent a threat to our life in different ways and aspects.

Keywords: technology, drones, unmanned aerial systems.

Drones or the low, slow, and small (LSS) unmanned aerial systems/vehicles (UAS or UAV) have spread very widely all over the world (Fig. 1). The easy way of obtaining commercial drones has caused an explosion in the use of these devices by private citizens. It has contributed to the development of new ways to use

UASs, from fighting forest fires and assisting search-and-rescue missions to racing for sport and delivering packages. An obvious benefit to society from these developments can be used to gain efficiencies and to contribute to the public good. Actually, as noted by Paul Scharre [2], «uninhabited systems can not only save human lives by undertaking dangerous missions in their place, they can enable new concepts of operation that would not be possible were human lives at risk» [3].

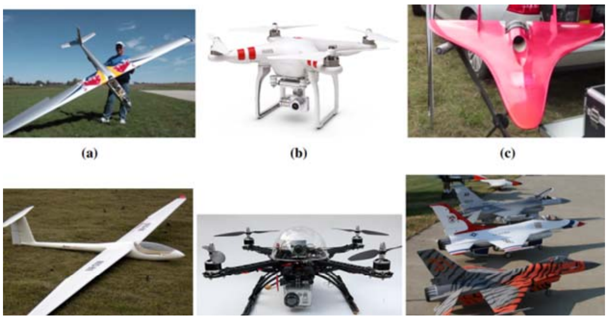

Fig. 1. Examples of commercially available LSS UAS [1]

To get a general understanding about the commercial UASs and their capabilities, you can see Table 1 [4].

Table 1

Commercial UASs and their capabilities[4]

Model	Weight (kg)	Payload (kg)	Flight time (mins)	Range (m)	Max speed (mph)	Camera (y/n–mp)	Operating conditions	Price (£)
Parrot BeeBop	0.4	0	12	250	29	Yes-14	Dry conditions only	700–900
Blade 350 QX2	1	0.2	10	1000	32	Yes	Dry conditions only	200–300
3Dr IRIS+	0.9	0.2	16	800-1000	40	Yes	Dry conditions only	500–600
DJI Phantom 2 Vision +	1.2	0.2	25	600	33	Yes-14	Dry conditions only	800–1200
DJI Phantom 3 Professional	1.2	0.3	28	1900	35	Yes-12	Dry conditions only	1000–1200
Walkera Scout X4	1.7	0.5–1.0	25	1200	40–50	Yes	Dry conditions only	700–900
Yuneec Q500 Typhoon	1.1	0.5	25	600	54	Yes-12	Dry conditions only	900–1100
Sky jib-X4 XL Ti-QR	15	7.5	15	3000–25000	24	Yes	Wind	7500–8000
Altura Zenith ZTX8	3.1	2.9	45	1000	44	Yes	Light rain / snow	15000 – 20000
Micro-Drones MD4-1000	2.65	1.2	88	5000	26	Yes	Light rain / snow	20000 – 30000

In order to categorize UASs, the NATO industrial advisory group (NIAG) report defines them based on their mass and the typical capabilities that are associated with each class, as shown in Table 2. Class I includes anything under 150 kg, while class II extends to the larger types between 150 and 600 kg. This upper class is generally restricted to military aircraft for now [5].

Table 2

Classification of drone types according to the values which are taken from the NATO LSS UAS detection report [5, 6]

Class (kg)	Category (kg)	Operating Altitude (AGL) (m)	Mission Radius (km)	Payload (kg)
Class I < 150	Micro < 2	To 90	5	0.2–0.5
Class I < 150	Mini 2–20	To 900	25	0.5–10
Class I < 150	Small <150	To 1500	50–100	5–50
Class II 150–600	Tactical	To 3000	200	25–200
Class III > 600	MALE OR HALE [7]	Several-thousands Kms		>200

Now, we can say that there are 21,000 confirmed unmanned aircraft currently in service around the world, though the actual number is likely to be more than 30,000, and the number of countries operating military drones of any kind has increased by an estimated 58 percent in the past decade, and 95 countries are believed to have an active inventory. Among these countries currently, eighty-five countries operate Class I UAVs, 44 countries operate Class II UAVs, and 31 countries operate Class III UAVs. Of the 95 countries with an active inventory, 49 countries operate at least one from two or more classes, while 18 countries operate at least one drone from each class [6].

