Free to Fly in Public Spaces: Drone Controllers' Privacy Perceptions and Practices

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Prior research has discovered various privacy concerns that bystanders have about drones. However, little is known about drone controllers' privacy perceptions and practices of drones. Understanding controllers' perspective is important because it will inform whether controllers' current practices protect or infringe on bystanders' privacy and what mechanisms could be designed to better address the potential privacy issues of drones. In this paper, we report results from interviews of 12 drone controllers in the US. Our interviewees treated safety as their top priority but considered privacy issues of drones exaggerated. Our results also highlight many significant differences in how controllers and bystanders think about drone privacy, for instance, how they determine public vs. private spaces and whether notice and consent of bystanders are needed.

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Drone; UAS; UAV; Privacy; Surveillance; Perceptions

INTRODUCTION

Drones are lightweight unmanned aircraft controlled by operators or onboard computers. Drones can enable numerous innovative applications but have also raised significant privacy concerns due to their maneuverability and capabilities of taking photos/videos and sensing the environment. For instance, in our prior work, we interviewed *drone bystanders* (i.e., people who had no experience operating drones but may be surrounded by flying drones) and found that bystanders had various privacy concerns about drones such as stalking, photo/video recording and sharing [16].

However, it is unclear how *drone controllers* (i.e., people who have directly operated drones) think and do about privacy in their practices. Answering this question is important because it will inform (1) whether controllers' current practices may protect or violate bystanders' privacy, and (2) what mechanisms could help controllers better address these privacy concerns.

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As a follow-up study of drone bystanders [16], we conducted interviews with 12 drone controllers in the US about their perceptions and practices of drones. We focused on drones for civilian rather than military purposes. Our controller interviewees were primarily concerned about safety and felt that the privacy risks of drones are exaggerated. Most of them also believed that they have the rights to fly drones and take photos/videos in public spaces without the need to get others' permission. While they adopted a legal definition of public space that is primarily based on ownership, our prior study of bystanders found that some bystanders followed a "social" definition in which the nature of a space is characterized by the social relationship within it, for instance, shopping with a close friend in a mall makes the space private [16].

This paper makes two main contributions. First, it provides a rich account of the perceptions and practices of drone controllers. Second, comparing our results with the prior literature on bystanders [16] uncovers significant privacy "mismatches" between drone controllers and bystanders. We discuss future directions to help bridge these mismatches.

RELATED WORK

Privacy issues of drones have been discussed in the literature. For instance, the Electronic Privacy Information Center (EPIC), a civil liberty organization highlights aerial surveillance as a critical privacy issue of drones [7]. Legal experts have also voiced ethical and privacy concerns regarding the use of drones (e.g., [3, 6]). Dunlap argues that when drones are used for surveillance, they can violate Americans' constitutional rights, particularly citing the Fourth Amendment, which protects people from unreasonable searches and seizures [6]. As for regulations in the U.S., the Federal Aviation Administration (FAA) requires drone controllers to register their drones with the agency [1]. The FAA's new rules on small drones focus on safety (e.g., prohibit night operations of drones) [8].

People's privacy concerns of tracking/recording technologies, such as wearable cameras (e.g., [9, 5, 11, 10]), CCTV (e.g., [15]), and RFID (e.g., [2]), have been studied extensively in the literature. However, privacy issues of drones are understudied. Clothier et al. conducted a survey in Australia and found that the respondents' overall attitudes towards drones were fairly neutral but less than one fifth of the respondents reported concerns about drone surveillance or spying [4]. Our prior study of drone bystanders in the US uncovered different privacy concerns about drones in general and under specific

drone usage scenarios [16]. While these two studies focused on ordinary citizens or bystanders (i.e., who did not have experience operating drones), the literature says little about drone controllers. Our present study fills the gap by focusing on drone controllers' privacy perceptions and practices.

METHODOLOGY

From January to March 2016, we conducted semi-structured interviews with 12 drone controllers in Syracuse, New York (US). We recruited our interviewees by posting study fliers in places such as university campus and parks. The interviews were conducted in a drone hobbyist club, our lab, and public places such as libraries. Each interview took about 1 hour with a payment of $10. 10 of our informants were male, and two were female. Their ages ranged from 20 to 62 years old with an average of 28. They also presented diverse occupations, including college students, a professional photographer, a tax officer, an office administrator and a retired worker.

