# DisplayDrone as Police Deployment Tool for Ubiquitously Available Public Displays and Digital Signage

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**ABSTRACT**

With the increasing payload and commercial proliferation of drones, creating ubiquitously available public displays becomes reality. While previous research suggested using flying public displays for emergency scenarios and crowd control, in this paper, we explore practical application possibilities of a flying media display – called DisplayDrone – in a police context and law enforcement. While a display is positioned in a visible location in 3D space, police officers can dynamically change the displayed text using a tablet-based control application. The work indicates that flying media displays have a large potential as a police deployment tool, but they are still subject to further investigations and technical developments.


iHDI '19 - International workshop on Human-Drone Interaction, CHI '19 Extended Abstracts, May 5, 2019, Glasgow, Scotland, UK http://hdi.famnit.upr.si

**KEYWORDS**

Human-Drone Interaction; Public Displays; police deployment tools; drones; DisplayDrone


**Figure 1: Police officers are using DisplayDrone to deploy a temporarily available "danger" sign that notifies passers-by about an upcoming hazard. The text on the display means "Stop! Danger!"**

## INTRODUCTION AND BACKGROUND

Drones and their future uses are currently subject of much controversy. On the one hand, drones are still an emerging technology [4] that are not fully explored, understood, and accepted [2] by the vast population yet. On the other hand, they offer a high innovation potential, both in terms of technology development and application area and therefore can facilitate the creation of flying user interfaces [6].While traditionally, user interfaces have to either be user-carried or mounted in the environment, with this step forward in drone technology, whole computer systems can fly to any 3D position and create new possibilities for Human-Drone Interaction.

Communicating information from drones to users is one of the key challenges in Human-Drone Interaction. Using the visual channel, most works were attaching flying displays, fog displays, or projectors to the drone to convey information to the user. For example, Schneegaß et al. [13] and Scheible et al. [12] attached displays to drones to provide ubiquitously available information displays. Another approach is to mount a projector onto the drone and provide information rather in-situ than just on a display. Scheible and Funk [11] suggested a projector and a canvas that is mounted to a drone for displaying information. In contrast, Brock et al. [3] and Knierim et al. [8] use a projector that displays information in front of the user on the floor. Research also suggested to mount projected fog displays [14], which add a see-through aspect to the projection or adding spherical LED displays to the drones [15]. Other works encode information in the bare presence of the drone. While Avila et al. [1] convey sound from the drone for navigation purposes, Cauchard et al. [5], Kim et al. [7], and Müller and Muirhead [10] are positioning the drone in a distance to the user and conveying information by just moving the drone.

This project adds to the field of display drones that can display information mobile, flexible and ad hoc in space as a flying media display (fMD). Through this, texts, images, videos or interactive content can be placed in real time where groups of people are temporarily present or in motion. We see potential applications among others by the police as well as authorities and organizations with security tasks. The focus of this work is on the exploration of flying media displays as information dissemination and guidance systems for the police (see Figure. 1).


**Figure 2: Flying outdoor prototype of our DisplayDrone**

**Outdoor Prototype.** It is intended for outdoor use, e.g. in the city on squares or streets, on event areas or in nature. For this purpose, a concept was developed based on our own preliminary work (displaydrone, In-situ displaydrone). As a flying device we used the standard aircraft DJI Matrice 600 Pro drone and mounted an HP 27es" 27-inc-LCD-Display" with a 1.920 x 1.080 Pixel resolution on it. The display has a weight of 3.5 kg and its brightness is 250 cd/m2. It is connected via an HDMI cable to an Asus Tinkerboard PC, which is mounted on the drone and functions as a media server. The total weight of the entire system is 14,5 kg. The flight time is approx. 20 minutes.

**SYSTEM: DISPLAYDRONE**


**Figure 3: Outdoor usage of our prototype DisplayDrone by police officers.**

Since airborne media displays can be brought very quickly and precisely into the area of operations, they have a high potential for an effective and security-promoting accompaniment in situations of operations. Using Flying media displays to warn, evacuate and steer affected people is seen as an essential step in the further management of such situations. Figure 3 shows a fictitious scenario, how the ad hoc commissioning of a flying media display could look in a danger scenario for the rescue of a group of people.

We built two prototypes of flying media displays (for outdoor usage - Figure 2, and indoor usage Figure 4) in order to gain initial insights into the suitability and effectiveness of flying media displays and to explore and demonstrate the added value of such displays.

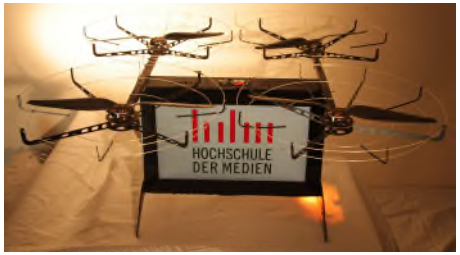


**Figure 4: Indoor prototype of our DisplayDrone**

**Indoor Prototype.** Its use is intended for scenarios in the indoor space, such as sports halls, event halls or stages. In order to explore the use of a DisplayDrone indoors, a custom made prototype was implemented with a double-sided display, which makes it possible to make display contents visible on the front as well as on the back of the flying media display, so that groups of people on opposite sides can read the contents simultaneously. The total weight of the prototype is 4.6 kg. The flight time is approx. 10 minutes. Built-in pressure sensors make it possible to keep the flight altitude stable indoors. The device must be controlled manually by a pilot. To protect the environment, a propeller protection device was installed around the rotors.

