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Unmanned Aircraft System for Media Production: An Extension of Defense Technology

Titikorn Tantawutho
Unmanned Aircraft Systems Training Centre, Defense Technology Institute, Nonthaburi, Thailand, titikorn.t@dti.or.th

Vipada Khongphueng
Public Relations and Corporate Communication Division, Defense Technology Institute, Nonthaburi, Thailand, vipada.kh@dti.or.th

Abstract

The defense industry has played a major impact in enhancing global economy. S-curve 11th is the target industry which promotes Eastern Economic Corridor (ECC) in Thailand. The state-of-the-art in defense technology is increasing all the time including Unmanned Aircraft System (UAS) which can be used for the media production in defense technology. UAS pilots for media production in defense technology are different from other UAS pilots. They require hard and soft skills such as management, decision, planning and knowledge for controller and cinematography. The UAS knowledge and controller can be learned from a remoted pilot license course but the soft skills can be partly developed from experiences. The purpose of this study is to lay guideline for using the UAS media production in defense technology with the expectation of providing specific views and multiple domains in research area. It is a combination of engineering, art and management. The content in this article is based on experiences from UAS operation.

Keywords

UAS Cinematography, Media Production, UAS Pilots, Defense Technology

1. Introduction

Unmanned Aircraft System (UAS) or Unmanned Aerial Vehicle (UAV), commonly known as a drone, is an aircraft system without pilots on board. It can be operated manually and autonomously for take-off, landing, holding the position, orbiting and moving with waypoint by remote control or command and control station (Tsach et al., 2010). UAS is very popular for applying in many fields for examples, agriculture in spreading the water or fertilizer and sowing

the seeds, search and rescue, surveillance and reconnaissance, terrain mapping and cartography, military mission, enjoyment and media production.

Defence Technology Institute (DTI) under Ministry of Defence of Thailand is responsible for research and development on defense technology which requires approval from Defence Council. The output prototypes and innovations have impacted not only on the military but also civilian purposes (Defence Technology Institute, 2009).

Recent innovative and developed output of DTI includes amphibious armored personnel carrier (AAPC), armored personnel carrier (APC), ground to ground multi-purposed launcher, multi-purposed craft (MPC) and UAS. For the UAS, DTI has developed several sizes the aircraft such as mini as shown in Figure 1, small and medium in accordance with various usage purposes.

Figure 1: *The mini UAS (D-Eyes 02) by DTI*

UAS can be a major tool for defence technology media production. There are a lot of media types such as photos, videos, newspapers, posters, presentations and websites. The UAS technology can support experimental research and development processes and show usability, performance and efficiency. Therefore, the UAS for media production can offer the degree of freedom superior to specific physical constraints in camera crane, dollies, steadycams and camera track (Galvane et al., 2017). The main purpose of UAS media production to create a unique scene which costs less than shooting on a helicopter or plane

2. UAS Media Production Challenges

UAS photography has many advantages in creating map, sightseeing, recording evidences, searching and rescuing, cinematographic media production. The UAS media production creates a fascinated perspective of pictures or videos as well as captivates the audiences, more exciting than common media from a bird eye view. However, there are many limitations for operating UAS such as limited operation range of distance, ceiling and time, wind direction and velocity, weather, visibility, no-fly zone and permission requirements. There are several rules and regulations to follow such as Notice To Airmen (NOTAM) and flight regulations which are related to The International Civil Aviation Organization (ICAO) and The Civil Aviation Authority of Thailand (CAAT) regulations (Phrommas, R., 2016).

2.1 Non-Technical Issues

These are issues related to the laws and regulations.

2.1.1 Flight Regulations

The flight regulations in Thailand are released by CAAT. These regulations cover various topics such as UAS types, weight, flight height and radius, restricted area and distance between object and person. Operating UAS in 9 kilometers near any airports or temporary airfields is prohibited. Additionally, no UASs are allowed to fly close to any hospital, government places and some restricted areas without permission (The Civil Aviation Authority of Thailand, 2017). However, the remoted pilot license has not become effective at present in Thailand.

2.1.2 Data Privacy and Laws

The data privacy for UAS photos and videos is controlled by the legal restrictions in many countries. The privacy concerns human faces or facial images and videos if it is not agreed upon (Mademlis et al., 2018).

2.1.3 Coordination

The UAS has been used in numerous missions. However, it is confronted with communication misunderstanding which is caused by poor collaboration among stakeholders such as UAS staffs (mission commanders, internal pilots, external pilots, payload operators and technicians), media production director and staffs, air traffic control or flight rule operator etc. (Headquarters Department of the Army, n.d.).

2.2 Technical Issues

These are issues related directly to the operation of UAS.

2.2.1 Pilot Skill and Competency

The UAS accident rate has been increasing rapidly and the cause of this error includes skill-based error, poor decision making and perception error. The skill-based errors occurred when a UAS controller has insufficient skill, competency and experiences. If the controller has insufficient knowledge, he might perform poor subsequent decision making. Perception error is caused by misconception or misjudgment (Oncu & Yildiz, 2014). Basic knowledge requirement for the UAS pilot are UAS regulations, airspace classification and operation, weather, loading and performance and operations (radio communications procedures, airport operations, emergency procedures, aeronautical decision making, physiology and maintenance and inspection procedures) (The Federal Aviation Administration, 2018).

