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UTILIZATION OF UNMANNED AERIAL VEHICLE (UAV) TECHNOLOGY IN CRIME SCENE INVESTIGATION

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Abstract

This paper presents and discusses a range of new technologies that use the new development of Unmanned Aerial Vehicles for a range of incident investigations and analysis scenarios. This paper addressed previous studies conducted within the Crime Scene Investigation System. The reconstruction of the crime scene is a method to secure, process and reconstruct the specific scene of the crime. It is a process of preserving the evidence, evaluating the evidence and building the possible scene for the crime. The process includes a framework that is used as a guidance on what must be followed in order to get all evidence endorsed in the courtroom. In this paper, journals with elaboration would support the specific objective. This will enable users to understand the specific purpose of utilizing Unmanned Aerial Vehicles (UAVs) in a crime scene investigation.

Keywords: Aircraft, Crime scene, DJI, Drone, Radar, Unmanned aerial vehicle.

1. Introduction

The development of unmanned aerial vehicles has gone a long way from a spying machine to commercial toys. However, the usage and adaptation of unmanned aerial vehicles in an organization to ease process of work have expanse .For instance, now most of the law enforcement agency and private organization are adopting it to help them to carry out activities like law enforcement surveillance, agricultural maintenance, sports event footage, movie shooting and search and seizure. While there are many legitimate applications, media reports on the misuse of unmanned air vehicle technologies are rising breaching the Civil Aviation Authority Air Navigation Regulations. This rapid advancement has led to a better quality of life for many people. Drones or unmanned aerial vehicles are such technical innovation that can help society simplify everyday activities.

Investigations into a crime scene are multi-faceted which not only involved in gathering trace evidence that also documentation and recording of the scene, reconstruction of scene etc. According to [1] during a traditional crime scene investigation the investigator will face many challenges and difficulties due to size and nature of the crime scene. For example, the particular nature of the crime scene may slow down the investigator work and will make the job difficult to evaluate [2]. In some cases, geographical location of the scene may affect the work of the investigator such as crime scene near riverbank, cliff edges, hills, etc., making it possible to secure the crime scene quickly and efficiently and maintain the integrity of evidence to able to use in court and criminal proceedings.

In addition, in the case of a serious crime like a murder, obtaining the proof is an incredibly a critical issue .Evidence like tire tracks, footprints, DNA is very fragile which is easy to be disturbed and left at the crime scene .This is because if this crime scene occur in an outskirt area or jungle can Make the investigator a difficult task to walk through the path to gather evidence. With the advancement of technology in 20th century has a solution to these problems by using unmanned aerial vehicles (UAVs) as a part of a crime scene investigation team. UAVs could not only be used for the reconstruction of the crime scene but could also be used for tasks such as traffic incident detection and traffic control assistance. It will make the use of UAVs in police and forensic operations extremely easy.

2. Unmanned Aerial Vehicle

Drones are also known as Unmanned aerial vehicles (UAV). They are being operated without a human pilot on board. UAVs is an advanced technology that are a component of an unmanned aircraft system. This system consists of elements that are UAV itself, ground based control or controller and the communication channel between the two.

Large UAVs may be dedicated to control systems where it will be mounted on a vehicle on the ground or in trailers with full of equipment to monitor the UAV, in doing so it allow close proximity to UAVs restricted by distance or communication services. For operational planning and observation UAVs are used. In addition, this technology is now available to support crew members in the emergency response area. UAVs are graded based on the elevation range, strength and power, and whether it could support a wide range of communication (distance in KM). Every UAV device is graded based with all these attributes, to check whether is it comply the aviation regulation law. For instance, the pilot of a drone that can fly more than 1000 feet is required to you have flying license. UAV with certain capabilities should only be used by the military and private contractors. The smallest categories of UAV are also driven by ground controlling stations consisting of laptops and other components which are adequately compact to accommodate the smaller vehicles such RF Control ,WIFI Control, This controller usually comes in bundled with the aircraft where is transmits a unique signal between the controller and the on board devices.

UAVs equipped with advanced-precision cameras can maneuvers around the disaster zone, take photographs which allow the team to conduct image and structural analysis. As UAV operations must always requires an on-site staff or crew, to assist in monitoring the UAV performance .in accessing the disaster area before entering the disaster zone would be beneficial for members of the team in charge. In the case of search and rescue, once the UAV analyse the zone or disaster area, it will determine whether there's survival detected via image analysis. If a survivor is detected the crew member, we try to make contact the survivor and perform a quick rescue operation. Another example of UAV, a nano UAVs where is designed to be small, with a purpose to analyse the structural damage to a structure and sense survivor stuck inside debris.

