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# THE USE OF DRONES BY FIREFIGHTERS: CONDUCTING EMERGENCY RESPONSE OPERATIONS

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**Abstract:** Drones have proved to be a valuable tool in the fight against forest fires. Equipped with high-resolution cameras and thermal sensors, they allow firefighting teams to monitor affected areas in real time, identifying hotspots and hard-to-reach spots. In addition, drones help to map large areas quickly, providing accurate data for decision-making and combat strategy. Some models can also be used to drop products such as fire retardants or water on specific areas. Agility and the ability to operate in dangerous terrain make drones essential allies in forest fire management.
**Keywords:** Emergency, Drone, Firefighters, Technology

## INTRODUCTION

In recent years, technology has played a key role in various industries, and in the emergency sector, it's no different. One of the most significant advances has been the use of drones, or unmanned aerial vehicles (UAVs), by fire crews. Drones offer a range of benefits, from improving safety to optimizing incident response, revolutionizing traditional practices, rescues and rescues in hard-to-reach areas. In this article, we'll explore how drones are being integrated into firefighter operations, their applications, challenges and the future of this technology. Practices that can be useful in fighting forest fires (MUNIZ, 2023)

## HOW DRONES ARE BEING USED BY FIREFIGHTERS

The adoption of drones by firefighting teams has begun to gain momentum in recent years, especially with the evolution of camera and sensor technologies and the reduction in the cost of acquiring and operating UAVs. Drones are used in a variety of situations, providing a bird's eye view and real-time data to help make quick and accurate decisions. The main applications include:

Figure 01: example of a drone

### FIRE MONITORING

One of the most common ways drones are used is to monitor fires, especially in large areas such as forests or difficult-to-access terrain. Drones equipped with high-definition cameras, thermal cameras and gas sensors can fly over the affected area, providing detailed images and real-time data on the spread of the fire, high temperatures and the presence of toxic fumes. This information is essential for firefighters to plan fire attack routes and define evacuation strategies for nearby areas. The use of flame retardant chemicals can be added (KOCH, 2024).

### SEARCH AND RESCUE

Drones also play an important role in search and rescue operations, particularly in hard-to-reach places such as mountains, landslides or flooded areas. Equipped with high-resolution cameras and infrared sensors, drones can locate victims even in conditions of low visibility or in hard-to-reach places. In addition, they can provide information about the surrounding environment, helping teams to avoid natural traps or other dangers.

### MONITORING NATURAL DISASTERS

In natural disaster scenarios such as earthquakes, floods or tsunamis, drones are often used to carry out rapid damage assessments. They can fly over affected areas, capture detailed images and generate maps in real time, which facilitates the planning and coordination of rescue and humanitarian aid operations. With drones, firefighters can better assess conditions on the ground before sending teams into dangerous areas.

### INSPECTION OF INFRASTRUCTURE AND EQUIPMENT

In addition to their functions during emergency response, drones are also useful in preventive operations. For example, they can be used to inspect buildings, power lines, roofs and other critical equipment to identify faults before they become emergencies. This can prevent fires or other incidents from occurring and help teams respond more quickly to situations of imminent risk.

## BENEFITS OF USING DRONES

The use of drones by firefighters presents a series of advantages that transform the way emergency operations are carried out. Some of the main benefits include:

### INCREASED SECURITY

One of the biggest advantages of drones is that they improve the safety of firefighting teams. In fire or disaster situations, conditions can be extremely dangerous, with risks of collapse, explosions and exposure to toxic gases. Drones allow firefighters to monitor the situation remotely, preventing the team from putting themselves at unnecessary risk. In addition, aerial images can help identify fire hotspots or areas that require more attention, allowing for a more strategic response.

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Figure 02: Aerial image of a fire

## SAVING TIME AND RESOURCES

The use of drones also contributes to a more agile and effective response. With the ability to quickly fly over large areas and provide real-time data, drones help speed up situation assessment and decision-making. This is particularly important in forest fires or natural disasters, where response time can be a crucial factor in saving lives and protecting property. In addition, by replacing activities such as the manual inspection of dangerous areas, drones save human and material resources, optimizing operations.

