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Drone Forensic - A Useful Technique in Wildlife Forensics

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ABSTRACT

Animal trafficking and poaching, illegal timber trade and many such related activities are crimes that are observed globally. There has been a constant attempt to prevent these activities for the protection of flora and fauna so as to maintain species survival from the past. Traditional investigative techniques and strategies are less effective in this field since such crimes are harder to track down specifically because of the wider area of wildlife inhabitation. Drone forensics is considered as a branch of digital forensics which includes recovery of digital data from drones under conditions pertaining to forensics. Unmanned Aerial Vehicles UAVs) also known as drones can capture the birds-eye view of crime scene, wildlife areas, residential or commercial fires/explosions, searching for evidence more quickly and efficiently. Drones, in wildlife, assist in illegal activity tracking, animal monitoring, population counting, reforestation planning and more. They are also considered to be far more accurate at counting species and are capable of recording vast amounts of data more quickly, in comparison to manual work. This paper aims at examining and possibly identifying how drones can be used potentially in the field of wildlife forensics.

Keywords: Wildlife; Wildlife forensics; Digital forensics; Drones, Unmanned Aerial vehicle.

Introduction

Digital forensics is a science of finding evidence from digital media like a mobile phone, computer network, etc. It helps in the analysis, inspection, identification and preservation of the digital evidence residing in various types of electronic devices. Digital forensics include disk forensics, data-base forensics, network forensics, wireless forensics, malware forensics, email forensics, memory forensics, mobile forensics, etc. Another new addition in this list is drone forensics (Williams, 2022). Unmanned Aerial Vehicles UAVs) or Drones are small pilotless aircraft that can be controlled remotely. Formerly the use of drones was confined to military purposes, however in recent years their civilian usage has grown significantly.

UAVs are being explored in law enforcement settings, search and rescue missions, agriculture maintenance, filming, deterring and identification of poaching. The drone forensics is a significant domain used to identify, collect, preserve, reconstruct, analyse and document potential UAV incidents (Al-Room *et al.,* 2021).

Drones have been around for decades. Ease of availability and affordability of unmanned aerial vehicles have led to an increase in its popularity amongst the public. This increase in the number of drones in the commercial market has given heed to crimes and illegal activities such as invasion of privacy (Yang *et al.,* 2021). However, drones also play a key role in research, particularly in moderating and monitoring wildlife. The images and data they collect can tell us a lot about animals and possible conservation techniques. Poaching and the illegal wildlife trade and such wildlife crime are a multibillion-dollar global industry. Biodiversity is threatened due to the commercialization and overexploitation of wildlife. Efforts from wildlife law enforcement to prevent wildlife crime are a necessity (Ivosevic *et al.,* 2015). The applied field in this area is termed as Conservation forensics, which uses scientific techniques to gather data related to wildlife crime. Conservation drones are remote-controlled devices capable of collecting information from difficult-to-access places while minimising disturbance. Although drones are being used in many research disciplines, their application to wildlife research still remains unexplored in-depth Bouafif *et al.,* 2018)

DRONE FORENSICS – A RELATIVELY NEW FIELD

Drone forensics is a sub field of digital forensics which deals with the acquiring, analysis and investigation of evidence from drones or Unmanned Aerial Vehicles UAVs) and other components of Unmanned Aerial System UAS) comprising GCS and remote controller (Yousef, 2020). Drone forensics can be regarded as a combined field of mobile forensics and wireless forensics since the primary component in this field is drones that are controlled remotely by a radio controller, mobile phone or tablet (De Alwis). This is a relatively new field, the full potential of which is not fully utilised in forensic science. Researches in the field of drone forensics in the recent times, focus mainly on acquiring data from drones that are used for various and a large number of illegal activities like voyeurism, the invasion of the privacy of citizens and sensitive places, the smuggling of contraband items, the spying on individuals or other nation states, espionage on companies and government entities, and the unauthorised launching of aerial missile attacks (Iqbal *et al.,* 2019). The drones otherwise called Unmanned Aerial Vehicles or Uncrewed Aerial Vehicles are flying robots devised to operate in the air to capture images and videos of a target or targeted area. Initially used exclusively in the military, drones at present are widely exploited in many other fields from cartography to agriculture, law enforcement to disaster management, photography to commercial transportation and emergency medical supply. There is an increasing interest in the study of drones world-wide in almost all sectors, notably by MNCs to develop technologies to adopt drones as an asset (Urbanová *et al.,* 2017).

