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EFFICIENCY OF DRONE-ASSISTED PROCEDURES FOR DISASTER VICTIM IDENTIFICATION IN HAZARDOUS ENVIRONMENTS COMPARED TO CONVENTIONAL PROCEDURES

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ABSTRACT

Manual ground searches and cadaver dogs are traditional methods for locating remains, but they can be time and resource intensive, resulting in a delay in locating remains, and victim identification. The present study was designed to employ drones in the localisation of mass disaster victims and early processes of victim identification in the field, without waiting for victims to be transported. Five specific objectives were established (1) To analyse the time efficiency for retrieval of secondary identifiers in drone-assisted procedures compared to conventional procedures in DVI, focusing on the impact of hazardous environments (2) To determine the image quality, detection accuracy and sensitivity of secondary identifiers in drone-assisted procedures compared to conventional procedures in DVI, focusing on the impact of hazardous environments (3) To determine the optimum flight altitude for thermal drone operations in identifying decomposed rabbit carcasses under varying altitudes (4) To assess differences in thermal signatures between clothed, unclothed, and live rabbits using a thermal drone, by evaluating the influence of larval mass development on heat detectability (5) To construct a comprehensive, evidence-based checklist for drone-assisted procedures in DVI, incorporating expert opinions and consensus through the Delphi Method, and addressing key operational, technical, and safety protocols. A randomised simulation study was conducted to compare conventional and drone-assisted procedures in terms of time efficiency and image quality. Additionally, the study explored the use of thermal drones to detect decomposing remains by identifying maggot mass temperatures using rabbit carcasses at various heights. A Delphi method was employed to develop a drone checklist for drone applications, gathering expert input through a structured feedback process. Our results demonstrated that the average time taken in hazardous environments were fastest in drone-assisted procedures compared to conventional procedures. However, while the accuracy and inter-rater reliability of the drone-assisted procedure were found to be statistically significant ($p < 0.005$), they were not absolute. Although the method demonstrated improved performance compared to conventional techniques, it did not achieve 100% accuracy across all cases indicating a need for further investigation to ensure consistency and precision in real-world application. For objective (3), 15m above ground level was proven to be the optimal height, as it showed the greatest contrast between the carcass heat signature and the background ($p < 0.005$). Our data suggested the potential window of detection of thermal signatures was detectable up to 7 days post-deposition. This could be an important guideline for the search and recovery teams for operational implementation in this tropical region. For last objective, the constructs for standard drone-assisted procedures application checklist in DVI has been identified and established by using Delphi method involved 9 panels from drone and DVI experts. A strong consensus emerged, with all respondents affirming that drone-assisted technology is essential for advancing DVI efforts. This preliminary study presents a novel and innovative approach by being the first to incorporate drone technology, specifically thermal drones, for the remote detection of decomposing human remains in tropical regions. Additionally, it proposes the first framework for a standardised drone checklist tailored to DVI operations. These findings lay the groundwork for incorporating advanced drone-assisted technologies into forensic and disaster response, offering significant potential to improve the efficiency, safety, and effectiveness of future DVI efforts.

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TABLE OF CONTENTS

CHAPTER 1

INTRODUCTION

1.1 Research Background

Unmanned aerial vehicles (UAVs), known as drones, are small aircraft flying autonomously or piloted vehicles. Drones are also known as Unmanned Aerial Systems (UAS), Remotely Piloted Vehicles (RPVs), and Remotely Piloted Aircraft Systems (RPAS), in addition to being referred to as UAVs. The term "drone" is more widely recognised compared to UAV, UAS, RPV, or RPAS (Restas, 2015; Sahu et al., 2024). Drones can autonomously conduct control operations using onboard autopilot systems with no direct human intervention (Mohsan et al., 2023). However, drones can also be remotely piloted through pre-programmed computer software or remote control from a ground base station (Mohd Sabri et al., 2023).

Drones are being widely used and have gained significant attention in the last decade in diverse fields both in civil and military purposes. In civil applications, drones are employed for various agricultural tasks, including crop monitoring (Bendig et al., 2014), vegetation mapping (Díaz-Varela et al., 2015), and pest management (Hunter et al., 2020). Drones are also used for marine faunal detections (Colefax et al., 2019; Barreto et al., 2021), habitat destruction assessment (Barnas et al., 2019), mapping geographical locations (Kucharczyk & Hugenholtz, 2019; Chang et al., 2020) and wildlife monitoring (Ivosevic et al., 2015; Chabot & Bird, 2015; Hodgson et al., 2016). In the case of military and policing applications, drones are used in crime scene surveillance, security, and reconnaissance (Bucknell & Bassindale, 2017; Mohsan et al., 2022). The rapid development of drone technology has enabled greater use of drones in various industries, providing more cost-efficient operations without risking human life. Drones can be rapidly and easily deployed, offering swift mobility, and access to remote or dangerous areas (Mohsan et al., 2022). Owing to the advancements in drone technology, their application has been extended to play a more prominent role in disaster response and humanitarian efforts.

When a disaster strikes, a rapid and effective response is critical to assisting the populace, reducing the number of victims, improving first responder's capabilities, and