

# Designing an autonomous drone infrastructure for surveillance with facial recognition



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**Abstract**— the use of drones in the modern world has been increasing. From the little drones children play with in their backyard and parks to their distant cousins in warfare, movie making, nature observing, and the list continues to increase. As the uses of drones becomes more normalized in everyday life there has been a demand for harsher laws to prevent unlawful uses of our beloved toys (S. McNeal 2015). These laws mean there are restrictions on who can fly certain drones and where drones can be operated. One aim of this research paper is to challenge the question: if we can't fly the drones, can we make the drones fly themselves and achieve meaningful results? One such application of this question is to design infrastructure that would allow law enforcement agencies and search & rescue agencies to employ the help of autonomous drones with facial recognition for law keeping and searching for people of interest in urban areas.

**Keywords**—law enforcement, facial recognition, autonomous drones, restrictions, results, infrastructure.

## I. INTRODUCTION

In this literature review, the use of autonomous drones for surveillance, specifically, the uses of facial recognition software in drones is assessed and ethical and moral reasoning questioned. This is because the use of drones in recent years has become a controversial topic especially when considering their use in warfare as according to a paper by (O'Dwyer & Coymak 2019), "Armed drones are now a key component of military strategy". There is a lot of research into drones for warfare but there is less research into drones for

domestic surveillance and when domestic surveillance is the case; "The campaigns mounted by privacy advocates oftentimes make a compelling case about the threat of pervasive surveillance (S. McNeal 2015). The argument that stems from a fear of lack of privacy. The very privacy that is already challenged by the use of CCTV surveillance systems. My argument to this is justified by the proved fact that cameras "provide safety and security for the wider law-abiding public (Muthusenthil B et al 2018) and I believe drone surveillance would further support this statement."

Furthermore, surveillance systems have been proven to significantly reduce crime rates (Brandon C et al), an example case study being Lewisham, UK, at a station car park, in 4 months vehicle crime had reduced by 75% from 24 to 6. Hence the inclusion of surveillance drones is deemed necessary and justifiable as a paper by (Dilshad, N. et al) titled "Application and Challenges in Video Surveillance via Drone: A brief Survey" highlights the limitations of CCTV, namely: limited area coverage, no location sharing and lack of tracking capabilities.

In addition, when considering search and rescue operations, research by (Dilshad, N. et al) showed that when comparing the efficiency and accuracy of detecting a missing or lost person in an image by UAV quad-copter versus manual visual search by a human, the drone excelled in all 3 main characteristics that were focused on, prevision, recall and speed. For evaluation, a total of 49 high-resolution colour images from the HERIDAL dataset were used. This dataset was accumulated from multiple locations in regions of Herzegovina (BiH) and Dalmatia (Croatia) by several UAVs (e.g., DJI Mavic Pro 3 or Phantom 3) on relative elevations of 30m to 60m. The image resolution is about

12 Mega Pixels, i.e., 4256 by 2848 pixels, to be exact, describing enough clarity and details. The experimental results show that the respondents failed to spot all 104 targets in the selected pictures. The average recall and average precision's were 80.43% and 90.98%, respectively.

The maximum number of false detection's was 8, mostly relating to animals, clothes, and several other objects. The manual search took almost 42 minutes for each person. Conversely, automatic search by drones took much less time [6]. This research proves that the technology is there and drones are more than capable of being used for surveillance.

## II. BACKGROUND CONTEXT

### A. Drones for surveillance

A research paper titled "Design and development of an aircraft type portable drone for surveillance and disaster management" talks about how an autonomous drone was created with a variety of use cases in mind, including but not limited to "surveillance, traffic jam monitoring and disaster management" (Hasan, K.M. et al). The results showed that the proposed drone was capable of cruising at a speed of 45 – 62km/h meaning it would easily following a mobile target in an urban area and it could transmit real-time video to the ground control station, making it ideal for surveillance. Of course the drone itself was not inconspicuous meaning a potential target of surveillance would know they were being followed. The audio system of the drone could be used for announcement of emergency messages making it idea in disaster situations such as warning people at beaches during a tsunami or looking for and alerting trapped people during an earthquake or other natural disaster. Furthermore, the drone could carry a payload of 1.8kg meaning it could be used to deliver emergency supplies to people in hard to reach locations during disasters or potentially put out fires with a mobile fire extinguisher. Lastly the drone itself was also portable as it fit in a small carrying box making it easy for emergency services to take it with them as standard issue. This could either create a new job role of drone operator in each of the emergency sectors or lead to the development of a company of drone operator contractors that can be hired by the emergency services or the public sector in accordance with law and privacy requirements. The cost of this particular drone was within \$700 meaning the average cost of state of the art drones capable of achieving similar results would be ~ the same.

