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Research Paper
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Uncrewed Aircraft Systems- An Advancement for the Safety of Wildland Firefighters

Wildland firefighting is one of the most hazardous career paths with immediate dangers related to fire's unpredictability, aviation accidents, direct contact with fire and as well as lingering health issues from smoke inhalation, prolonged heat exposure, and exhaustion. Between the years of 2000 and 2013, 298 wildland firefighters died due to their occupation and 78 of these firefighters died as a result of aviation accidents (Butler, 2015). While there will never be complete safety while working on the fireline, technological advancements can provide alternatives and safer plans for suppression efforts (Sewall, 2024). In NWCG's Report on Wildland Firefighter Fatalities in the United States (2017), one of the major causes of fatalities was accidents involving aircraft. While aircraft are a necessity in fighting wildfires today, some applications for crewed aircraft can be shifted to the use of uncrewed aircraft, commonly referred to as "drones".

Aircraft use on the wildland fireline is integral to many suppression efforts. Air tankers provide water and retardant resources where engines cannot gain access in areas of rugged terrain or minimal road access. Helicopters are used for water and resource drops, mapping the fire's perimeter, injured person extraction, and can act as an aerial fire activity monitor (Ausonio, 2021). Missions like these pose a serious risk to the pilot and other crew as these aircraft operate at low altitudes with low visibility and high speeds. These conditions create a situation where hazards can be difficult to identify before it is too late to mitigate those hazards. While crewed aircraft are crucial to some wildfire containment strategies, they can be expensive to operate and can be grounded due to high winds, low visibility, and cannot operate after sunset or before sunrise (Momeni, 2024). In suppression efforts where having crewed aircraft is not necessary such as

mapping, hotspot location, and aerial ignition, drones can fill the role quite well while keeping personnel on the ground (Akhloufi, 2021).

Uncrewed aerial vehicles for wildland firefighting have dramatically increased in their usage in the past ten years and have greatly improved firefighting capabilities while increasing safety. Integration of uncrewed aircraft into wildland firefighting has unlocked the ability to fly in low visibility conditions while all other aircraft are grounded (National Wildfire Coordinating Group, 2024). These uncrewed aircraft can be equipped with a variety of cameras and sensors, such as thermal imagery that can detect the fire's heat output even in dense smoke or after the sun sets. Fire activity tends to calm down at night due to higher humidity and lower temperatures. During this time of reduced fire activity, management techniques such as direct suppression can have a greater impact on containment and can provide safer working conditions for firefighters who are working on the line. Having uncrewed aircraft with thermal imagery in the sky after dark while all other aircraft are unavailable can provide valuable intel to crews on the location of hotspots or flare-ups (Lattimer, 2023). Thermal imaging can also detect any increases in fire activity during the day when ground crews may not be able to see the head of the fire or any hazardous situations caused by weather changes (Momeni, 2024). The pilot of drone can alert the crews on the change in fire activity sooner than a look-out would be able and can allow time to change management strategies or evacuate (Lattimer, 2023).

Wildfire perimeter maps are essential data for reports and understanding the extent of the fires damage (Dulchinos, n.d.). Often, larger fires are mapped via helicopter where the pilot flies low to the ground and is required to follow the fire's edge creating the need for sharp turns and possibly some hazardous terrain changes like canyons that are difficult to navigate (Butler, 2015). This type of mapping requires an incredibly experienced pilot and can pose many dangers. Drones are

commonly used for many mapping applications and are also used in place of helicopters to map the fire. Drones have the ability to get closer to the direct edge of the fire while lowering the concern of collisions with trees, powerlines, or other higher altitude structures (National Wildfire Coordinating Group, 2024). Not only do they reduce risks experienced by helicopter pilots, they also can operate at a lower cost and create a more accurate map.