2.1. Technology used in UAVs

The technology of UAV has to expand amazingly with many private industries and some law enforcement agency has discovered the UAV can be a value in crime scene investigation. Generally, for every drone controller unit is required to connect to an application in the mobile device which will provide ability for the operator to view path and navigate the UAV. The navigation in handling the movement of the drone is mostly handle manually using the controller. However, in some cases, with the help of powerful programming tool which will provide the ability to the drone to automate itself. In addition, for commercial drone the signal and the range of the coverage may be insufficient, hence devices like signal extender can be used to help user to extend the coverage of the drone signal as a result a longer distance of flight is delivered.

2.2. Radar positioning and return home

The modern UAV are designed with Dual Global Navigation Satellite System (GNSS). The GNSS is being used as a receiver in the drone. It allows the system to calculate the position, velocity and time from receiving signals broadcast from the satellite Most of the modern drone in the market is able to support and fly in both modes .for instance, Drone brand from DJI have a modes called ‘P-mode’ where Is uses both GPS & GLONASS and ‘ATTI mode’. ‘ATTI mode’ provide the user the ability to control the drone on their own.

At the same time, the drone will capture the GPS coordinated of the drone location and save it as a “Home point”. In some case of high-end drone, a High-end GNSS systems is integrated where it uses Satellite Constellation technology. This technology is so advance where group of satellites works together to provide coordinated coverage and synchronized for an accurate of intersection is provided.

2.2.1. Obstacle detection and collision avoidance technology

Generally, high tech drones are fully equipped with cameras and several sensors [3]. The number of sensors may vary depends on the type of drone and the price. The more the number of sensors equipped on the drone, the more expensive the price will be. Sensors and camera are used to detect obstacle in advance and avoid any collision towards the aircraft. The sensor built in in every drone a pre-program to continuously scan for the surrounding for any possible collision or obstacle .If an obstacle is detected it will prompt an alert to the controller and the operator ask them to avoid collision. Most of the high-end commercial drone such as DJI Phantom and Mavic air are fully equipped with this technology.

As shown in Fig. 1, a DJI Phantom drone is fully equipped with high tech sensors and cameras to avoid collision and obstacle. These features integrated in a drone is very significant as it could maintain possible or unintended crash for the operator and the victim. As shown in the figure it is fully equipped with sensor surrounding the drone itself, followed by a main camera at the front. The Camera placed in the front does not only record footage, but it is pre-program to determine and detect object ahead.

Fig. 1. Obstacle detection and collision avoidance technology in DJI (dronezon.com).

2.2.2. No-fly zone drone technology

Developers like DJI what license to develop drone technology are fully equipped with service that is compliant to the law and the regulation provided by the authorities. There are some high-security areas that have restricted flying drone. For instance, high security areas such as airports runway, military area and guarded resident are restricted to fly. This is because when a drone is flying at airport area, many potential issues may arise such as a potential collision with an aircraft landing and it may destruct the communication signal between the call tower control and the aeroplane on the air.

As a result, to this regulation top manufacturers like DJI have implement the no-fly zone features, where the application will determine the location of the drone whether it trespass a restricted area. Using GPS technology built in, it will automatically detect and stop the drone from entering the restricted area. In the event of a user attempting to initiate a drone within a no-fly area the drone engine will not be functioning, and the user will not be able to operate the drone. As shown in Fig. 2 is an example of DJI application that highlight restricted area for the user. In Fig. 2, the highlighted area in red shows area of an airport. Generally, the area of restricted are within the range of 5 to 3 kilometres radius from the source of restriction.

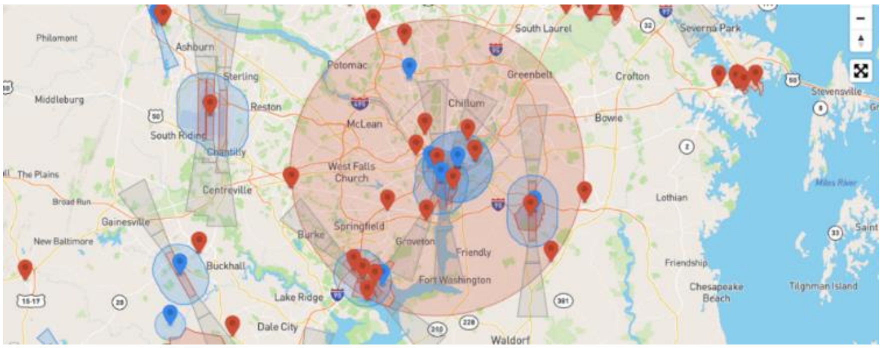

Fig. 2. No-fly zone drone technology in DJI [4].

