

# E-BOOK OF EXTENDED ABSTRACT

## THE 14<sup>TH</sup> INTERNATIONAL INVENTION, INNOVATION & DESIGN COMPETITION 2025



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# DRONE-CONTROLLER INTEGRATED FORENSIC TIMELINE (DRIFT): A FRAMEWORK FOR DRONE AND ANDROID MOBILE CONTROLLER FORENSICS

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## ABSTRACT

The increasing deployment of Unmanned Aerial Vehicles (UAVs) or drones across various sectors presents significant challenges, including potential misuse such as unauthorised surveillance and airspace violations. To address these concerns, this research introduces a novel forensic framework, DRIFT, designed to enhance drone forensics by integrating data from both drones and Android smartphone controllers. The DRIFT framework provides a comprehensive approach to digital artifact acquisition and analysis, offering critical insights into drone-related forensic investigations. This study applies DRIFT to analyse digital artifacts from the DJI Mini 3 drone and its Android-based controller (DJI RC-N1) without rooting the device. Data acquisition was performed using both static and dynamic methods on the drone and physical and logical methods on the smartphone. Dynamic acquisition of the drone revealed richer artifacts, including EXIF metadata containing key information such as latitude, longitude, and altitude. Although flight log data were not found on the drone itself, they were successfully extracted from the smartphone via logical acquisition by identifying the DJI Fly application package (dji.go.v5). The extracted flight logs were then converted into .kmz format using Phantomhelp.com and visualised in Google Earth to confirm airspace violations. This research highlights the significance of the DRIFT framework in integrating acquisition methods and understanding application structures to obtain valid forensic evidence while preserving the integrity of the device.

**Keywords:** DRIFT framework, drone forensics, android acquisition, DJI Mini 3, flight logs

## 1. INTRODUCTION

Unmanned Aerial Vehicles (UAVs), or drones, are remotely operated aircraft widely used in fields such as aerial photography, surveillance, and terrain mapping. Once limited to military use, drones are now increasingly adopted across commercial and personal sectors, including industries like coal mining, where they are employed for tasks such as road mapping and site monitoring (Kumar & Agrawal, 2021). According to Statista, global drone sales reached 5 million units in 2020 and are projected to grow to 9.6 million by 2030. However, the growing accessibility and advanced capabilities of drones have also raised concerns about misuse, including unauthorised flights, smuggling, espionage, and privacy violations (Studiawan et al., 2023). These risks highlight the urgent need for drone forensics to detect, analyze, and extract digital evidence from drones and their controllers in cases of potential violations (Almusayli et al., 2024). In response to the case study, this research introduces a new framework called Drone-Controller Integrated Forensic Timeline (DRIFT) to guide forensic investigations involving drones and Android-based controllers. DRIFT provides a systematic approach to identifying and analysing digital artifacts, enabling investigators to examine data such as flight records and metadata to verify potential drone flight violations. By following this structured workflow, DRIFT enhances accuracy, minimises errors, and supports the admissibility of findings as valid digital evidence.

## 2. METHODOLOGY

This study adopts a case study approach using a DJI Mini 3 drone and a DJI RC-N1 controller integrated with an Android-based smartphone (VIVO V19). The research employs digital forensic methods based on the procedural framework developed in DRIFT. For the drone, both static and dynamic acquisition techniques were employed. Static acquisition involved creating a bit-by-bit forensic image of the microSD card using FTK Imager, while dynamic acquisition was conducted with the drone powered on to observe real-time system activity. The acquired data was analysed using Autopsy. For the Android controller, physical acquisition was carried out using MOBILedit Forensic, followed by logical acquisition using Android Debug Bridge (ADB) to extract relevant data. All procedures were repeated four times for consistency: twice for the drone (static and dynamic) and twice for the controller (physical and logical, with the device in airplane mode). The DRIFT framework is proposed as a novel method for enhancing forensic investigations related to potential drone flight violations in restricted areas. The workflow of the DRIFT Framework is illustrated in Figure 1.