Firefighters strive to quickly contain the fire, especially in high priority such as areas with fuel loading and areas near development. Drones equipped with cameras can survey the fire without putting a human in the sky and are able to locate the primary concerns (Momeni, 2024). Realtime data can help crews to be dispatched to these locations quickly. These drones provide real-time surveillance of fire activity. Locating fire behavior changes such at flair-ups, crown runs, and shifts in the direction of the head of the fire can provide valuable knowledge to firefighters on the line and can indicate if a team needs to move towards a safety zone or leave an area (Sewall, 2024)

While uncrewed aircraft systems provide significant advancement in wildland firefighting, they do have some limitations. First, according to FAA regulations, the drone must stay within visual line of sight (National Wildfire Coordinating Group, 2024). Operators could encounter issues where the drone cannot be flown any further from their current location as they would need to transverse impassable geographic regions such as deep canyons or large bodies of water. Additionally, in dense smoke conditions, the drone may not be able to be flown as far from the pilot (Lattimer, 2015). A second issue that can be encountered with drone operations is battery life. While this can be mitigated with charging stations on the transport vehicles, it can be difficult to gain access to electricity near fires if these charging stations do not work (Momeni, 2024).

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Wildland firefighting is a dangerous occupation. Organizations such as the National Wildfire Coordinating Group strive to find ways to educate firefighters on possible hazards they could encounter and implement practices that prioritize safety. Aviation is just one aspect of fire management that can cause fatalities and injuries. While some crewed aircraft are necessary, uncrewed aircraft have been implemented by many agencies to keep firefighters on the ground when it is possible. Uncrewed aircraft can benefit wildland firefighting groups by increasing efficiency and more importantly, creating a safer work environment for personnel on and above the fireline.

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References

Akhloufi, M. A., Couturier, A., & Castro, N. A. (2021). Unmanned Aerial Vehicles for Wildland Fires: Sensing, Perception, Cooperation and Assistance. *Drones (Basel)*, *5*(1), 15-. https://doi.org/10.3390/drones5010015

Ausonio, E., Bagnerini, P., & Ghio, M. (2021). Drone Swarms in Fire Suppression Activities: A Conceptual Framework. *Drones (Basel)*, *5*(1), 17-. https://doi.org/10.3390/drones5010017

Butler, C. R., O'Connor, M. B., & Lincoln, J. M. (2015). Aviation-Related Wildland Firefighter Fatalities — United States, 2000–2013. *MMWR. Morbidity and Mortality Weekly Report*, *64*(29), 793–796. https://doi.org/10.15585/mmwr.mm6429a4

Dulchinos, V., Keeler, J. N., Sadler, G., Holm, L. J., Pradhan, K. D., Battiste, V., Lachter, J., & Brandt, S. L. (n.d.). *Human-Autonomy Teaming Assistant to Support Small Uncrewed Aircraft Systems for Wildland Firefighting Operations*.

Lattimer, B. Y., Huang, X., Delichatsios, M. A., Levendis, Y. A., Kochersberger, K., Manzello, S., Frank, P., Jones, T., Salvador, J., Delgado, C., Angelats, E., Parés, M. E., Martín, D., McAllister, S., & Suzuki, S. (2023). Use of Unmanned Aerial Systems in Outdoor Firefighting. *Fire Technology*, *59*(6), 2961–2988. https://doi.org/10.1007/s10694-023-01437-0

Sewall, E. (2024, April 11). UAS in aerial firefighting: how are drones addressing our growing wildfire challenges? *Commercial UAV News*. https://www.commercialuavnews.com/public-

safety/uas-in-aerial-firefighting-how-are-drones-addressing-our-growing-wildfire-challenges

National Wildfire Coordinating Group. (2017). NWCG Report on Wildland Firefighter Fatalities in the United States: 2007-2016. (PMS 481). https://www.nwcg.gov/publications/841

National Wildfire Coordinating Group. (2024). NWCG Standards for Fire Unmanned Aircraft Systems Operations. (PMS 515).

Momeni, M. Mohammad J, S. Al-e-Hashem, M. (2024). Collaboration of thermal sensors and drones in fighting wildfires; Mathematical model and heuristic approach. *Internet of Things*, 26. https://doi.org/10.1016/j.iot.2024.101168.

Momeni, M. Soleimani, H. Shahparvari, S. Afshar-Nadjafi, B. (2023). A multi-agency coordination resource allocation and routing decision-making problem: A coordinated truck-and-drone DSS for improved wildfire detection coverage. *International Journal of Disaster Risk Reduction*, 97. https://doi.org/10.1016/j.ijdrr.2023.104027