2.2.3. ‘Ready to fly’ gps mode drone technology

Ready to fly mode technology is a tool they provide the operator to pinpoint the location that they desired to fly. This features provide an automate ability for the operator or the user to fly the drone without doing any manual flying. This is done as simple as pinpoint location on the map in the application as shown in Fig. 3. The drone will automatically fly over the pinpoint location based on the GPS coordination set. Before this feature is operational the drone is required to calibrate the compass where he will determine the exact location of the drone by GPS set the light [4]. Once the desired location is determined and the coordinate of each path will be send to the drone. After all this process is done, with a click of a button in the application or the controller the drone will fly according to the pre-set GPS coordinate.

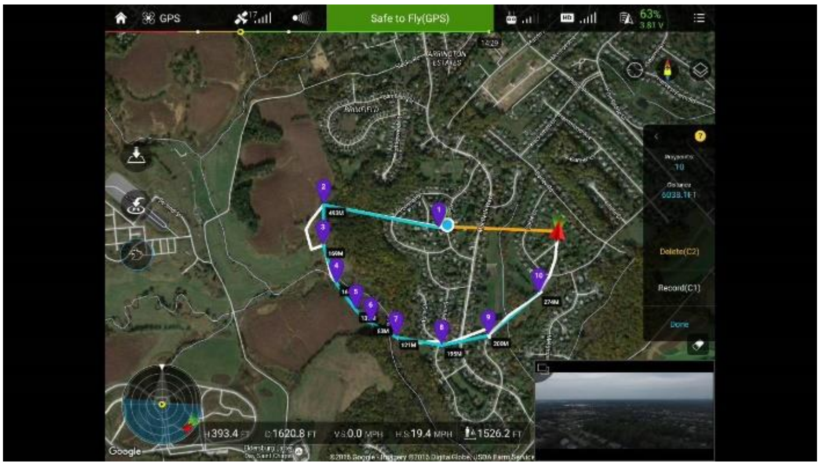

Fig. 3. GPS ‘ready to fly’ in DJI app (cyberspaceandtime.com).

2.2.4. FPV live video transmission drone technology

Another amazing features that most of drone technology provided is FPV or known as “First Person View”. The unmanned aircraft is equipped with a video camera which broadcasts the live video to the pilot on the ground. This achieved through live streaming of a camera where it transfers the image to goggles or to the pilots monitoring via radio waves (typically using 2.4 GHz or 5.8 GHz). This will provide the user a real thrill and clearer view while handing the drone on air. As shown in Fig. 4, Most of the drone capable to transmit first person view over a 4G or LTE network which will provide an unlimited range and low latency video. Some of the drone that support these features such as Sky drone FPV 2 are mostly use for racing competition.

Fig. 4. FPV live video transmission drone technology in DJI app (dji.com).

2.2.5. Operating systems in drone technology

Finally, yet importantly, the technology behind the advancement of drone is its operating system. Most unmanned aircraft use Linux, and a few uses Microsoft Windows. The Linux Foundation started the Drone code Project in 2014. This open source and collaborative project can bring existing technology to another level with most of the operating system in UAV such as Pix4D can provide a Drone mapping for public safety with is able to Transform images into 2D and 3D as an digital evidence for court (Pix4D SA, 2020) [5, 6].

3. Application of UAV in Crime Scene Investigation

In an investigation of the crime scene, the investigator is facing several challenges because of the complicated nature of the crime scene areas. For example, if there has been a crime in a hill area, the evidence and secondary crime scene may be applied to the bottom hill area and the road. Barricading, recording, filming and videotaping these crime activities is incredibly necessary and at the same time challenging. An investigator must also outline the crime scene that reflects the locations of the evidence as well as search for and gather the evidence without interference. Any form of contamination may result in loss of the evidence value and restrict the scope of the analysis. The handling and investigation of the crime scene is time-consuming. Therefore, with the help of UAV advanced technology this issue can be avoided and investigation contact it can be handled and managed accordingly.