## ACCURACY AND REAL-TIME DATA COLLECTION

Drones equipped with thermal cameras, high-precision sensors and other advanced technologies provide detailed and accurate information about conditions on the ground. During a fire, for example, thermal images make it possible to identify hotspots even under dense smoke, facilitating fire control. This real-time data collection also helps operations managers make informed decisions and allocate resources more efficiently.

## ACCESS TO HARD-TO-REACH AREAS

In many cases, drones are the only viable way to access hard-to-reach areas, such as mountainous terrain, dense forests or collapsed structures. With the ability to fly over these locations, drones offer a clear view of the situation without the need to expose firefighters to dangerous conditions.

## CHALLENGES AND LIMITATIONS

Despite the many benefits, the use of drones by firefighters is not without its challenges and limitations. Examples:

## TRAINING AND CAPACITY BUILDING

The effective use of drones requires specialized training. Fire crews need to learn how to operate drones safely and efficiently, as well as understand how to interpret the data collected by the aircraft. This requires investments in training and appropriate equipment, which can be a challenge for some fire departments, especially those with limited budgets.



Figure 03: Drone training

## CLIMATIC CONDITIONS

Although drones are extremely useful in many situations, adverse weather conditions can pose an obstacle. Strong winds, heavy rain or fog can make it difficult for drones to fly, reducing their effectiveness in certain scenarios. In addition, battery life is also a limitation, as the flight time of drones is restricted and depends on the capacity of the battery.

## REGULATION AND PRIVACY

The operation of drones is also subject to strict regulations, especially regarding the use of airspace. Local and national authorities have rules restricting where and when drones can be used, which can complicate their

implementation in some areas. In addition, privacy issues can arise when drones capture images of residential or private areas during rescue or monitoring operations.

## METHODOLOGY

After defining the research problem and the guiding question, data collection began.

In the first stage, a search was carried out for literature in virtual repositories: SCIELO and LILACS, guided by the following descriptors: crisis, security forces, drones, operations and technology. The inclusion criteria were texts that were available in full and related to the context of public security forces and the use of drones. The texts obtained supported the introduction and helped formulate the article.

The literature review is specified by Oliveira (1992) as a procedure that allows data to be collected by means of an ordered and planned search carried out on data storage platforms.

## THE FUTURE OF DRONES IN THE FIRE DEPARTMENT

The future of drone use by firefighters looks promising as the technology continues to evolve. The expectation is that, over time, drones will become an even more integrated tool in emergency operations. Among the innovations that could emerge are:

- **Autonomous Drones**: In the future, drones are expected to be increasingly autonomous, with the ability to operate without human intervention. This could improve the efficiency of operations, allowing drones to carry out complex tasks independently, such as surveying areas or delivering supplies.

- **Integration with Artificial** Intelligence: The integration of artificial intelligence (AI) will allow drones to carry out data analysis in real time, detecting patterns and suggesting strategies to firefighters. This could include predicting the spread of fires or locating victims in a disaster.

- **Improved Battery Autonomy**: Advances in battery technology can increase the flight time of drones, allowing for longer missions and coverage of wider areas without the need for recharging.

- **Collaboration with Other Technologies**: The future may also involve collaboration between drones and other emerging technologies, such as ground robots and advanced communication systems, forming a more efficient and integral emergency response network.

## CONCLUSION

The use of drones by firefighters is revolutionizing the way rescue, firefighting and disaster monitoring operations are carried out. They offer a number of advantages, from improving safety to optimizing resources and collecting data in real time. However, there are still challenges to be faced, such as the need for specialized training and current technological limitations. As technology advances, we can expect drones to become an even more essential tool in emergency operations, helping to save lives and protect communities in critical situations.

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