

POSSIBILITIES OF USING SMALL ROTOR UAVS

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This article highlights the possibilities of using small rotor unmanned aerial vehicles called multicopters. It deals with the definition of "pilotless aircraft" and „pilotless aircraft system“ and divides multicopters according to the selected criteria. Furthermore, it describes some of the specific manners of use of multicopters while performing the tasks.

Keywords: multicopter, unmanned aerial vehicle, UAV

1 INTRODUCTION

The development of technology in the field of aerodynamics, microelectronics, optics and navigation at the end of the 20th century enabled the implementation of a new category of unmanned aircrafts. Small rotor unmanned aerial vehicles, so called multicopters or x-copters, are small-sized, remote-controlled pilotless aerial vehicles propelled by several rotors. The big advantage of these aircrafts is that various equipment can be fixed very easily to their structures. The most frequently used equipment is optical sensors making pictures or videos, infrared thermo cameras, meteorological sensors etc. It depends on the type of the task to which they are deployed. Due to their small sizes and low operating costs they can be applied in various sectors for specific tasks. Origins of their use can be found in the military sector, but over time they started to be used also in civilian operations, where it was too risky and unnecessary to expose the crew of aircrafts to the danger and threat to life.

Parameters, such as size and noisiness, are significantly preferable to those of traditional aircrafts. Low noisiness allows these aircrafts silently and anonymously get into the guarded objects of interest and risk areas. Their potential loss causes no serious moral or material problem, as their operating and acquisition costs are relatively low. Long duration of flight allows their deployment also in the long-term missions. Additionally, in these cases no "recovery time" for the aircraft crew is necessary. Unmanned aerial vehicles are relatively young and still evolving field of aviation technology. Wide range of possibilities for their use in various areas and so far gained experience in their operation shows us their huge future perspective.

2 UAV, UAS

UAV abbreviation comes from the English name of "Unmanned Aerial Vehicle". The name implies the most important characteristic and advantage of these aircrafts in comparison with conventional manned flying vehicles, which is that the pilot is not physically present on the board of the machine. The designation "unmanned" describe a situation when the pilot is not located directly on the board of the aircraft, but at the remote-control station from which the UAV can be partially operated by pilot or by fully automated systems, according to predefined missions or by autonomous complex dynamical systems. Thus, it is not strictly necessary the drone to be operated by itself. In many cases, pilot and crew are responsible for carrying out the trajectory and the operation of the flight even though their absence on the board. Civil Aviation Authority (CAA) defines these drones as the "aircraft designed for flight without a pilot on board".

UAS – unmanned aerial system is a term brought by the U.S. Department of Defence and accepted by the U.S. FAA (Federal Aviation Administration). This term replaces the term "Unmanned Aerial Vehicles" (UAVs), i.e. unmanned aircraft. A typical unmanned aerial system includes a drone, control system, data communications system and other support facilities.

3 MULTICOPTERS

The primary advantage of the deployment of unmanned multicopters is the protection of the lives and health of employees working in hazardous and dangerous industries. Another

substantial advantage over the use of conventional aircrafts such as helicopters is the significant reduction of the costs. Using radio control camera, hung below the central part of the multicopter, can be navigated over the area of interest, and thus can obtain necessary images or video. The image is simultaneously projected onto the screen placed in the ground station. So called "video glasses" enables immediate monitoring of the area from the point of view of the camera.

Built-in gyroscopes ensure the stability of the recorded image, and GPS positioning system ensures the stability of the position even in time, that in case when person controlling the machine put away the control transmitter for a while. This demonstrates the ease of use of such machines. The modular payload concept allows flexibility in adjusting the equipment needed for the task performed. According to the type of task performed, digital camera, camera with night vision or thermo camera can be installed, enabling also the on-line video transmission. For certain tasks, it is preferable to install a video camera with integrated recording on internal memory card with higher quality recording.

Many manufacturers offer together with the multicopter also already mentioned ground station that keeps in the central system all the data recorded during the flight. Ground station is being stored in the protective case in order to avoid its physical damage. Waypoint editor, an application provided together with the ground station allows developing a detailed plan of the route, which may be performed by the multicopter on itself using the built-in GPS.

In addition, except of the recording of the route made, there are also other applications offering various functions such as making panorama images or spinning around the recorded subject. Three-dimensional visualization of the flight route can be directly exported to Google Earth application.

The entire model, including its accessories, is foldable into the portable case that fits into the boot of the car. Therefore this simple platform is suitable also for urgent cases. After arrival at the place multicopter is ready to take off within 3-5 minutes. Rapid deployment of the multicopter into the actions becomes an important factor especially in urgent cases such as mass car accidents,

industrial accidents, fire or natural disasters. Other times, purchase costs is the primary reason for its deployment into the action, as this is incomparably lower than that of the common methods, so even small companies can afford to purchase the machine.