Photography: The scene of crime and the evidence are photographed with an overview, a middle view and a close-up view. A high-resolution camera with a certified professional is also required. Rarely, evidence beyond the scope of photographers such as in lakes, wetlands, mountain slopes etc. is difficult to photograph. However, with the help of a drone the investigator can easily photograph the evidence in minutes. Moreover, if the drone equipped with high pixel camera can provide Clearview or exact view of the evidence without disturbing evidence area .it can be flown at a large height in rural areas, in the mountains or around waterways to search or investigate the crime scene.

Videotaping: Videotaping is another type of documentation to capture the entire crime scene in a flow. Like photography, the crime scene can also be videotaped with a drone. This can reliably, effectively and in short time videotape the wide inaccessible crime scenes. Videotaping is a being used to outline the crime scene and is being advisable to use in key cases. While video cannot still replace photographs because of its lower resolution, video recording provides an easily comprehensible vision platform showing the layout and location of the crime scene [7].

Evidence: Searching for evidence is the most crucial part of investigation, as every evidence gathered and recorded should be properly managed and handled well. Any temperament occurs during their gathering of evidence this could jeopardize the entire case. Furthermore, some evidence may be overlooked even though search pattern techniques are used. With the help of a drone, to locate and search the evidence it could be another way of collection method that could help during in investigation. Having another set of eyes in the sky, can make the evidence gathered solid and more accurate. Thus, a concrete case will be the outcome of it.

Reconstruction/mapping: With the right technology and software implemented in reconstructing and mapping the crime scene can provide the investigator the better and clear view of the scene. With the assist of LIDAR technology (Light Illumination Detection and Ranging) we are able to digitally map the whole crime scene at an instance. Generally, this technology is embedded in the system of the drone which it emits highly coherent laser light to the surface of the evidence and the crime scene [7]. Once the light received to the evidence and the crime scene the drone will automatically calculate the distance between each evidence on the crime scene. The advanced 3D digital image can be identified using this type of calculation data and can successfully reconstruct the crime scene. The LIDAR technology lets us map proofs like glasses, traces of blood, fur, skin, saliva, etc.

Investigation: The Crime scene phases such as recording processing, videotaping, evidence collection and reconstruction can be done by the use of a drone. A drone can be used in tele forensics as an important tool to help the investigative expert from the laboratory directly. For example, once a fingerprint is found on the crime scene, the fingerprints can be imaged and sent by the drone directly to the fingerprint department. The scanned object from the scene can be analysed and the findings obtained will be send to investigator team in no time. The integration of a drone in Tele-forensic will thus simplify the process of investigation and save the time.

4. A Real-Life Use of Drones and Lighting in Night Crime Scene Reconstruction

On 5th September 2019, FoxFury Lighting Solutions, Sundance Media Group, and Pix4D brought the popular Night CSI drone demo event back to Las Vegas for

Interdrone 2019 [8]. The demonstration is being used to display on the how Drone Technology is being used in order to have an efficient process on mapping and document a crime scene in a non-destructive manner.

The scenario is, the scene of this crime consisted of one victim who has been attacked and is positioned on a remote road on the edge of Henderson, NV. The location is also remote enough that vehicles and equipment are difficult to access the crime scene. Passing through rainstorms and high winds provided the investigators of the crime scene and additional obstacles and made it imperative that they handle the situation quickly before extreme weather affected the scene or evidence as shown in Fig. 5.

Fig. 5. The scene and conditions (foxfury.com).

Before the UAV team can carry out a map - based mission of the crime scene, a pre-flight checklist must be completed. This includes checking the calibration of the drone, charging batteries, pilot control (PIC) and visual observer (VO) whether they are Competent in terms of mental and physical condition to operate the mission safely. The team must also confirm that it can operate in the provided airspace and has the clearance and permission to travel [9]. Finally, a comprehensive weather analysis is required to ensure that passing or changing conditions will not hinder the task or put the investigative crews at risk on the field.

Due to the lack of significant ambient lighting in this remote area, scene illumination has been implemented to provide documentation with adequate light. FoxFury Nomad T56 lights were placed across the perimeter of the crime scene to provide even illumination across the entire operation. Greater lighting on the crime scene allows the drone camera to produce sharper images with less noise and higher resolution [9]. It also lets the camera shoot faster, which is crucial when the drone is flying over a scene to take pictures. The drone has also been fitted with its own search light and strobing light to ensure that FAA 107.29 complies with FAA rules in order to fly at night as shown in Figs. 6 and 7.