Another research project on the use of drones for surveillance was the "Collaborating miniature drones for surveillance and reconnaissance". The creation of a swarm of Unmanned Aerial Vehicles for the formation of a drone swarm is discussed.

### B. Public opinion of Autonomous drones

There is a lack of information on attitudes to autonomous drones in the United Kingdom however

according to a new study published by (Mariam. M), opinions towards remote drones is positive. The research dubbed "Project Xcelerate" Consortium led by BT [12] and Altitude Angel [11] showed results demonstrating that 68% of the British public believe that drones would positively impact their lives while nearly 49% said they would be optimistic or excited about the potential drone technology holds.

Furthermore, the research showed that people were hopeful to see drones in riskier jobs such as firefighting (76%) and inspecting infrastructure (70%). Whereas 2/5 of the sample size would like to see drones employed in order to extend human capabilities and tackle problems such as tracking criminals (65%) and investigating crimes(73%). These statistics support the implementation of autonomous drones with surveillance capabilities because this would be necessary for the various tasks that people are hopeful to seem them employed in.

On the other hand, 38% of the sample size expressed some concerns for the use of drones in the UK with 46% of adults arguing about drone misuse and public safety and another 48% arguing about privacy alongside personal data and private property being the primary concerns. Arguably, according to the results, public opinion could be due to public misconceptions as 47% of the sample size were found to believe that drone usage remains unregulated.

It is important to mention that the report is just one part of Project Xcelerate's broader work on the UK Government's Future Flight Programme [13] and the findings will be leveraged to inform the consortium's work in addressing some of the challenges surrounding the public acceptance of drones.

Nonetheless, the results of the research showed how applicable drones can be to daily lives for people in the UK and the purpose of this research is to help make this a reality. That being said, it is clear that there will have to be restrictions on the use of drones for the project to be viable and the use of drones will have to be backed by their application via a reputable agency such as the policy or search and rescue agencies that can justify their use in the public for those who are worried about their privacy being disregarded.

### C. Uses of autonomous drones

Plenty of research has been carried out on autonomous drones, highlighting their significance as a topic. According to "The use of drones in maritime sector-areas and benefits" by Krystosik-Gromadzińska, DNV GL is currently testing autonomous drones with hyperspectral cameras for use in ship tank inspections.

The paper argues that autonomous drones for inspection in maritime conditions, ensure human safety and operational efficiency during transportation from port to ship and they also reduce the carbon footprint when used over the sea.

Other research on autonomous drones include the development of autonomous drones for delivering items that use GNSS with a compass as the main tool; with the aim of delivering medical aid to patients in emergency situations and implementation in agriculture in Indonesia. This research was carried out by (Patrik Aurello et al). The results demonstrated that the use cases are realistic and very viable as experiments showed that the average of positional deviation of landing position between the actual landing position and the desired landing position in the flight tests of flying from start to goal is 1.1125 m and for the tests that use the algorithm which uses course-over-ground, the positional deviation has average of 2.39 m. Meaning that the technology is there when developing autonomous drone that operate via GNSS.

### III. ALTERNATIVE RESEARCH METHODS

Asides from running experiments in simulation with the drone and using Virtual machines to simulate a raspberry pi communicating with a host device such as a phone or computer observations on the interaction between people and the drone will also be taken. These observations will be used to analyze public response to drones for surveillance asides from their feedback in a survey which could also be a viable option for gathering support for justification of the use of drones for surveillance. It would be interesting to see if people's response to the surveys also matched their responses to an implementation of an autonomous drone surveilling an area.

### IV. FINDINGS AND CONCLUSION

The results of various research on existing papers shows how controversial the topic of drones is. It is very hard to design a useful drone for surveillance that will not be at the mercy of the public as the drones will have to fly low to the ground at times leaving them vulnerable to malicious actions.

Moreover, it is also hard to design a multi-functional drone as the past research in drones show that drones have to be designed as modular in order to be multi-functional in which case a universal standard will be required if the drones will be applicable to various organizations as this is the only way they can then be

quickly retrofitted as necessary for each task that is demanded of them.

Furthermore, in the context of preserving the drones the only real way to protect the collective moving forward and prevent them from vandalism would be to create laws that protect both people's privacy while also ensuring that drones are treated with the same authority and presence of the organizations that they will be created for or employed by.

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