Manufacturers do not focus only on their sales, but also on offering complex services to their use for any purpose. Multicopter thus is a simple means for obtaining documents for urban study of cities, mapping environmental burden, and conservationists can use it for monitoring of the monuments. The machine applies also in looking for the missing persons as its deployment is significantly cheaper and more operational. Abroad it is often used also in utilities and telecommunication services as well as in monitoring the traffic situation or seat of fire from the bird's-eye view.

The possibility of their rapid deployment is especially important in case of fire, natural disasters, industrial accidents or multiple car crashes. In any case, there is no doubt that there is a wide range of application of these small unmanned rotor aircrafts.

3.1 Types of multicopters

In terms of the number of rotors, small unmanned aerial vehicles can be divided into 2 groups: the UAVs with one main rotor and UAVs with multiple main rotors. There are also several types of electric multicopters as X4/Quad, Y4, Hexa, Y6, Octo, H-4/H-Quad, X8, H8, V4/V-Tail Quad. Each type is specific for its structural layout of propellers that can be expanded and skewed, the central part can be moved and thus new design can be created - a design that removes obstacles placed in front of the camera, which is not blocked anymore by the propellers.

4. POSSIBILITIES OF THE USE

Rapid development of small UAVs was caused by the progress in IT technologies, miniaturization, technical and technological. Besides the armed forces of different countries also police forces, fire-fighting forces, rescue organizations, mining and geological research companies, various communication organizations

etc. have begun to use the advantages of small rotor UAVs.

In all these organizations, regardless whether they belong to the military or civilian sector, the presumption of using small rotor UAVs grows. The considerable number of advantages of their deployment in various missions includes also the fact that they can be deployed in transparent as well as in blind terrain or in an environment contaminated with gases or vapours dangerous to humans. Alternatively, in areas that seriously endanger the health and life of the pilot.

Multicopters are perfect platforms able to carry specific equipment needed for successful completion of some missions. Missions like fast delivery of the consignment or obtaining necessary images by fixed video cameras, photo cameras, night, day, and other sensors. Besides of the constant maintaining of protection of persons operating these small drones, they provide also significant costs savings in comparison with standard manned aircrafts.

Unmanned multicopters have a number of important advantages over the conventional manned aircraft and helicopters. The most important advantage is the ability to keep hanging in the air during the flight, go reverse, take off and land smoothly, as well as manoeuvre in the space like helicopters can do. UAVs with multiple rotors have the ability of stable flight, which is ensured by smaller engines and rotor blades, while the number of oscillations decreases significantly. Diametrically opposite rotors eliminate reciprocally their own deviations during the flight. Due to all these properties and advantages exists nowadays a wide range of use of these small unmanned aerial vehicles.

4.1 Military and police missions

For military uses, much lower probability of revelation during the research mission and greater safety of the life and health of the crew are definitely the biggest advantages of multicopters.

In areas of armed conflict often arises a situation in which soldiers do not have an overview from where the enemy is shooting at them. Very often they have to rely only on their hearing or sight, which is inefficient in such cases. Future soldiers could be equipped not only with small UAVs, but also with fire detector. Such a

detector would localize the position of attacker. Soldier, after evaluating the data required, would send the multicopter to designated enemy area to conduct a survey. After the detection of the position of the enemy, the data would be transferred to digital maps available to all the members of the intervention unit.

Their operation is simple also in the field conditions, in which multicopter gives to the operator exact information about battlefield. This can be very important especially in the situation when the operator needs to know immediately what is going on "around the corner". It is certainly much easier and safer to send small unmanned multicopter to the enemy area to make a survey than a large helicopter with crew on board or ground research team which can be easily revealed. The explorer can carry the multicopter very easily on his back and transfer it wherever needed. There is an increasing trend in car accidents on the roads each year, which represent a huge burden for the security forces. The police department is responsible for securing of the accident place, for gathering the evidences as well as for potential reconstruction of the accident. Current standard methods of obtaining aerial images performed by helicopters are due to obvious reasons very difficult. In regards of time and costs difficulty, multicopters would be more appropriate and more effective alternative. Right after the arrival of the police units into the place of, for example, chain car accident, the person entitled to piloting could send the multicopter over the target area to immediate monitoring and assessing of the situation. In the future we can assume their deployment also by the police forces for similar purposes as police dogs fulfil during the routine errands.

Multicopters could help also public forces to ensure safety oversight on the borders and reveal easily illegal immigrants. Border guards could use them for constant monitoring of the places with frequent illegal border crossing. An important result of this action would be the reduction of the criminality in border areas.