But the more important is not the operating but the developing of drones; at least 24 countries are currently developing new military unmanned aircraft. These projects include 10 Class I systems, 12 Class II systems, and 36 Class III systems. At least seven countries are exploring potential designs for next-generation drones, including stealthy aircraft (U.S., China, Russia, and France), high-altitude pseudo-satellites (U.S., China, U.K.), swarms (U.S., China, U.K.), and manned-unmanned teaming systems (Australia, Japan, U.K., China, and the U.S.). People's Republic of China appears to have the most active drone development programs of any country, with at least 11 parallel projects underway as of this writing [6].

The hobbyist drones have only recently exploded in popularity while military-support drones have been in use since the early 1960s (Fig. 2). For example, between 2011 and 2013, SZ DJI Technology Co., the largest manufacturer of hobbyist drones, saw an almost 3,000 percent increase in annual revenue – to $130 million – and reached $500 million in 2014 [8].

Continuing this pattern of growth, as sales of hobbyist drones continue to increase, we are likely to see an attendant reduction in cost and increase in drone capabilities. These developments will in turn grant individuals unprecedented access to highly advanced technologies [8]. The growth was also remarkable in the military spending on drones. A preliminary review of the US Department of Defense's (DOD) budget request for financial year (FY) 2019, finds approximately $9.39 billion in drone-related procurement, research and development, and construction funding, which is 26 percent more than for the FY 2018 request (Tab. 3) [10].

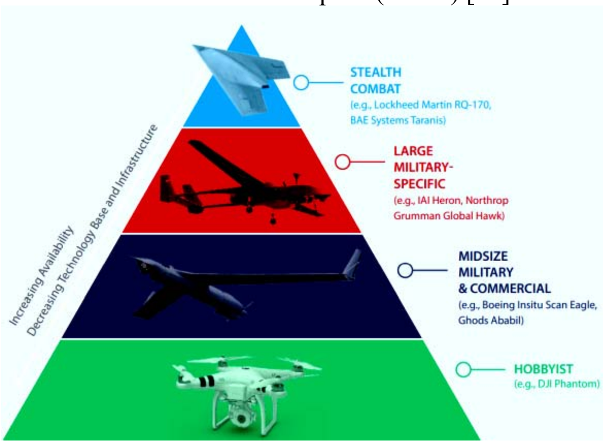

Fig. 2. Proliferation of Drones [8, 9]

Table 3

Estimated drone spending in USA-FY 2019 [10]

Spending by Department	*$ millions*
Air Force	2,636
Navy and Marines	3,766
Army	1,701
Defense Wide	1,287
Spending by Category	*$ millions*
Air	6,045
Ground	429
Sea	982
Counter-Drone	1,052
Autonomy, Teaming, Swarms	866
Other	16
Total	9,390

Their ability to deliver strikes against hard targets relatively cheaply and with impressive endurance and covert intelligence, allowing them to remain on station providing continuous support for many hours at a time, has made them the weapon of choice for many militaries using them in counterinsurgency and low-intensity conflicts, especially in the Middle East [11]. By taking the advantage of the hole in the market, China, in particular, has become an increasingly influential player. The US is trying to maintain its dominant and exclusive role in the field by implementing a selective export policy on drones. Alternatively, over the past few years, China has supplied armed drones to several countries that are not authorized to purchase them from the US, and at a dramatically cheaper price [11, 12].

Nowadays, the number of countries that make up a second generation of armed drone producers and operators [13] is noticeable. Till now, Russia's indigenous systems has been primarily comprised of small, micro-tactical, and surveillance UAVs, such as the Eleron and Orlan series, the Navodchik-2, the Korsar, the Granat, and vertical take-off rotary wing drones such as the VRT300. Recently, a 'heavy' stealth drone similar to the American X-47B, called the Okhotnik, is being developed by Sukhoi, a major Russian arms producer, and is expected to enter into service in 2020 [14].

There are so many factors playing a huge role in developing the drones. Size, weight, and power are critical to any technological system and advances in these fields are unavoidable. The last developments in wireless power transfer are already reaching greater distances; alternative fuel options are being explored by a number of companies. Boeing, for example, is investing in the development of hydrogen engines, whereas others, like the Solar Eagle and Zephyr (both by QinetiQ, UK), have turned to integrating solar energy sources into their systems.

