MICRO UNMANNED AIR VEHICLES FORMATION PROCESS AND MODELS

BURAK ATCIOGLU

Turkısh Aır Force Academy

Abstract— Everything is in progress and in a constant state of flux nowadays. The newest marvel of our era, UAVs, have the largest share in this fast paced change. UAVs have large areas of usage therefore they have also large forms of tilisation. They are invented with the help of new technology and insect-sized micro unmanned air vehicle came to light. This invention increased performance of troops because they are very effective with the least loss rate of units at operations. In addition, they are easy-to-use and portable.

This essay provides information about unmanned air vehicles' present-day conversion and micro unmanned air vehicles. It also compares manned and unmanned air vehicles and why we use unmanned air vehicles. It explores where we are using micro air vehicles and gives several examples which are very good at in their field.

Keywords— Unmanned Air Vehicles, Portable, Micro UAVs, Developed Technology.

I. UNMANNED AIR VEHICLES

1) Advantages andPresent-day Conversion

Technology has reached to an unimaginable and a mind-bending extent in our era. First of all computer age then internet age and mankind is proceeding towards robotic age rapidly. This progression accompanies new engineering marvels. One of these engineering marvels is micro UAVs (unmanned air vehicle). UAVs now have an irreplaceable importance in modern warfare.

Although plane is the newest invention in the field of transportation, commercial and military, it is the most current vehicle. Importance of planes are getting increase in military as are in other fields because planes are striking power of countries ever after. Unmanned air vehicles are superseding manned air vehicles in late years. UAV's are regarded as new and popular science area of new era. They are originally used for observation and intelligent but now being used as a predator(Wu, Sun & Zhou, 2004).

Materials of unmanned air vehicles are high-tech workhorse hence production cost is high.Developing technology provides opportunities along with advantages of overcoming some costly and troubled circumstances and these are underlying reasons of why unmanned technology use become widespread. Supremacy such as unmanned planes can be controlled through autonomous or ground station and low possibility of seen or hit by enemy however troubles like vital systems for maintenance of manned planes, required places for cockpit in addition, manned planes' manoeuvre and operation capability are limited by human ability (such as fatigue, work time, G tolerance etc.).UAVs are preferredbecause of all these reasons (Unmanned Aircraft System Flight Regulation, 2010).

One of the most expensive personnel group to raise is pilots all over the world for example raising a pilot costs 27 million dollars in Turkey(kokpit.aero, 2015). Therefore, loss of aircraft together with skilled personnel both as material and as ability loss for armies. UAV has no pilot so when a UAV is lost it is just a vehicle not a personnel solow cost of loss make UAVsmore appealing. Purchase prise of an MQ-9(unmanned air vehicle) is 22.5 million dollars however, purchase prise of an F-16 Block52 is 47 million dollars(Hasik,2012). UAVs have a role in enemy air defence factors being lingered and use as bait for main aggression factors managed to pass firing line several times in history.

2) Why Unmanned Air Vehicle

Air vehicles are designed for fulfill determined duties. Designer has to decide which kind of air vehicles are proper for the duty and will it be manned aircraft or unmanned aircraft. It depends on the duty whether aircraft will be manned or unmanned. Generally UAVs are used for dull, dirty and dangerousduties. In addition, it is used for research and environmental missions.

Which ones are these dull, dirty and dangerous missions?

Long-time reconnaissance and peeping missions that are caused losing attention of air crew because they are working for a long time at a stretch. This reason is prevent missions to accomplish successfully. Using of UAVs equipped with high definition video camera and radar will be more effective and cheaper for this kind of mission.

UAVs are easily perform a duty in a place where dangerous for people because of chemical and nuclear risk. Toxic chemicals purification and crop disinfestation are example for dirty missions.

UAVs are skillful in aggression and air defence missions because they are small and have featured of invisibility that is why it could give successful results. In addition, they are used in forest fire control. They are used in this kind of missionsnumerously.

UAVs first manufacture, usage, maintenance,fuel and hangar costs are cheaper than manned air vehicles

which assume the same mission. Usage of UAVs are more advantageous than manned ones at missions that are defined above. They are used in both military and civilian missions prevalently nowadays.

II. MICRO UNMANNED AIR VEHICLES

It is certain that UAVs are useful but armed forces around the world need for smaller, more agile systems. This system can be easily transported and operated by troops on the ground. Researches in line with the requirementsare lead us to the development of micro unmanned air vehicles. These vehicles can peer around corners, fly into buildings secretly and generally keep troops from the danger.

A branch of UAVs, Micro Fliers and Micro Air Vehicles(MAV), that are excessively small and by mandatorily,excessively maneuverable. These devices are approximately 20 cm in size weighing less than 100 grams; nearly the size of a small bird or larger flying insects. The demonstrated and proposed uses for these MAV are numerous and involve both military and civilian applications.

This process was started in the early nineties from microsystems (Micro-Electro-Mechanical Systems, or MEMS) research. There are alsoforthcoming researches relating to micro fliers. It was a long and co-operated process. There are technic equipments for UAV like mechanical systems, sensors, controls and communication devices. These have to be minituarized for micro UAVs. Some laboratories worked on feasibility and some worked on miniaturizing of systems.

