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Unmanned aerial vehicles: A preliminary analysis of forensic challenges

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ABSTRACT

As unmanned aerial vehicles have become more affordable, their popularity with the general public and commercial organisations has seen significant growth in recent years. Whilst remaining a device for both the hobbyist and aircraft-enthusiast to enjoy, they are now also used for carrying out activities such as law enforcement surveillance, agricultural maintenance, acquiring specialist movie and sports event footage along with search and seizure activities. Conversely, despite maintaining many legitimate uses, there are also increasing media reports of unmanned aerial vehicle technology being abused, ranging from physical assaults due to negligent flights to breaches of Civil Aviation Authority Air Navigation Regulations, requiring a forensic analysis of these devices in order to establish the chain of events. This article presents an introductory discussion of unmanned aerial vehicle analysis and provides the results of a digital forensic investigation of a test Parrot Bebop unmanned aerial vehicle. Directions for the acquisition and analysis of the device's internal storage are provided along with an interpretation of on-board flight data, captured media and operating system. Further, as the device can be controlled via Android and iOS devices using the application FreeFlight3, forensic analysis of these devices is also presented. Results showed the ability to recover flight data from both the unmanned aerial vehicle and controller handsets along with captured media, however problems exist with establishing the definitive owner of the device, particularly if a user had abandoned it at the scene of a crime.

Introduction

Unmanned Aerial Vehicles (UAVs), also referred to as Remotely Piloted Aircraft Systems (RPAS) (European RPAS Steering Group, 2013) or drones, are small pilotless aircraft that are controlled remotely (Civil Aviation Authority, n.d.). Whilst now used extensively in the military (Valavanis, 2008) and traditionally confined to members of the public maintaining an enthusiasm for aircraft (Civil Aviation Authority, n.d.), in recent years civilian use of UAVs has now increased (Colomina and Molina, 2014) prompting the UK House of Lords to describe 2014 as the 'year of the drone' (House of Lords European Union Committee, 2015). Although the availability of definitive sales figures at the time of writing is sparse, reports from Forbes (2015) indicate significant increases in UAV sales on eBay and statistics estimate sales to reach 290,000 units in China (Statista, 2015a). Further, Deloitte (2015) predict that in excess of 1 million units globally will be sold by the close of 2015, with the combined commercial and public UAV markets in the United States expected to be worth over 10 billion dollars by 2020 (Statista, 2015b).

As UAVs have become more affordable, their range of use is expanding, leading to commercial exploitation. In 2015, media reports indicated Amazon's planned intention

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to utilise UAV delivery systems (BBC News, 2015a), namely 'Amazon Prime Air' (Amazon, n.d.), with the parcel firm DHL (2014) having already undertaken test flights using their 'parcelcopter' to the North Sea island of Juist. In addition, the use of UAVs for tasks such as police surveillance and patrol purposes (BBC News, 2015b; Sussex Police, 2015), agricultural maintenance (Huang et al., 2013), search and rescue missions (Schlag, 2012; Villasenor, 2013), filming movie scenes (Reid, 2014) and as a method for deterring and identifying poachers in Africa (BBC News, 2015c) have been identified. There is a clear legitimate use for this technology with an ever-expanding list of ways to deploy this technology for the benefit of both individuals and society. However, conversely, for every valid application, the possibility of the malicious use of UAVs remains, increasing the chance of these devices forming part of criminal investigations, ultimately requiring a digital forensic investigation.

In 2015, the UK House of Lords European Union Committee raised concerns over the rising use of UAVs, despite the potential for this emerging technology to be a source of benefit to the economy. Comments from Chief Inspector Nick Aldworth, Chief Inspector of Operations in the Metropolitan Police (Parliamentlive.tv, 2014) highlighted the threats to privacy posed by UAVs and the potential for these devices to cause harassment, thoughts echoed by Finn and Wright (2012). Subsequently, a number of incidents involving the misuse of UAVs have been reported following breaches of Air Navigation Orders at sporting events including football (BBC News, 2015d) and tennis (BBC News, 2015e). In addition reports of abandoned UAVs in Parliamentary and Royal residences (Robinson, 2015) and the White House (BBC News, 2015g) have been made. Media reports have also documented the use of UAVs for transporting illicit items into prison environments (Delgado and Slater, 2015). At present, the true extent of the threat posed by this emerging technology has not yet been recognised, as it is subject only to the inventiveness of the criminal mind and continued mechanical development of these devices. As UAVs continue to become more sophisticated, with greater power consumption and range of flight, the scope of activities a user can undertake will continue to expand, bringing with it a new wave of unacceptable practice.