To ensure the validity of comparison between this study and our previous study of bystanders, we adopted the same interview protocol and data analysis approach [16]. We re-framed many interview questions to focus on the perspective of drone controllers. The interview consists of general questions about drone controllers' perceptions of drones (e.g.,"Do you see any benefits or drawbacks of drones?"); purposes and practices of using drones (e.g.,"Where do you fly your drone(s)?"); expected notice and control (e.g.,"Do you feel people should get others' (e.g., bystanders) permissions before flying a drone or taking pictures/videos?"), and controllers' attitudes towards drone usage under different scenarios. We used the same five drone scenarios based on real-world drone usage from our previous study of bystanders [16]. These scenarios are (1) recording a promotion event in a shopping mall by a store owner; (2) delivering packages by Amazon; (3) recording a friend's party; (4) reporting a parade by a news agency; and (5) searching suspects in a residential area by the local police. We asked our interviewees if they would operate the drone as described in each scenario and why.

We audio recorded the interviews upon informants' permissions. The interviews were then transcribed and analyzed qualitatively. Similar to our previous study [16], we conducted a thematic analysis. 12 Two co-authors (coders) used ATLAS.ti, a popular qualitative analysis software, to manually and independently generate initial codes that capture meanings of the same subset of our interview data at a fine-grained level (usually at the sentence level). Then, the two coders convened, discussed, and converged their codes into a code book of 135 unique codes ranging from drone usage (e.g., photography) to privacy concerns (e.g., identifying people) to drone community (e.g., irresponsible controllers). Next, the coders used the agreed-upon code book to code the interview data. The inter-coder reliability was 0.85. We grouped 135 codes into ten themes: drones in general, drone usage, safety concerns, privacy concerns, permission, private/public spaces, scenario questions, application design, drone community, and regulations.

FINDINGS

We present major themes from our interviews and use pseudonyms for our interviewees.

General perceptions of drones. All of our interviewees have flown a drone themselves and most of them own a drone. Overall, they were passionate about this emerging technology. However, some of them preferred not to use the word "drone." For instance, Mike (28, male, drone hobbyist) avoided the term "drone" because it comes with certain connotations from which he wanted to dissociate. He said, *"usually I associate the word drone with the military drone that performs air strikes and things like that."* So, instead, he used the term "quad" as he further explained, *"I still try to insist on calling them quads because I won't fall into what the media has done in calling them and dubbing them drones."* By using a different and arguably more neutral term "quad," Mark deliberately separated himself from the sensitive military use of drones and the media's newsworthy and often controversial accounts of drones (e.g., a drone crashed on the White House lawn [12]).

General use of drone. When asked why they fly drones, many interviewees mentioned that radio-controlled drones are just fun to fly. Other interviewees talked about drones allow them to pursue their personal interests such as photography and DIY (do-it-yourself) projects. Our interviewees noted that safety is their highest priority in drone operations, including the safety of both drones and people. Our interviewees reported relying on their common sense (e.g., avoid flying near a crowd) and caution when operating drones. They were also thoughtful about where to or not to fly their drones. They reported usually flying in public parks and deliberately avoiding places such as surrounding areas of airports and schools with children.

Taking and/or sharing photos/videos. Many interviewees also used their drones to take pictures/videos, mostly for landscape, as Mike explained, *"they're actually mostly landscape, that's sort of what I'm interested in as a sort of photographer."* They kept the photos for personal use, or share with their friends in social media. For example, Tim (23, male, electronic engineer student) described, *"I share the photos/videos on Instagram [@***] and Facebook."* When asked whether the photos captured bystanders, Tim continued "*I would imagine that I have taken photos/videos with bystanders in them, but nothing extremely close where someone watching the video could recognize anyone. I have shared these photos/videos online, or have given them to friends who want to use them.*" These drone practices may explain their privacy perceptions.

Privacy Perceptions

While our interviewees valued privacy, they also felt that the privacy concerns about drones are exaggerated and even misguided by the media's sensational reports of drones. They framed their opinions mainly along the lines of public vs. private spaces and claimed that they have the (Constitutional) rights to fly drones in public spaces.

Public vs. private spaces. First, our interviewees had fairly consistent views of public and private spaces based on ownership. Ross (26, male, software engineer), for example, described, *"I define [public space] as like places that are generally open to the public like anybody can walk by and it's open and free to access."* Tim put it more bluntly: *"the way I think*

about it is that public space is public space, you can do whatever you want in public space." For private space, Mark had a typical definition, *"the space that's owned by a particular person or particular business entity then that's private."*

However, our interviewees differed in their interpretations of a specific case. Some defined the airspace over people's personal property as public space, as Dan (23, male, media student) argued, *"my definition is aligned with the legal definition of airspace ownership actually. So as I currently understand that you might own your house and the land, however, you do not own the airspace above you."* While this is legally true in the US, others were more sensitive socially. For example, Jake argued, *"generally I look at the fenced off area as private property and even though you don't really own the airspace above your property it's still not a very nice thing to do."* Jake's comment points to the nuanced social expectations of privacy and his sensitivity in respecting such expectations.