2.2.2 Mission and Scenario Planning

The use of UAS in public and military environments is well known. In the public sectors, UAS is used for forestry, agriculture and search and rescue but the military has more specific missions. Therefore, mission requirements are of importance because they are related to management, planning, safety and communication (Eaton et al., 2016).

2.2.3 UAS Classification

The UAS is classified in different aspects but common subjects are not complicated. They may be classified by weights, operation altitude, mission radius, endurance and typical use. The categories of UAS can be grouped as High Altitude Long Endurance (HALE), Medium Altitude Long Endurance (MALE), Medium Range or Tactical UAV (TUAV), Mini UAV (MUAV), Micro UAV (MAV) and Nano Air Vehicles (NAV) which are used for suitable missions (Gupta et al., 2013).

2.2.4 Environment

The effectiveness of completion of mission in UAS depends on the environment conditions. The impacts of environment include visibility, safety and completion of a mission. The UAS pilots should be concerned with sun-angle, illumination, cloudiness, wind velocity and direction, weather, humidity, location and georeferencing or ground point (Tmusic et al., 2020)

2.2.5 UAS System

The issue on the UAS systems is related to limited payload, limited battery life or flight time, disturbing sound from engines and propellers, autonomous UAS software, line of sight between the UAS pilots and aircraft and unplanned missions (Mademlis et al., 2019). Path

planning (waypoint) and targeted navigation (tracking) are basic functions in commercial UAS which are easy to use; however, the reliability and agility are involved with the software algorithms (Zhou et al., 2020).

2.2.6 Communication System

The UAS communication which is related to system capabilities and efficiency is a major factor in all missions. There are many network architectures suitable for UAS specific functions, services and requirements. However, the common UAS network architecture is ad-hoc, consisting of the remote control and drone. It is always used in the commercial drones also for the performance operations. There are several architectures such as relay nodes, network gateways, UAS to UAS (U2U), UAS to Infrastructure (U2I), distributed control, centralize control and UAS based data storage which could be used. Therefore, the techniques and architectures can be applied only to appropriate environment applications and missions (Jawhara et al., 2017).

2.2.7 UAS Cinematography

The various shot types in UAS cinematography can be described in two criteria. The first type is Framing Shot Type (FST). The FST is based on visual inspections such as Extreme Long Shot (ELS), Very Long Shot (VLS), Long Shot (LS), Medium Shot (MS), Medium Close-Up (MCU), Close-Up (CU), Two-Shot/Three-Shot (2S/3S) and Over The-Shoulder (OTS). The second type is UAS/Camera Motion Trajectory (CMT). The CMT is related to the motion of UAS such as Static Shot (SS), Static Shot of Still Target (SSST), Static Shot of Moving Target (SSMT), Static Aerial Pan (SAP), Static Aerial Tilt (SAT), Fly-Over (FLYOVER), Fly-By (FLYBY), Chase/Follow Shot (CHASE) and Descent (DESCENT). These techniques are not fixed. The UAS pilot can apply different techniques in one scene but the pilot must be aware of complicated contents (Mademlis et al., 2019). The media production skill is one of the creating media skills.

3. UAS Media Production in Defensive Missions

There are many studies and practices in this area which provide some recommendations and guidelines for the UAS media production pilots as follow.

3.1 Preparation

- The UAS pilots must complete the flight regulations and laws before operating any UAS (see Figure 2). There are some commercial UASs which are complying with the

international flight regulations. They are not allowed to takeoff or calibrate the system in or nearby No-Fly Zone such as airports, palaces, military zones and other restriction areas. For military operations, they use their own system for the mission.

Figure 2: *The operation of UAS Pilots*

- The UAS pilots must clearly understand the overall of missions and create the storyboards such as the flight path, UAS movement and camera motion.
- The UAS pilots must have a clear perception of the mission area. Each mission areas need some specific considerations. Firstly, obstacles such as mountain, building, tree etc. which affect to UAS line-of-sight communication, visibility and safety must be considered. Secondly, the UAS operation areas including Takeoff/Landing areas, Emergency Landing areas, ground points or reference points and Flight paths must be carefully specified. Thirdly, signal usage which is important to the communication system and datalink must be reviewed. Engineers/technicians must use a spectrum analyzer or equipment to analyze the frequency, transmission power and direction of signal in mission areas.
- The UAS pilots must plan and choose the compatible UAS for government missions and areas. Military missions are different from the private ones such as recording the missile launchers testing in Army, monitoring the AAPC sea operations in Navy, tracking the drug trafficking for policemen and searching the wildfire for foresters.
- The UAS pilots must concentrate on the weather forecast including Meteorological Report (METAR), Terminal Aerodrome Forecast (TAF), weather radar information,

weather satellite radar information or the related weather data and NOTAM. The NOTAM is the information notice for an aviation authority to alert aircraft pilots.