Fig. 6. Nomad T56 scene light illuminates a mock crime scene (foxfury.com).

Fig. 7. Lighting system powered for Drone (foxfury.com).

One of the goals was to demonstrate how a crime scene can be recorded at night. Besides having enough light to illumine the crime scene, other considerations had to be considered before carrying out a night flight. For first timer pilot, while operating under CFR 14 section 107, the Pilot in Command must have a daytime waiver. Moreover, scouting must be done to ensure that there are no wires, power lines, trees or other obstacles that could disrupt with the objective. The operator must choose whether to fly manually or on a pre-determined set path before flying the drone. All work should be completed, but decisions must be made in advance and considerations taken. When the drone is flying manually by the pilot, it must fly in a consistent level to produce the highest-quality view or map to be generated. The working area is then conveyed to the ground crew so that everyone knows the drone is overhead.

The Evo flown in a configuration of grid type capturing nadir images (looking down straight). It then flew around the scene an orbital pattern to capture oblique images that would improve the 3D model. The flight time for the demonstration was about 20 minutes. If it were a real test, the drone would gradually fly a more extensive pattern in order to acquire more images. It would have increased the flight time to 30-60 minutes. As shown in Fig. 8, the drone is used investigating the crime scene with overview height.

Once the flight had finished, the drone then returned to the landing zone with memory cards collected and the data were loaded into the photogrammetry program by Pix4D to construct an ortho-mosaic scene model [8]. On that night, a point cloud and model were generated to give a detailed presentation of the scene as shown in Fig. 9.

Fig. 8. Drone investigating the crime scene (fpxfury.com).

Figure 10 shows a 2D Orthomosaic map. The point cloud and Orthomosaic map (with 3D information) can be viewed with the software itself. This demonstration shows how drones can be used to construct an accurate scene model that can be examined instantly or well as years after the case. Even in a remote and challenging area, it is possible to photograph, map, and process the scene itself quickly and with minimal disturbance. This technology gives researchers a whole new toolkit to complete their work securely, accurately and effectively.

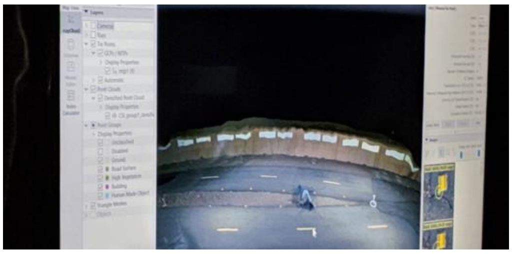

Fig. 9. Pix4D photogrammetry software in use (foxfury.com).

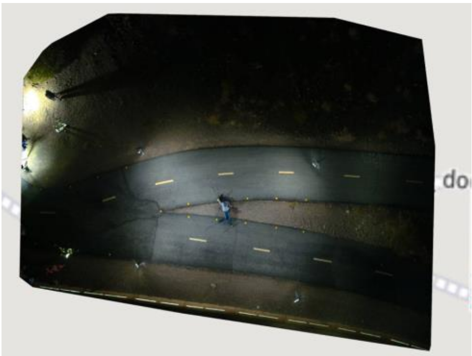

Fig. 10. 3D construct of the crime scene.

5. Conclusion

Military forces use drones for covert operations and terrorist attacks. After the 2011 World Trade Centre attack and the "War on Terror," the United States used drones in Yemen, Afghanistan, Kashmir and many others to kill alleged terrorists. Israel acquires the world's largest exporter of armed drones used in all fields, from spying to precise rocket attacks.

However, the use of UAV has proven to become a resourceful method for investigating and handling the crime scene. The implementation of such technologies in research agencies would reduce time and effort normally consumed. Modernization of investigative procedures requires an hour to deal with the current rate of omission of crimes and their treatment. Even though, Drones can prove useless in harsh weather conditions. The performance of aircrafts can be hampered, and it can collapse, since it uses rotor-oriented equipment and a low battery life. This can be substituted with drones powered by hydrogen fuel to solve the problem as an example. The proposed use in criminal investigation of drones will certainly prove an advantage for enforcement authorities if it is well managed and incorporated.

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