Technology is now becoming more practical and affordable because batteries and other electronic components have been improved recently and engineers who have been talking about MAVs or Nano Air Vehicles for more than decade are now working easily.With the help of developed technology microprocessors are also becoming cheaper, faster and more capable otherwise technology from the remote-control world is starting to become pervasive and affordable(Tomi & Eija, 2009).

DARPA has a program about micro air vehicles. There have been researches for years so there are a good many results of researches thus DARPA founded. There are plenty of areas for using MAVs in military. Deployment of troop and platon have vital importance for military so they are used in this direction. They are used in reconnaissance and surveillance operations, battlefield situational awarenessand rescue operations are uniquely situated for field operations (Kendrick, 2014).

It has sensors which can be positioned remote and also provide biohazard and hazardous materials' detection. It has professional surveillance ability. It takes images with infra red and audio monitoring systems in real time and night. Mobile MAV deployments include mine field scanning, hazard conditions monitoring for instance real time tracking of hazardous clouds, troop deployments and strength assessments, pinpoint target designators, and offensive payload capabilities. Civil-Civil use of MAV, at least initially, was a cross-over from military applications. Primary deployments included police reconnaissance and surveillance, crowd control, border surveillance and control(Eisenbeiss, 2004).

More recently, MAV have been used for search and rescue operations, the remote monitoring and detection of chemical leaks and biohazards, pollution monitoring, and traffic management and accident documentation. Before striking examples about Micro air vehicles it is worth to mention about the most extensive conference IEEE International Conference on Robotics and Automationabout robotics and automation that is hold in Germany in 2013.Robots' ability to learn and ability to recognizing objects were classic topics for the conference but developments on area of nano and micro robotics are stamped the conference.

Pioneering models of this type of robots started to introduce one after another to world public opinion especially reformed in USA, Germany and Holland. It is mentioned about multifarious projects and they are all have one thing in common which is all scientists who work on this topic take inspiration from the nature while make all the things real.

Scientists who take inspiration from nature get into some technical troubles and they try to solve them looking animals in nature for instance examining flying technics of some birds. Almost all vehicles that are designed ideally, it's planned to act as the same as examples in nature just flapping wings to fly. The most important reasons of this living creatures in nature are toget efficiency with least material and least energy. They have feature of self-repairing, silent running, aesthetic view and they are biodegradable, recyclable and nature-friendly, enduring, flexible and long-lasting.

There are two problems still trend topic and preoccupying scientists which are weight and capacity of energy resources which are maintained these vehicles from the point of energy and there is no autonomous decision making mechanism yet. Despite the fact that these nano and micro unmanned vehicles are still in babyhood, successful projects have already come to light.

1) Black Hornet

UAVs are not just military but also civilian vehicles but military ones come to the forefront. One of them is Black Hornet Nano which is developed by Prox Dynamics. It allows armed unions to observe potential threats secretly. This small, remote-controlled aircraft saves lives of front line soldiers and helps them with their operations. The unit measures around 10*2.5 cm and provides troops on

the ground with local situational awareness. They are small enough to fit in one hand and weight is just over 16g including batteries.

When armed forces are in a critical operation they need intelligence, surveillance and reconnaissance and The Black Horned offers them these needs. It supplies situational awareness in the battle field and gives access to remote locations.

First step was taken in april 2008 on Black Hornet project. Serial production was started in 2012 but it was not easy to come this point. It has gone through some flying and other sorts of tests. Prox Dynamics had contract with The UK Ministry of Defence. It was a 20 million pound contract for the delivery of 160 units of Black Hornets. They are used in operations influentially by the UK army. They are also there to fulfill expectations about supplying the surveillance requirements when The UK armed forces in Afghanistan(Excell, 2013).

It is easy to train an UAV operator. Even in 20 minutes an operator can be trained. The air vehicle has three cameras; one looking forward, one looking straight down, and one pointing downward at 45 degrees. A Black Hornet package contains two helicopters, and each one's charge is reached to ninety in 20-25 minutes, the same as its hovering time, when one needs to be recharged the other is ready to fly. Top speed is 25 km/h and it has night vision capabilities, fitted with long-wave infrared video sensors. These can convey video streams or high-resolution still images via a digital data-link(Egan, 2006).

The Black Hornet is designed for easy transportation the entire system fits in a soldier's pocket. Noise of the system is hard to hear and it makes the aircraft more stealthy and re-usable. The small UAV is readily available to fly and takes less than a minute for takeoff.

It was used in Operation Herrick, named all British operations in the war, in Afghanistan. Operation Herrick personnelsare deploy the Black Hornet from the front line to fly into enemy territory to take video and still images before returning to the operator. Large area of Afghanistan is muddy, dusty and grey so it is designed for this location it is the same as area and not easily noticed. It is capable of flying for 20 minutes on quiet electric motors. It has been used to look around corners or over walls and other obstacles to identify any hidden dangers and enemy positions(Joint Doctrine Note, 2011).