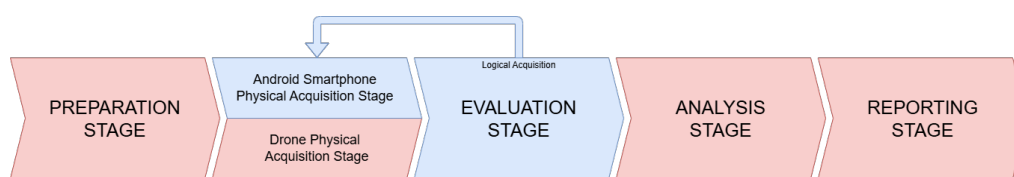


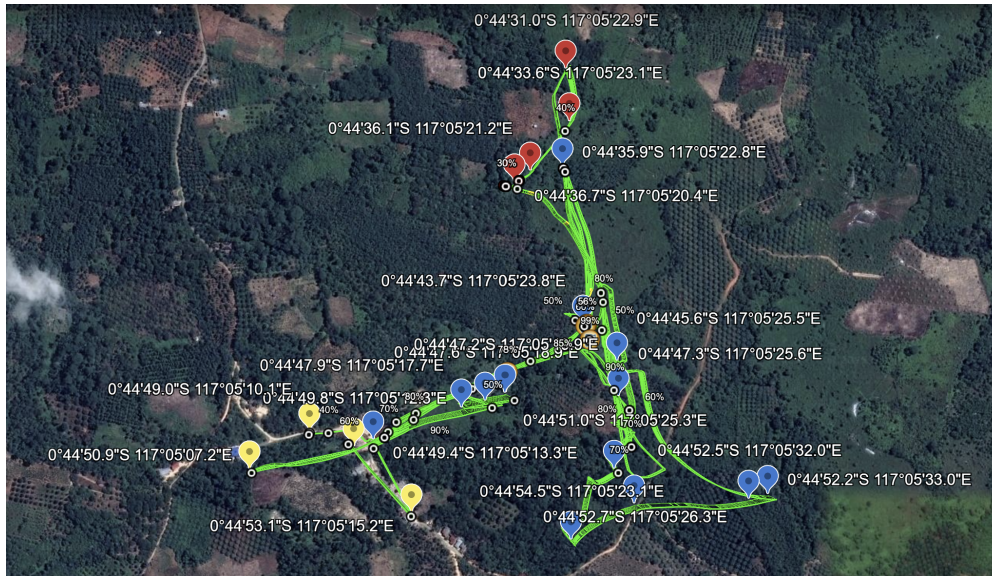
Figure 1 DRIFT Framework

Figure 1 illustrates the forensic workflow of the DRIFT framework, utilising two distinct colour-coded paths, namely pink and blue, to represent the separate acquisition processes for the drone and the Android smartphone controller, respectively. The pink path outlines the sequence applied to the drone, beginning at the Preparation Stage and proceeding directly to the Drone Physical Acquisition Stage. The process then advances to the Analysis Stage, and finally to the Reporting Stage, bypassing the Evaluation Stage. This direct progression is justified by the nature of the drone's data, which primarily consists of media files such as images and videos embedded with metadata. These data are typically complete and self-contained upon physical acquisition, eliminating the need for additional evaluation. In contrast, the blue path depicts a more iterative and conditional process specifically tailored for the Android smartphone controller. It also begins at the Preparation Stage and proceeds to the Android Smartphone Physical Acquisition Stage. The data acquired at this point is examined in the Evaluation Stage to determine whether critical forensic artifacts, such as flight log files, have been successfully retrieved. If the necessary data is present, the workflow proceeds to the Analysis Stage, followed by the Reporting Stage. However, if essential artifacts are not found, the process loops back to an additional acquisition phase via the Logical Acquisition Stage, in an attempt to extract the missing data. Once the data is successfully obtained, the workflow resumes at the Analysis Stage and concludes with the Reporting Stage. This dual-path workflow highlights the flexibility and robustness of the DRIFT framework in accommodating the distinct characteristics and requirements of forensic acquisition for both drones and Android-based controllers. The inclusion of the Evaluation Stage for smartphone controller ensures that only validated and relevant data advance to the analysis phase, thereby enhancing the reliability, accuracy, and forensic soundness of the overall investigation process.

## 3. FINDINGS

The application of the DRIFT framework in this study proved effective in guiding a structured forensic investigation of both the drone and its Android-based controller. During the static acquisition of the drone, only image and video files were recovered from the microSD card. However, the dynamic acquisition process produced richer artifacts, including image files embedded with EXIF metadata

containing precise GPS coordinates. On the controller side, physical acquisition using MOBILedit Forensic uncovered a video file that included geolocation data identifying the drone's initial takeoff point. Subsequently, logical acquisition via Android Debug Bridge (ADB) led to the successful of detailed flight logs associated with the DJI Fly application. These log files were processed using PhantomHelp.com to convert them into coordinate data. Finally, all recovered GPS points were analyzed and visualised using Google Earth, allowing for a comprehensive examination of the drone's flight path and potential airspace violations. The analysis results are illustrated in Figure 2.



**Figure 2.** Analysis Results of the Drone Flight Path Coordinates by EXIF Metadata (UAV)

Based on Figure 2, the blue points on the map indicate designated coal mining areas authorised for drone-based surveying and mapping activities. These locations represent the legal operational zones permitted by the mining company and served as the primary focus of this case study. In contrast, the red and yellow points mark coordinates located outside the authorised coal mining zone. The presence of these points suggests that the drone crossed beyond the approved boundaries, indicating a potential violation of operational procedures and flight safety regulations in restricted areas. Additionally, the green line represents the actual flight path of the drone, visually confirming the breach into unauthorised territory.

#### 4. CONCLUSION

This research successfully conducted a digital forensic investigation on the DJI Mini 3 drone and the DJI RC-N1 controller based on an Android smartphone using the DRIFT framework. The framework emphasises a rootless acquisition approach on Android smartphones, allowing the collection of digital artifacts without altering the device's system. The analysis revealed that video coordinates were obtained through MOBILedit physical acquisition, while the dynamic acquisition of the drone generated EXIF metadata artifacts, such as latitude, longitude, and altitude. Photos and videos also revealed territorial violations. In addition, flight log artifacts were successfully extracted through logical acquisition on the controller. These findings highlight the importance of combining both physical and logical approaches, as well as understanding the application's file system structure, to retrieve valid and reliable digital artifacts. Overall, the DRIFT framework has demonstrated its effectiveness in drone-related forensic investigations, offering valuable opportunities for further development in forensic acquisition approaches.

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