No privacy expectations in public spaces. Most interviewees generally felt that people should have expectations of privacy in private spaces but not in public spaces. Dan was quite vocal about this, saying *"I think the American public needs to really understand that when they're in public they shouldn't expect any privacy, that's just pure and simple."* As a result, our interviewees usually did not ask for people's permission before flying their drones in public space. Alex, for instance, had a clear view: *"So if you are in a public property, you should not get permission from anyone because you are flying in an area that is open to everyone, so you are allowed to use it like it's open to everyone."*

Some of them even stressed that they have the legal rights to take photos in public spaces without people's permissions. For instances, Alex reasoned, *"if you think about First Amendment, we are allowed to photography [sic], as a photographer, anyone in anywhere as long as you are in public property."* Sasha (22, female, photographer) held the same belief, explaining *"again I'm protected by my First Amendment to take, as a free press, to take a picture so I do not. You know, if I'm having a nice day I will tell you, but I know the law, therefore if I don't I'm okay with my own conscience for not asking."* Among other things, the First Amendment to the US Constitution prohibits abridging the freedom of speech and infringing on the freedom of the press.

Since we do not have the legal expertise, we consulted American lawyers regarding the validity of the above interviewees' claims. Both lawyers disagreed with interviewees' claims regarding their constitutional rights to fly drones in public spaces partly because airspace is not a public space. The US government has "complete and exclusive national sovereignty in the air space" over this country.

In contrast, interviewees mostly agreed that people should have privacy in private space. However, one interviewee, Dan held the view that *"If you don't want your indoor activity to be reviewed because there is a drone outside of your window, I'm sorry you just have to put a curtain down."*

Ask for permissions. While our interviewees claimed that they do not need to ask for permissions to fly drones in public spaces, in practice they do sometimes. Jake told us one story, *"the last time I asked people was over the bridge in [a town], there were two people out there fishing and I said hey I want to bring my quad up and film it, do you mind if I get you guys."* Jake got the permission to film but he explained why he asked, *"I don't want to annoy people and I mean you really can't get into trouble per se...but they can scream at you, they can yell at you, they can be very violent to you."* In this case, Jake asked for permission to show politeness and to avoid unnecessary confrontation. But they were also practical about asking permission, as Jake illustrated, *"When there's a large crowd, it's not worth taking the time to ask everyone individually, just avoid."*

Drones vs. DSLR. Some interviewees felt the accusation of using civilian drones for spying is misplaced. They compared drones with other photographic equipments, such as DSLR (Digital Single-Lens Reflex) cameras. For instance, Alex explained, *"Drones don't have telephoto lenses which can zoom in as well as shoot from the ground, which I think it's sort of misguided privacy concern people have because you can do more damage in privacy, invading privacy more with DSLR and telephoto lens."* Mike stressed the intent of usage, *"So if the intent is the same, you know the equipments might not be that different by the way of doing it."*

Scenario-based perceptions. Besides questions about controllers' general perceptions of drones, we also provided specific scenarios to further investigate their acceptance of drone usage in each scenario. Our interviewees' responses were relatively consistent across scenarios. They indicated that they would fly the drone in the scenarios. Their decisions were mainly based on whether they have the permission to fly. For instance, for the mall scenario, they said they would fly if they have a Section 333 exempt, which allows individuals to fly drones for commercial purposes in the U.S.

Drone regulations. While our interviewees reported being reasonable and considerate in their own drone usage, they almost unanimously suggested the need for some form of drone regulation. Our interviewees supported the FAA drone registration requirement. Furthermore, some interviewees suggested having a drone license. Others disagreed, for instance, one interviewee argued that drones are not deadly weapons, thus he did not need a license. In addition, some interviewees also advocated for drone controller training so that controllers can know more about how to fly and how to be safe and skillful.

Construct a positive community identity. Several interviewees talked about the overall image of the drone community and disdained irresponsible/reckless drone usage. Jake shared his past experience, *"I drove by the prison and I actually saw a drone like hovering over the prison. That's definitely something very stupid . Very stupid and that could increase laws for us."* Jake's concern highlights the potential externalities (e.g., stricter laws) as a result of some drone controllers' irresponsible behavior. John agreed, *"they don't have license, everybody can fly. Then some people would do something stupid that can damage the whole community."* With drone registration, license and training, their hope was that the drone controller

community as a whole will behave responsibly which can improve the public perceptions of drones and the community.