DRONES IN FORENSIC SCIENCE

Similar to how Ground-penetrating radars, the Global Positioning System – GPS, 3D contacts digitizers, and surface laser scanning are used in forensic science for documentation of crime scenes and finding potential evidence related to a crime, drones can also be used for various forensic related purposes (Mendis, *et al.,* 2016). The use of drones in forensics is extended but not limited to crime scene recording and documentation, scene reconstruction, videotaping, safety assessment of the crime scenes and producing raw data suitable for producing 3D models (Rocke *et al.,* 2021). In the investigation of homicide, suicide, accidents and any other crimes, drones can be utilised for capturing overall, mid-range and closeup photography of the crime scene as well as the physical evidence present. There are researches conducted to employ drones to aid in the investigation of burial like mass grave excavation (Ruwaimana *et al.,* 2018) as well as the extent of usage of drones in photographing trace evidence like fibres.

ADVANTAGES OF DRONES OVER ITS ALTERNATIVES

A research conducted on the mapping of mangrove vegetation using drone and satellite images showed that drones can be a better alternative to satellite images since they can produce higher resolution images though both give aerial images. Also, satellite images are not always available and accessible at ease (Tatsidou, *et al.,* 2019).

The manipulation of drones in forensic science is viable due to its following advantages; 1. It is non–invasive, safe and fast, 2. It minimises the contamination of crime scenes as there is no manual stepping inside the crime scene that can tamper fingerprint, footprint or such traces, 3. It can capture the aerial photograph giving the investigators 'bird's eye view' of the scene of crime, 4. A comparative study of drones and satellite images revealed that drone images provide highest accuracy images in both object and pixel based classification, 5. Recent developments in drone technology like long battery run time, waterproof nature, simplified data size, hyperspectral proximity sensor, active remote sensing and newer models in the market made drones cost effective and many more.

WORKING OF DRONES

A Chinese company-DJI 76.8% of the market), Intel 3.7%), Yuneec 3.1%) and Parrot 2.2%) are some of the leading drone manufacturers. The Centre for a New American Security categorises drones into 4 major categories;1. Hobbyist Drones which are operated for recreational purposes, 2. Midsize Military and Commercial Drones which are mainly used by the military for surveillance, reconnaissance or payload delivery services. 3. Large Military-Specific Drones used in military infrastructure and training and 4. Stealth Combat Drones (Chamoso *et al.,* 2018). However, the basic components for operation of all types of drones are homogenous. Drones are basically aircraft fitted with cameras and sensors controlled remotely by a radio controller, mobile phone or tablet (Yi-Ming, 2000). The components that make up a drone include Propellers, Motor, Receiver, Transmitter, GPS Module, Battery, Camera, Electronic Speed Controllers along with data storage systems. Drones are made up of plastic or such lightweight durable material fitted with various types of cameras and sensors along with Global Navigation Satellite System GNSS) such as GPS and GLONASS. Most drones use the Linux operating system while Microsoft Windows is also being used. The camera and sensors used depend on the manufacturer and the functional category that it belongs to. The captured data is stored as volatile memory in the internal storage system while noval drones have imaging technologies like LIDAR, which capture images through UV, IR and visible filters and are stored in the internal memory as well as in the remote system that operates the drone. The navigation of drones can be managed with an android or IOS phone or radio controller.