Moreover, it is very easy to remodel multicopter to a robotic guardian protecting private lands, buildings, industrial buildings, parcels, etc. In comparison with humans or guard dog, multicopter flies high above the ground, therefore

its movement is much faster. It can monitor the target area from different angles without any major problems in dealing with the various obstacles,.

With the correct security algorithm multicopter can be programmed to cover the greatest area of observation possible. Depending on the security requirements multicopter can be set up to perform various tasks during the monitoring, for example, to record unusual movements, make pictures of these movements and send them immediately to the ground control station.

4.2 Documenting of industrial buildings

Roads, rail systems, bridges, tunnels, buildings, solar panels, wind turbines, etc. can be easily and quickly monitored and mapped by unmanned aerial platforms, such as multicopters. Intelligent sensor ensures safe distance from the object, allowing observation of the reference object under any circumstances even in the places where the danger of explosion is. All the acquired images, videos, positioning and flight data are immediately written down and further analyzed in details, which can be an enormous advantage in the process of reconstruction or repair of facilities.

Especially due to weather conditions and regular and long term use the bridges are getting increasingly damaged. Even the smallest cracks in reinforced concrete structures or steel beams may cause the collapse of the bridge, which could ultimately have disastrous and tragic consequences especially for human life. The aim of using unmanned platforms and their big advantage while checking the construction of bridges is that their implementation does not affect normal operation of the bridge. Respectively, this method is only the complementary one to the methods based on using helicopters, special scaffolding, cranes, industrial climbers etc. The main factors taken into consideration while choosing the most appropriate method by the responsible authorities are: costs reduction resulting from the minimization of number of personnel needed to perform monitoring, reduction of operating costs, significant reduction of the time needed to execute the control and in particular increased safety in the workplace.

4.3 Measuring of the air pollution and safeguarding of the human life

If the measuring device is placed too close to the surface, it can not provide all the requested information especially because of weather conditions and its immobility. Small rotor UAVs on the base of copters can fly high above the streets and buildings of the city or stay at a certain position the time long enough to measure highly dangerous and harmful emissions. Such an analysis of the situation in real time made by multicopter can be then used for forecasts or immediate warning.

Another area in which the small rotor unmanned aerial vehicles may find their application in the near future is the transport of medical needs or samples to distant laboratories and clinics. Machines, originally designed for military purposes, thus would be used also in rescue situations of human life.

In the third developing countries, where the road infrastructures largely consist of unpaved roads that become intransitive during the wet seasons, multicopters would enable easy loads transfer to the destination. Such climatic and geographical conditions often cause delays in medical assistance and delays in the deliveries of medical materials or medical test results. Another important aspect of a bad situation in developing countries are long distances between health centres and laboratories that couriers and ambulances with medical supplies must overcome. This can be sometimes very difficult even in good weather conditions due to poor quality of the roads. In addition, in such areas dominate very serious types of contagious diseases and the delivery time of drugs and other medical materials plays therefore a key role.

Multicopters sent out from the clinics are able to reach the pre-determined destination only by using programmed GPS and microelectronic gyroscope. The machine leaves the load in the final destination and automatically return to the sending station. Multicopter can take off and land on itself automatically as programmed without any other control. Multicopter can take off and land from any type of surface, even from the hands. Small sizes of the machine do not represent any danger for people standing around while landing or taking off. The payload of the machine is sufficient

for deliveries of blood samples, saliva or certain amount of blood for transfusion. The transmitted samples can be sterilized, so the risk of transmission of live bacteria and viruses that could potentially escape in case of machine accident, is thus reduced. The machine can also deliver consignments in a very short time to the cities and areas with poor or no phone signal.

5 CONCLUSION

Currently multicopters are primarily used for military purposes. Armed forces of most countries all around the world already possess these machines and deploy them daily to various military operations. As a result, the demands on their operation and evaluation of the information obtained during the performance of tasks have significantly increased. It has been proved that deployment of UAVs is efficient, effective, and for ensuring the safety of human life irreplaceable. Therefore, they have a big potential to become a part of the equipment of each soldier in the near future.

In the civilian sector obviously potential users still have not got convinced about their benefits. We can say that up to now it still has not come to their massive development especially because there is lack of funds needed for the research. Nowadays, the development of these machines progresses only very slowly, but one can assume its rapid increase right after obtaining more knowledge about the multicopters and about advantages of their use in the civilian sector.

The theme of small rotor UAVs is very extensive and together with the development of artificial intelligence used in multicopters, the possibilities of their use in the real life will be extended also for the tasks that we even cannot imagine today.

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