**DroneCast software.** We have built the DroneCast software [8] that is used to upload media content to the DisplayDrone. For example, if the DisplayDrone is to be used during a police evacuation of a large event site to display temporary collection points to which people are to move. Depending on the situation, context, and task of the use of the display, the content must be able to be adapted dynamically and ad hoc. With the DroneCast software it is possible to switch content such as pictures, animations, videos, or scrolling text to the display of the DisplayDrone. Figure 5 shows the system-components diagram and outlines the components' interactions.

**Police applications**

The possible areas of application in which flying media displays are a useful communication and information instrument touch almost all police operations. This applies to a large number of tactical individual measures as well as to special operational situations. The tactical individual measures in which the media display can be sensibly used include, for example, barricade of the area, reconnaissance, tracing, public relations work, evacuation, tactical communication, traffic measures, warnings, clearing emergency and rescue routes as well as guidance of groups of people on the move. Other situations include unorganized gatherings such as flash mobs, but especially large events with a high risk potential such as meetings, public viewing, open-air concerts or public festivals, Christmas markets or city festivals. Furthermore, a flying media display would be useful in the event of major damage events such as train accidents, traffic accidents or weather catastrophes in order to support the rescue of human lives.

## DISCUSSION

In order for flying media displays to be used sensibly in emergency situations, their display contents must meet certain requirements. Since the displays have to inform people in panic, they should provide simple and clear information in conjunction with strong optical and acoustic signals, such as blue light and siren. The contents of the display must take into account the heterogeneity of those affected, e.g. children, the elderly, other nationalities, etc. Multilingual advertisements and announcements are therefore indispensable. The correct positioning of the display is also important so that the target group can perceive and see the flying media display accordingly. This means that the pilot must hold the display at a suitable height and distance from the group of people so that the text size and images appear large enough and the information is clearly recognizable.

**Large potential.** We see a large potential for fMDs as a police tool, as they can be airborne, brought very quickly and precisely into the area of operations. They therefore have a good chance of becoming an effective and safety-enhancing tool to support operations, especially as an information and control instrument. Since the display contents can be loaded in real time and dynamically populated with

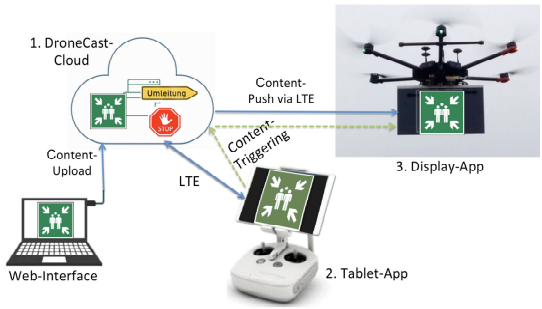


**Figure 5: Components that are integrated in our DisplayDrone system**

**Figure 6: A police officer uses the tablet computer to dynamically control the content of DisplayDrone.**

messages to match the context, there is a very wide range of applications. However, there are a number of important factors that still need to be resolved or investigated:

**Effectiveness of fMDs.** The effectiveness of fMDs should be examined more closely, i.e. on the one hand whether fMDs prove themselves in the reality of the operation in the manner intended by the police, and on the other hand whether the information and instructions for action disseminated via fMDs are actually recognized, understood and implemented by the population concerned. What things play a role here? How, for example, do the positioning of the display (including height, distance, speed) affect the target group so that they can perceive and see the fMD well?

**Weather resistance and wind.** Furthermore a high wind and weather resistance of the fMDs is necessary. Our Outdoor DisplayDrone prototype flew very stable in the tests. Future fMDs should always be usable even in humid weather and not be susceptible to stronger winds. The size of the display and the exposed area to the wind can become a problem. Therefore a high air permeability of future display types and materials plays an important role.

**Light conditions.** The LCD display of our Outdoor-DisplayDrone prototype had a brightness of 250 cd/m(2). This meant that the ticker could still be read easily by the naked eye at 100 meters in daylight and slightly cloudy weather. In sunny weather, however, this would have been more difficult or even impossible. In order for fMDs to find their way into everyday police operations in the future, the brightness of the displays must increase drastically.

Our next steps of our ongoing research with the prototypes we have built, will include user tests together with the police in realistic contexts.

## CONCLUSION

In summary, our explorations so far have shown that the operational suitability of fMDs as a police tool is subject to further investigations and further technical developments. On the basis of the current state of knowledge and the results achieved to date on fMDs, the German police team, which we have been working with in our workshops, believes that after proven efficacy and technical improvements, fMDs will in future be integrated into police operations as an everyday tool.

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