DRONES IN WILDLIFE FORENSICS

Flora and fauna, listed in the red list or otherwise, around the world is currently subject to a number of crimes. The real scale of such illegal activities is difficult to quantify since these are mostly undetected. The monetary value of wildlife crime is estimated as $32 billion USD per year, excluding illegal fishing and illegal timber logging (Pires, *et al.,* 2011). INTERPOL defines wildlife crime as ''the taking, trading, exploiting or possessing of the world's wild flora and fauna in contravention of national and international laws''. A broader definition of wildlife crimes apart from the given definition include 1) poaching for trade or personal possession; 2) illegally killing for bush meat; and 3) killing animals due to human animal conflict. Any wildlife crime or Illegal Wildlife Trade IWT) involves people associated at three main different levels i.e, harvesters, intermediates and consumers (Phelps *et al.,* 2016). Harvesters are associated with the collection of wildlife resources, activities of whom include poaching, logging, overfishing and so on. They work in closer proximity to the wildlife inhabitation. Intermediates are the middlemen working as logisticians and processors engaged in physical transformation of harvested wildlife resources and the consumers are category of people who may or may not be unaware of the source of the resources but utilise them for medicinal, ornamental, cultural, recreational, food, or as construction materials. IWT is a criminal syndicate among which harvesters are loosely organised while the next levels are more organised and difficult to track (Kretser *et al.,* 2015). Wildlife conservationists, law enforcement authorities at the borders and several international organisations like CITES, TRAFFIC and so on at present are motivations behind the reduction of wildlife crimes to a considerable extent. Genome wide SNP genotyping, multiple microcrystalline analysis, DNA barcoding, Inter-Simple Sequence Repeating ISSR), High Resolution Melting HRM) Analysis are some scientific techniques used for identification of species in case of poached and trafficked animals (Rodionov *et al*., 2021). Research is being conducted on the development of mobile applications and websites for identification of such species. Though all of these measures identify species and aids to tackle poached

and trafficked flora and fauna, much accurate preventive measures like situational crime prevention, are in dire need. Situational Crime Prevention SCP) is a practical approach in addressing these issues, opportunity reducing conservation being the most relevant. The usage of drones to guard and surveil wildlife inhabitation can be an appropriate opportunity reducing conservation. The utilisation of drones in wildlife forensics is not a much-researched area though conservationists employ drones for species monitoring and mapping vegetation cover. Employing drones in and around wildlife inhabitation for surbilliemce and monitoring can help identify illegal activities in regards to wildlife. Today, we might consider hunters ivory and exotic animal pelts as a thing of the past, unfortunately, the situation not being so. Even today, one of the significant wildlife threats continues to be illegal poaching of animals, pushing many species on the verge of extinction. Drones prove to be a valuable tool in putting a halt to this $70 billion-per-year industry. Drones can be used to conduct surveillance on poachers, in areas where harvesters are likely to be operating (Kumar *et al*., 2018). Some electrical drones are armed with thermal cameras and imaging software. These are helpful in analysing the real-time data aiding the criminals to be caught effectively. Using thermal-imaging, drones capture heat signatures which indicate poachers and wildlife traffickers. David Wilkie, the director of conservation measures for the Wildlife Conservation Society, stated they had deployed drones in Belize to examine illegal fishing near the vulnerable reef area. With the use of funds from Google, the World Wildlife Fund is using different technology methods such as drones to combat poaching in Africa. The Associated Press used a drone to observe a mission in Hluhluwe-iMfolozi to look for heat-emitting objects in shapes of similarity to a rice grain for tracking a team of poachers such as a tracker, shooter, and carrier all of those who are armed with a rifle and an axe to chop off the rhino's horn to later sell in the black market (Kriangwanich *et al*., 2021).

Drones also find its use in wildlife monitoring. Manual counts can be unreliable whereas drone-based counts are more accurate, the difference between human and drone-based counts being particularly significant. Drones are also capable of capturing aerial imagery of wildlife, making population counts almost effortless. By observing a species, you change their environment and run the risk of scarring or stressing individuals. Use of a conservation drone can allow wildlife monitoring that does not disturb wildlife, and is more efficient in covering larger distances than can be achieved on land or sea. Researchers are able to examine individual animal's health, perform population counts, observe migration routes, monitor trends in populations over time (Kurland *et al*., 2017) and study animal behaviour such as mating. At Fort Collins Science Centre in Colorado, a population count of Sandhill cranes Grus canadensis) was accomplished in only four hours. Using a modified former military drone, the biologists counted 14,000 sandhill cranes, which would have taken many people several days to accomplish on land. With a conservation drone, it was possible to survey 30 to 50 kilometres of Colorado without missing or recounting individuals. Aerial imagery yields interesting data with a high success rate. A geographic mapping program captures hundreds of images combining these images into one big map. Similar to a Google Earth map, conservation drone images are more detailed, using 2 centimetres resolution/pixel. Conservation Drones can be used to map a variety of landscapes such as ocean waters, and forest and depict a timeline of ecological issues. For example, drones can monitor U.S. National Parks and wildlife safe zones and the health of their ecosystems. Conservation Drones have had field tests in tropical forests due to the ongoing process of deforestation. These forests are home to many endangered species and help in the reduction of climate change. With the contributing factors to carbon emissions, deforestation has contributed 15% of global greenhouse gas emissions, which have disturbed global forests with rates of 13 million hectares in recent years. With the success rate of 100% from the 32 missions these Conservation Drones have endured in locating areas of deforestation, they have aided the research of climate change.

