Design of Delivery Drone and the Interaction: A Public User Perspective

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Abstract

Drones will likely enter public spaces soon for deliveries, interacting with humans as recipients or bystanders. Understanding their requirements and factors contributing to uncertainty is crucial for safer Human-Drone Interaction design. Twelve participants were interviewed and engaged in focus groups. Preliminary results indicate the need for clear communication of drone intentions through design and interfaces, guiding future research and design concepts to be tested with user studies for delivery drones in public spaces.

CCS Concepts

• **Human-centered computing**; • **Human computer interaction**; • **Empirical studies in HCI**;

Keywords

Drones, Human-Drone Interaction, Interviews, Focus Groups, Uncertainty

1 Introduction

Robots, especially drones, are becoming part of daily life, with the consumer drone market expected to grow from $8.77 billion in

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2022 to $54.81 billion by 2030 [2]. This growth enables drones to enter public spaces and cater to public needs, including delivering packages. However, designing drones to operate safely in public spaces is challenging due to diverse situational factors and the involvement of various stakeholders, including users, bystanders, and vulnerable populations [10].

According to an expert interview study [3], the public interacts with drones mainly as recipients of a package or as bystanders nearby. While recipients and bystanders can share the same interaction space during a delivery scenario, their roles differ based on their intentions and awareness of the robot's purpose. Recipients are aware of the drone's purpose, while bystanders might have limited awareness of the purpose. While recipients' needs have been studied in Human-Drone Interaction (HDI) [5, 8], the role and needs of bystanders have rarely been explored. Bystanders, who encounter delivery robots on the road more often than recipients [6], may feel discomfort due to unfamiliarity with drones. The difference in human roles likely necessitates varying expectations during interactions, such as different levels of information about the drone's intentions, which can impact trust and feelings of uncertainty [3]. Addressing these differences presents challenges in drone design and interaction that are rarely covered in HDI literature.

Feelings of uncertainty among humans may arise when drone interactions deviate from expectations, causing discomfort, especially among those with limited experience. Companies like Zipline, Wing, and Matternet use diverse drone models, differing in appearance, interfaces, forms, and delivery methods [4, 7, 9], raising questions about the impact of appearance and interfaces on user perceptions and uncertainties. Currently, there is a knowledge gap in understanding and comparing user requirements for the two human roles (recipients and bystanders) in HDI. Consequently, designing drones and public interaction spaces to accommodate these needs is challenging. Our study aims to explore factors contributing to uncertainty, identify user requirements, and propose design(s) to support safe and natural interactions between the public (i.e.,

recipients and bystanders) and delivery drones in public spaces lacking dedicated landing spots, such as park.

2 Methods

Twelve participants (five male, seven female), aged 25 to 34 years (M = 29.2, SD = 3.2), with limited drone experience, and none with delivery drones, took part in the study. Participants were from various backgrounds: five Chinese, two Dutch, two Indian, and one each from Brazil, Greece, and Indonesia. Overall, participants expressed a positive attitude towards technology interaction (M = 3.8, SD = 0.6).

The study employed a user-centered design process with two stages: personal interviews and subsequent focus groups with ideation sessions. Conducted via Microsoft Teams in June and July 2024, the interviews were recorded and lasted approximately one hour. Participants engaged after reviewing a document outlining two fictional scenarios, which detailed the roles of recipient and bystander in an outdoor park. Interviews focused on extracting requirements for both roles, prioritised using the MoSCoW method [1]. A semi-structured format was employed, with interview questions refined through three pilot studies and discussions among the research group. The interview questions focused on understanding participants' motivations, specifically what causes them to feel uncertain during interactions, what information they require, and how they prefer to receive it.

Following the interviews, focus groups were held in person at the Eindhoven University of Technology in June and July 2024, with four sessions involving three participants each, moderated by the first and second authors. These sessions were audio-recorded and aimed to explore user perceptions and preferences regarding drone interaction. Participants storyboarded interactions and sketched drone designs, envisioning themselves in the roles of recipient and bystander. The interview questions, storyboard, and sketching tasks were conducted separately for each role and in sequential order. At the session's conclusion, videos of existing delivery drones were shown to prompt reflection and potential design refinements. Participants were selected for their design backgrounds, facilitating effective communication of complex ideas through sketches.

The interview recordings were transcribed automatically, reviewed by the first and second authors for accuracy against the original recordings, and then subjected to thematic analysis. Both authors familiarised themselves with the data and analysed it by coding and categorising emergent themes and sub-themes through mutual discussion between the first and second authors. A degree of saturation was reached in the interview results, with similar themes emerging across the sample. The first iteration of interview results is presented, but they are subject to further analysis. Focus group data, yet to be analysed, will compare and complement interview findings, providing user-suggested design considerations.

3 Preliminary results and discussion

The study methods and preliminary interview results revealed themes such as factors contributing to feelings of uncertainty, recipient and bystander expectations, and potential design solutions to mitigate these uncertainties for HDI with delivery drones in public spaces like parks. Our findings indicate that uncertainty arises from factors such as safety, differing user expectations, environmental dynamics, and situational criticality (e.g., emergency vs. non-emergency deliveries). A possibility to manage uncertainty is by aligning HDI design with public user (i.e., recipient and bystander) expectations. Recipients expect information on drone intentions and identification, while bystanders seek clarity on the drone's purpose, delivery location, and consideration for their privacy. Drone purpose can be communicated through its appearance, and intentions, including delivery location, and identification can be conveyed via interfaces (e.g., LEDs, projection, speakers) on the drone or recipient's mobile phone. Privacy can be maintained by using a security code on the recipient's mobile phone to verify the information. The design recommendations will be based on interview and focus group results. Despite being in the early analysis stages, our research identifies factors contributing to HDI uncertainties and outlines expectations for both recipient and bystander roles, offering directions for future research to develop design concepts and test them through user studies, focusing on the introduction of delivery drones in public spaces lacking dedicated landing spots.

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