DISCUSSION

Our prior study focused on drone bystanders [16], while this study focused on drone controllers. Both groups are important stakeholders of the drone ecosystem and their perspectives are useful in understanding the privacy implications of drones. We highlight many notable differences between the two groups.

Controllers vs. bystanders. First, while bystanders are fine with calling this emerging technology "drones," some controllers deliberately use "quads" instead of "drones" to avoid the controversial or negative connotations of drones, which are often associated with military drones for spying.

Second, controllers are generally positive or even enthusiastic about this emerging consumer technology of drones. Their highest priority is ensuring safety of drones and people. In comparison, bystanders have mixed feelings about drones. They see potential benefits and applications of drones, but they are also concerned about safety, security and privacy issues that drones can pose.

Third, bystanders have several privacy concerns about drones, such as peeking and stalking as well as taking and sharing pictures/videos. They are also concerned that they may not see the flying drones and their controllers, which limit their abilities to communicate their privacy preferences (e.g., drones not taking pictures/videos that capture them) to the controllers. In contrast, most controllers feel that the privacy issues of drones are exaggerated because they value others' privacy and rely on their common sense to operate drones appropriately. They also debunk the perceptions that drone cameras can easily and clearly capture people's faces from the air.

Fourth, when determining their acceptance of specific drone usage, both bystanders and controllers consider whether the drone is operating in a public or private space. However, their definitions of public/private space differ. Controllers mainly use the ownership of a place to differentiate public vs. private space. They believe that private space is legally owned by a private entity (e.g., people's houses), whereas public space is owned by the public (e.g., parks). This type of understanding is more aligned with the legal definitions of public/private spaces. Bystanders' definitions of private space and public space rest on three factors: ownership, sensitivity of the place, and nature of activity in the place. In particular, some bystanders characterize spaces based on the activities and social relationships within the space. For instance, shopping with a close friend in a mall would make it a private space because of the close personal relationship between friends. This highlights the "social" definition of space.

Fifth, when considering the specific drone usage scenarios, bystanders consider three criteria: (1) whether the drone is operating in a public/private space; (2) what is the intended purpose of the drone usage; and (3) notification and consent of the drone usage. In comparison, controllers mainly focus on whether they have the permission to fly the drone in the scenario (e.g., need a permit for commercial use of drones).

Sixth, several bystanders expect to be notified and asked for their permission before a surrounding drone taking pictures/videos even in a public park. While controllers may sometimes do that to be polite, many of them believe that they have the constitutional rights (citing the First Amendment) to fly drones and take pictures and videos in public spaces without getting others' permission. The National Telecommunications and Information Administration (NTIA) recently released a document of voluntary best practices for commercial and non-commercial use of drones, for instance, "If you can, tell other people you'll be taking pictures or video of them before you do" [13]. Controllers' belief that they are entitled to freely operating drones in public space may dissuade them from following these best practices.

These mismatches between controllers and bystanders are perhaps not surprising given that they have different roles and interests in the context of drones. But, these mismatches can lead to tensions especially when bystanders' privacy concerns about drones are not adequately addressed by controllers.

Mitigate bystanders' privacy concerns. One future direction is to enable bystanders and controllers to communicate directly so that bystanders can express their privacy concerns or preferences and controllers can explain their drone usage (e.g., purpose). Direct communication can help bridge some of the mismatches between the two groups. Since bystanders may not see drone controllers, enabling electronic communication channels (e.g., via a website of a mobile app) would be useful. In addition, NTIA's best practices of drones is a good step towards educating controllers about potential privacy risk of drone usage and practical strategies to mitigate these risks. However, these best practices are voluntary so controllers may not adopt them. Many of our interviewees expressed their hopes to create a positive image of the overall drone community. These best practices and other privacy mechanisms can be emphasized as improving the image of the drone community, which can help incentivize adoption.

Study limitations. First, our study has a relatively small sample size. While we only interviewed 12 drone controllers, we did not find any significantly new findings from our last three interviews. Second, we only interviewed controllers in the US, therefore it is unclear whether our findings would be similar for controllers in other countries. Third, our interview data is self reported and might be subject to the social desirability bias. In particular, our controller interviewees may withhold sharing their drone practices that can be considered as privacy invasive, for instance, taking pictures that capture a bystander's face and making the pictures public online. Lastly, self-reported data can divert from actual behavior [14].

CONCLUSION

We interviewed drone controllers in the US to understand their privacy perceptions and practices of drones. The results suggest that they treat safety as their highest priority but consider privacy issues of drones overstated. Comparing with our prior study of drone bystanders, we highlight important mismatches between controllers and bystanders on how they view drone privacy. Future work should explore how to bridge these mismatches and mitigate bystanders' privacy concerns.

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