DISCUSSION

Throughout this paper, the term drone forensics is used in the context of usage of drones in forensics science along with the given definitions, though researchers in the past have defined drone forensics as the investigation and analysis of drones in forensic settings (Daly, 2021). Thus, this paper tries to put forth that drone forensics needn’t necessarily be forensic investigation of drones, but involves its usage in the respective field. With the

literature reviewed in the course of communication of this paper, it is perceptible that drone forensics can be employed in wildlife forensics among its successful manipulation in other fields. Drones are a better alternative to other similar technology for tackling wildlife crimes since they can capture a larger area and can be employed 24/7 for monitoring movement and activities in and at the border of forest areas and ocean waters. Among the three levels of actors associated in wildlife crimes, the harvesters are loosely organised which makes their detection using drones less challenging. However, intermediates or middlemen are largely a part of organised crime syndicate operating away from the regions of wildlife inhabitation forbidding the monitoring use of drones for their detection, limiting its use only near forests or waterbodies or such wildlife inhabitation areas. Researchers suggest that one of the chief reasons behind wildlife crimes are opportunistic locals whose livelihood depends on exploitation of wildlife resources. An appropriate Situational Crime Prevention technique is required to settle this issue. As suggested in this article, drones' technology, to an extent, can increase the risk of this illicit activity and is therefore an opportunity reducing conservation technique. To serve this purpose, drones need to be employed as surveillance systems in and around areas of wildlife inhabitation be it forests or wildlife sanctuaries or national parks or IUU Illegal Unregulated Unreported) fishing prone waterbodies. Novel waterproof drones with extended battery life should be used for the purpose. The integration of biometric technology to the drones can detect human presence and thus can give intimation to the authority regarding any unauthorised human entry into the wild. Recent biometric development in voice recognition and gait pattern can be imparted with drone technology for a much better result. With the new return to home feature in the drones (Torchia, 2016), it would be easier to switch the surveillance drones at regular intervals for supplying power.

A question that needs to be addressed while considering drone surveillance in places of wildlife inhabitation is if this could disturb the natural habitat of species. During a fieldwork done using drone (Harvey, 2014) the researchers observed that the birds flying around the area of drones tended to avoid it. The extent to which this question needs to be resolved requires actual field work for better insight. However, drones can be dangerous to the surrounding environment. Many countries have laws regarding the regulation of its use. For eg. In Singapore a certificate or licence is a must to obtain to fly a drone. Whereas in France, it is forbidden to fly drones over power plants. There's a possibility of accidents by flying drones in highly sensitive areas which can endanger wildlife and ruin tourist experience. Apart from all the measures taken, there will always remain some kind of impact on wildlife. However, drone research can be carried out more ethically, by mitigating these impact. Another of its limitations include the high budget involved. Although drones domestically used come in less price, drones used in conservation forensics could be of a higher price as the technologies involved can be expensive to purchase, putting a bigger price tag on the research being carried out.

Finally, research conducted on the possible attacks against drones revealed that they are vulnerable to different cyber-attacks like confidentiality attacks, integrity attack, availability attack. Within the reach of technology at fingertips, this might facilitate the perpetrators of wildlife crimes to manipulate drones to find wildlife resources by the mentioned attacks. An appropriate preventive measures to withstand such attacks should be considered while utilising drones for the said purpose.

CONCLUSION

The purpose underlying this paper is to expound how novel drone technology can be used in the field of wildlife forensics. With the ongoing and increasing threats in regards to wildlife trade, the scope of this paper extends to provide data on how noval drone technologies can be used in the field of wildlife forensics. Drone technology can be manoeuvred in tackling crimes pertaining to wildlife like IWF. This can be done at all three levels associated with IWT - the harvesters, the intermediates and the consumers. The idea this paper proposes, needs to be tested experimentally for a much better understanding of what it could yield in actual scenario.

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