This article provides a preliminary analysis of UAV devices, highlighting the challenges posed by this technology to the digital forensic practitioner and law enforcement investigations. A digital forensic analysis of a Parrot Bebop drone is presented, along with an investigation of the mobile devices used to pilot it, namely an iPhone 6 and Galaxy S3, both utilising the Parrot's dedicated UAVs flight navigation application 'FreeFlight3'. Evidence of ownership, flight paths and camera media is highlighted and discussed, providing a founding guide to approaching these devices in forensic investigations.

Specific UAV offences

Although the media has frequently reported the mishandling of UAVs, it is necessary to establish what actions actually constitute UAV misuse for the purposes of committing an offence. As a starting point, the Civil Aviation Authority (2015a), the United Kingdom's specialist aviation regulator has provided a number of regulations for acceptable UAV usage.

The first requirement lies with determining the classification of the suspect UAV in question. Guidance is provided under the Civil Aviation Authority (2015b) Air Navigation Regulations, where Section 255 interprets a 'Small unmanned aircraft' as a device with a mass no greater than 20 kg not including its fuel, but including all other components attached to the device at the start of flight. As a result, devices in this classification are exempt from a large proportion of the regulations in place, for example, any UAV above 20 kg in weight; permission to even fly the device must be sought from the Civil Aviation Authority. Article 138 of the Regulations prohibits a controller from recklessly or negligently causing or permitting an aircraft to endanger persons or property, where a flight can only take place if the controller is reasonably satisfied it can be safely made (Article 166(2)). As part of ensuring the safety of others, direct visual sight of the UAV must be maintained at all times to avoid collisions (Article 166(3)). Where the UAV has surveillance capabilities (a camera), Article 167(2) states that a flight cannot 'be over or within 150 m of any congested area', 'over or within 150 m of an organised open-air assembly of more than 1000 persons', 'within 50 m of any vessel, vehicle or structure which is not under the control of the person in charge of the aircraft' or 'within 50 m of any person' except for the person in charge of the device. Similar guidance is provided in the United States by the Federal Aviation Administration (2015).

Prosecutions for misuse of personal UAVs remain limited as of the time of writing, where in 2014, Robert Knowles became the first person to be prosecuted in the United Kingdom for illegally and dangerously flying a UAV in breach of United Kingdom Air Navigation Orders, incurring a £800 fine. Details of the case are as follows. After recovering Knowles's UAV from water surrounding a "submarine testing facility in Barrow-in-Furness, operated by the defence company, BAE Systems, analysis by the police of video footage taken from a camera fitted to the device subsequently revealed that during its flight it had skimmed over the busy Jubilee Bridge over Walney Chanel, well within the legally permitted 50 m separation distance required. The UAV had also flown through restricted airspace around the nuclear submarine facility before it inadvertently landed in the water" (Civil Aviation Authority, 2014). Knowles was charged with "flying a small unmanned surveillance aircraft within 50 m of a structure (Article 167 of the Air Navigation Order 2009) and flying over a nuclear installation (Regulation 3(2) of the Air Navigation (Restriction of Flying) (Nuclear Installations) Regulations 2007)" (Civil Aviation Authority, 2014).

In addition to aviation regulation breaches, a UAV controller can commit a number of other domestic offences. In England and Wales, the Sexual Offences Act 2003, section 67 defines an offence of voyeurism (summarised as an act of intentionally observing/recording another carrying out a private act without their consent, for the purposes of obtaining sexual gratification). With the ability to