The Black Hornet is connected to the operator with a digital data-link and GPS. Images are displayed on a small handheld terminal, which can be used by the operator to control the UAV. The Black Hornet is launched from a small box, which keeps broadcasted information and facts to use them later so a captured drone won't reveal anything it recorded. UAV can be controlled by operator or it can fly itself by defining its route.

U.S. army have tested it at an occurrent in the first quarter of 2015, and Prox Dynamics delivered a PD-100 with upgraded features for special forces testing in June 2015. By 2015, the Black Hornet had deployed with U.S. Marine Corps special operations teams(U.S. Air Force Remotedly Piloted Aircraft and Unmanned Aerial Vehicle Strategic Vision, 2006).

Another impressive example is Robobee.

2) Robobee

After twelve years of studying, a team in the leadership of Prof. Dr. Robert Wood from Harvard University succeeded to improve a mini robot which is flying like an insect and less than 1g, it is about 80 miligram. It has two elastic wings which can be moved independently from each other like insects and wing-width is just 3 cm. This micro UAV named RoboBee can fly by fluttering wings 120 times per second as if a real insect under favour of highly nimble and strong electronic muscles.

Specialists indicated that RoboBee has agility of a true insect and behind this property's main factor is ability of fluttering each two wings rapidly and independently of each other. Wing movements are controlled by a software which is reformed privately for it. RoboBee can reach such a high fluttering speed under favour of piezoelectric motor which also team's own invention. All these properties and splendid response speed make Robobee allow to have a high reflex system almost like all other insects in nature already. Thus, Robobee reacts immediately to abrupt air stream alteration especially occurring during flight and keep flying. It has no doubt at capability of manoeuvre in the air generally but there is one thing to solve. The thing is that it can't actualise landing manoeuvres as it should be so it lands ground harshly.

Researchers search which kind of motor is optimal for piezoelectric motor wings to motion. They realized in a short time that electromagnetic motors which use in big robots can't use in small ones and after much effort on their part they came up with their own invention: piezoelectric motor composed of slim ceramic lines. In every electric current it strains and let out thus electronic muscles of Robobee moving and fluttering wings rapidly.

Researchers know that they need large number of pioneering model for tests so they are preoccupying for this. They get rid of producing robots by hand under favour of developing very private production process. They reach the capacity that is producing intended pioneering models through computers both as in a short time and as cheaper. It is enabled to make easier design search of nano and micro UAVs which is planned to move on in long term with in droves and coordinated each other soit is a highly pleasing development in terms of science world(Autonomous Flying Microrobots(RoboBees), 2012).

3) Delfly

Delfly is developed by Delft Technical University which is a famous educational institution of Holland. Series of Delfly UAVs(DelFly I, DelFly II and DelFly micro) are one of the best of its kind. After success of DelFly I model which is 50 cm long and 21 g weighing, DelFly II is started to develop by same university. After design and developing process finished results are over expectations even their own engineers. It is 28 cm long and 16 g weighing even though it has micro camera. It can flutter wings fourteen times per second under favour of its 1,6 g weighing electromotor. It can also cover a distance backward half meter per second. Besides these properties it has another ability which is when it is on a target it can poise like helicopter. There is a problem about DelFly II which is requirement of energy. There is no such as energy resources which fulfill energy requirement in long term so flight time of DelFly II limited by 15 minutes(Cloon et. al., 2009).

The newest agent of DelFly series is DelFly micro. This model is small version of DelFly II as is evident from its name. Total weight of DelFly micro is 3 grams and 10 cm long. At the same time with these properties it is the world's smallest ornithopter that carries micro camera. It is especially a good example in terms of understanding of ornithopter's aerodynamics.

4) Bionicopter

Bionicopter project had started right after within a project named SmartBird that decipher birds' flight technic. Dragonfly has four wings and high manoeuvre capability. Purpose of this project is to produce a technic copy of dragonfly. This model 44 cm long and wing width is 63 cm and weighing just 175 grams. Bionicopter also has four wings such as dragonfly but its wings are composed of nickel-aluminium alloy and each wing move independently from each other with electronic muscles thus it has high manoeuvre capacity(Ridden, 2013).

Abrupt acceleration, sudden brake, right, left, up and down even backwards movements is like a routine manoeuvre for Bionicopter. It is equipped with a system which controls and analyzes its positions of flaps and rotating speed for avoiding likely quakes and position deviation. Bionicopter also hasn't got ability to make decisions autonomously like other micro UAVs so it is operated with remote control system.

CONCLUSION

Air forces have immense striking capability taking into the consideration of their distinctive talents of beat, speed and range capacities. Unmanned air vehicles are ideally suited for these capabilities. Along with micro UAVs, this situation grows apace. There are plenty of prototypes and some of them are mentioned above.

These are just outstanding examples of micro UAVs. Present situation of micro UAVs are beyond foreseen and process still continuing steadily to make them perfect. There are strengths and weaknesses of them and also they have opportunities and threats. Disadvantages are planned to minimize after improvement processes.

This essay provides information about where micro air vehicles are used and what abilities they have. It is mentioned about why MAV produced is and how they help troops. This essay also gives information about successful models. It is informative and beneficial for armies and other institutions which consider using micro air vehicles.

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