- Dry run and test flight in the real environment should be administered before the mission starts. UAV does not always conduct takeoff and landing on the ground or land. However, it sometimes does go on the naval ship deck, craft, boat, high building, wild, beach and mountain or by pilot hand.

3.2 Operational Conditions

- The UAS sometimes cannot perform takeoff or landing on the ground. Sometimes, the pilot has to use his hands as an alternative.
- Ground points are very important for the UAS pilots because all flying missions are based on pilot visualization. The selected ground point must be identified for ease to notice.
- There are unreceived GPS signal problems sometimes, which may be caused by magnetic field, obstacles and signal reflection. The magnetic field may occur when UAS takeoffs on the metal ground such as heliport, ship dock and craft. This material effects the GPS signal receiver and creates bad GPS signals. The obstacles and signal reflection occur while UAS takeoffs in the wild or tall building area. The UAS altitude measurement may get some errors. As a result, UAS pilots must carefully control the UAS according to his visual and gimbal (UAS camera). Moreover, the offline map can be applied to support some additional information.
- The UAS pilots for media production must be aware of the effects from the military missions. Examples are pressure reflection from artilleries or launchers after firing and communication interferences from other signal operations. The pressure reflection may cause damages to the UAS. The communication interferences are created by radar, high voltage poles and telephone poles. This equipment use similar frequency, high transmission power and similar operated direction. Therefore, these situations may interfere with UAS communication and datalink.
- Battery endurance planning is not corresponding to mission plan because of urgently changing mission. UAS pilots have to control the UAS to return home point for battery changing and fly back to complete the mission. The UAS pilots must create new power

supply plans for any changing missions. They sometimes have only one chance to record a video.

- The immediate change of mission may not fit with the old flight plan or storyboards but the mission sometimes changes immediately. The changing mission may affect time, light, objects and elements in media production. The UAS pilots should have backup plans as a result they will not miss the mission objectives.
- The UAS pilots must operate aircraft carefully in an area of valley, mountain, sea, wild or places obviously changing weather or wind and birds.

3.3 Post Flight

- The UAS pilots must do post flight inspection immediately after finishing each flight because it is necessary to inspect and clean the aircraft. The advantages of inspection are to check any damages and to get aircraft ready for the next flight. Moreover, the UAS pilots need to clean the dust and another dirtiness. This activity is for safety purpose.
- The UAS pilots must record flight operation data into pilot logbook and aircraft logbook.
- The UAS pilots must periodically check and maintain the aircraft apparatus such as battery lifetime, system configuration or version and another equipment.
- The UAS pilots and production team must check the integrity of recording files and should arrange the media files before going for the next production processes.

4. UAS Cinematography for Defense Technology

A framing shot type is significant in media production. The defense technology media product mostly uses the wide and long shot because of safety reason of the aircraft. The UAS pilots must gain the knowledge, competency and skills in controlling both the aircraft and the camera. Many operations can be recorded only once. Camera assistant functions and application may assist the UAS pilots to operate the camera easily. However, the UAS and camera manual mode may provide better scenes. According to hands or manual operation, the UAS pilots are able to control not only the frame vibration between UAS speed and shutter speed but also the involvement of foreground, background and objects.

Most of military innovative research outputs have been tested during daytime. The media production process has been performed along with the testing procedures. The photo format, photo modes, video resolution, white balance (Warm and Cold), aperture, shutter speed, ISO (Sensitivity), exposure values (Brighten and Darken), EV compensation, camera histogram

(White and Dark), camera orientation, dynamic range and focus are primary factors for media production. These factors can be configured for different frames and environments. The RAW photo format may produce a better photo quality than JPEG but JPEG requires less time in processing. Manual camera settings may get better natural results than automatic camera setting but the automatic setting one can take several shots continuously. A histogram function can set the exposure which supports the dynamic range to camera. Lowest ISO values may reduce noise for light up but the high value can solve diffused light problems. The shutter speed is determined by the frames per second (fps); therefore, it is related to the bit of motion blur. EV compensation should be configured before shooting photos or videos in order to compensate the light. The filter is another alternated solution for reducing light intensity, reflection and noise. White balance and color are used to show contrast, detail, shadow, highlight and dynamic range. Panorama shooting is captivated to the audiences for showing wide and overall scene while the point of view is suitable for emphasizing an object.

Figure 3: *The AAPC's sea testing operation photo by multi-rotor UAS*

Many UAS severe incidents caused by the carelessness of staff members have been recorded. For situation awareness, the UAS pilots should identify, analyze, assess and control the flight situation. All the risks have to be controlled at higher than a standard level.

5. Conclusion and Future Opinions

UAS has been used widely in media production in Thailand. However, there is no central organization responsible for UAS registering, training pilots and supportive staffs and advising

for the UAS maintenance. Although, there are many UAS training courses offering in Thailand but not many of them have been approved or authorize by CAAT and ICAO.

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