Also, there are plans to produce a solar powered Vulture drone, which would, in theory, be able to operate for a period of five years without interruption. Conventional mid-air refueling, as practiced by manned aircraft, is now executed by prototype drones [14]. Material science developments, such as graphene, carbon nano-tubes, molecular glue, metal foam and aerogel, are all likely to impact future developments in drone manufacturing as well. Making use of cutting edge materials science, drones are likely to become lighter, yet stronger, and will benefit from meta-materials that facilitate sub-wavelength imaging, for example, for greater stealth capabilities. Due to the continuous decrease in the cost of 3D-printing, the materials for manufacturing components will become more varied, allowing for a greater range of components to be built to higher specifications [14].

There are already a considerable number of open source software and hardware tools available on the Internet and, sometimes, for free, for developing the drones, which include autonomous flight technologies (Paparazzi drone), autopilot software with advanced data-logging, analysis and simulation tools (ArduPilot), multicopter stabilization technologies (LibrePilot), imagery mapping (OpenDroneMap), and smartphone integration software (Flone). The amateur users will continue to build viable combat drones and develop alternative methods to solve military problems, while the big commercial producers and militaries will expectedly maintain a tight hold on the most advanced and capable software and hardware technologies.

Drones provide a number of benefits but they can also be used by terrorist entities in five primary ways: for surveillance; for strategic communications; for smuggling or transporting materiel; for disrupting events or complementing other activities; and as a weapon. The last includes instances of a drone being piloted directly to a target, a weapon being directly mounted on a drone, and a drone delivering explosives [3]. UASs can also be modified to drop an explosive over a target, such as a VIP gathering or a stadium full of people.

When using a drone equipped with GPS navigation and video feed, this type of device could effectively and accurately deliver a pernicious payload on any desired target [15]. Terrorists' interest in drones is anything but new. While terror groups' interest in and use of drones has become more frequent over the last decade, especially as commercially available variants of drones have become more popular, sophisticated and accessible, the first documented terror case occurred more than two decades ago, when the Japanese apocalyptic group Aum Shinrikyo considered using a drone to distribute sarin gas [3]. As Michael Horowitz's adoption-capacity theory of the diffusion of major military innovations predicts, a reduction in the cost per unit of a technology and an increase in the commercial applications of that technology is likely to be accompanied by an enhanced rate of adoption [16].

The use of a single UAS by terrorists remains a threat, while the use of a group of drones, or an autonomous swarm, by terrorist entities has not yet been observed; the use of more and more advanced drones is likely to enhance the range and seriousness of the threat [3].

In 2018 the Russian military disabled a number of drones in a coordinated attack against two of its military installations. Some of them were destroyed by the Pantsir ZRPK, and some were neutralized using undisclosed electronic warfare measures. Though the offensive was ultimately unsuccessful, it demonstrated the growing sophistication of the unmanned aircraft that are increasingly finding their way into war zones across the globe [17]. The second incident occurred in London, when two drones blocked the operation of Gatwick Airport for a day. They had to cancel more than a thousand flights and the owners of the drones were never found. The British Ministry of Defense after this incident promised to allocate about 2 million pounds for the fight against UAVs. The market for counter-drone solutions is growing. The US counter-drone budget rose from $528.8 million in the FY 2018 request to $1.05 billion in the FY 2019 proposal, $468.8 million in procurement and $583.9 in research and development [10].

Drones in civilian airspace aren't required to carry transponders, so they cannot be detected and tracked with existing air traffic control systems. Relying on visual observation to detect drones is equally ineffective; at a distance of several hundred feet, drones can become all but invisible to the naked eye. Military radars are mostly designed to detect large, fast moving objects. As a result, they cannot always pick up LSS flying drones. Since UASs are cheap, it is impractical to use traditional air defense weapons, which can cost hundreds of thousands of dollars per unit, to shoot them down. Obviously, we need new specialized devices and methods of struggle [18].

Conclusion

As mentioned in [9] the future we want is not always the future that we will be lucky enough to have. Although drones were made as an entertainment accessory, they represent a threat to our life, security and privacy when they fall into to the wrong hands. This paper has made a point on their wide use and evolution, and the importance of doing more research into effective methods to secure ourselves against drones' threat.

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