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# Human-Drone Interaction: Drone Delivery & Services for Social Events

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**Abstract**

In recent years, there has been an increasing research interest in drones and its applications such as a drone delivery service, ping-pong play companion, and jogging companion. However, despite the growing interest in drones for social scenarios, there are only a few drones that have paid attention to factors such as drone's movements, appearance, and comfortable distance for natural human-robot interaction (HRI). In this study, we explore the critical factors for successful human-drone interactions (HDI) in a social scenario, and proposed a social friendly design by implementing new appearance and behaviors of a drone.

**Author Keywords**

Human-drone Interaction; Human-Robot Interaction; HRI; drone.

**ACM Classification Keywords**

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous;

**Introduction**

Drones have developed rapidly in the past few years and have been applied to many social events, such as drone delivery service [1], ping-pong play companion [11], and jogging companion [7]. However, despite the growing interest about drones, there are limited studies

have tried to discover how people interact with drones [3, 4, 6, 9, 10, 12]. Furthermore, most of the studies focus on gestures recognitions to control drone [2, 9, 10], and little studies have been done to explore other factors in human-drone interaction (HDI), such as drone's movements, appearance, and comfortable distance [2, 3, 4, 6].

In this paper, we explore what are the designable factors that make a drone a more social friendly robot. Few studies have looked into design considerations for HDI in a social context, which has its own specialty. In this regard, many interesting research questions can be followed like which factors are important and to be considered (e.g. distances, moving patterns) and how drone's behaviors will change people's perception of a drone. To answer these questions, we conduct a user study to observe how people would respond to a drone when it is flying in a close distance in a social event.

Our study indicates that an appearance of drone, drone's speed and sounds, distance between drone and subject are crucial factors on people's perception of the drone. Based on our findings, we also proposed a drone design to address those problems and get people more engaged to use a drone for their social events.

### **Design Research Methods**

To understand people's impressions and feelings of a moving drone, we conducted a user study with 4 participants (3 females, 1 male) in a simulated domestic environment. All participants were recruited via email advertisement and received no remuneration.

### *Study Scenario and Process*

We used Parrot AR Drone 2.0 in our study. This drone has its original indoor hulls that have black and military pattern to protect people/drone in case of collisions when flying indoors.

We consider a drone delivery service that people send a drone to deliver small objects like a wedding ring to a specific person or area for their social events as a main application of drone. We believe this is a good scenario to observe the responses of people when a drone approaches to them closely and flies around in short distance. Therefore, in our study, we attached a small plate to top of the drone and put a small key ring on the plate. The drone approached each of the participant from around five feet far to deliver the key. The drone approached each participant until the distance between the drone and the subject was close enough for them to pick up the object from the drone. The drone was manually controlled by an experimenter during the interaction, and would stop when the participants orally asked so. The whole scenario for each participant lasted 5 minutes in average.

After the interaction with drone, we then conducted a card sorting session. In our card sorting session, we asked participants to write words which could describe the drone, and words that express their feelings about the drones on post-it notes.

We then conducted a focus group interview with our participants to understand their experiences of interacting with the drone. Interview questions included topics such as if there was anything uncomfortable to them during the interaction and why, how did they feel

about the distance, the appearance, etc. The interview lasted about 40 minutes.

## Findings

### *Card sorting session*

A bunch of words were collected during the card sorting session. We then categorized the words into four groups: *drone's physical properties and behaviors*, *social roles*, *drone's emotional status*, and *participant's feelings of the interaction*.

Overall, participants showed their negative impressions about drones in the card sorting session. We found a significant number of post-it-notes wrote “unpredictable” or “unstable”, which are the most notable traits of the drone. They also described the drone as noisy, windy, breakable, and fast. Besides, we found some of them described a drone's flying behaviors as a reflection of the drone's emotional status (e.g. angry, nervous and fierce), which has been paid much attention in previous work [3]. Participants also made some interpretations of social roles regarding drone's appearance and behavior. They thought the drone was for “military” and “army” or looked like a “servant”. Their feelings towards drones were generally negative (e.g. dangerous, worrisome, scary, powerful and strong).

### *Focus group interview*

Based on our interview, we concluded the interview results below.

- “The drone is intrusive!”

Some participants thought the drone moved too fast and sometimes too close to them, which got them felt the drone was rude and intrusive.

- Need a sense of control in the interaction

Regarding the interaction process, participants preferred themselves approach the drone once the drone stopped at a certain distance. This interaction pattern could make them more comfortable and secure, as well as make the drone less intrusive.

- The appearance matters

Current appearance of the drone reminded participants of military, which made them uncomfortable. Therefore, they expected the drone to adopt modern design, and have a cool appearance. One participant even suggested business look in terms of making the drone look more reliable. Noticeably, when discussing preferable appearances, it was interesting that participants rejected the suggestion of cuteness. They felt it was too counter-intuitive since cuteness didn't match with drone's behaviors.

## Discussion

Our findings show that participants' concerns about potential dangers when interacting with a drone they cannot predict. Participants also state that they feel the drone intrudes them if the drone approaches too close without their consents. It is consistent with previous findings that people have safety and security concerns regarding moving drones [3, 4, 13]. Result also indicates that people feel uncomfortable and scared about drone's appearance. To mitigate this issue, we present the following design implications in terms of better HDI.

### *A drone needs to show its intention to Make the interaction comfortable and secure*

Studies have demonstrated that anticipation is an important factor to support fluent human-robot interaction [8]. Such social cue could be important in the interaction with drone, considering a drone's

behavior could be more unpredictable as it moves in a three-dimensional space. Therefore, an additional behavior of a drone to show its intention on subjects such as the direction of moving and/or speed would be desired for the HDI.

#### *A Respect to Personal Space and Providing a Sense of Control*

Our interview findings imply that people want to have a sense of control to the interaction process, especially in their personal space. Therefore, designers should leave enough spaces and give enough controls to users when design the HDI procedure.

#### *A friendlier look would help*

In our interview, participants mentioned that the original appearance would remind them of military. Therefore, designers should try to generate a friendlier appearance for drone. For example, participants mentioned they would like a modern design or business look for drones. Previous work also mentioned that designers should follow the design rules of transforming the drones to the object we normally use in daily life.

#### **Conclusion & What's next**

In this study, we explored what factors could affect people's interaction with a drone in a social scenario. We found that people generally consider a drone's moving patterns as unpredictable and unstable. Such moving patterns give people the impressions of drones as fierce and scary, and lead to negative feelings towards drones. Moreover, the appearance of the drone is strongly associated with military figures which could hinder the interaction. Based on the findings, we proposed that a drone needs to show its intentions during the interaction, respects user's personal space

and give controls to user within such distance and have a friendlier look.

#### *What's Next*

Based on the findings, we are designing a new appearance and behavior patterns of a flying robot to make people feel more comfortable in interaction. First, we decide to cover the body of the drone so that people won't see the movement of the propellers directly to make them feel safe. However, we should not block air flows of the propellers. Previous work showed that people preferred circular cover on drones [13]. Thus, we design a new appearance with narrow wood sticks referencing Asian style lamps. Second, we design two kinds of movements. One movement is up and down movement with our new appearance inspired by jellyfish movement. We consider changing the speed of the movement according to the velocity of the drone. Another movement is changing shape of the appearance according to the flight direction of the drone (the new designed skin will be skewed in the moving direction of the drone). These movements should let the drone to show its intended actions (see Figure 1). Figure 2 shows the prototype of the drone. We use one servo motor with Arduino kit, to achieve the jellyfish-like up-and-down movement to indicate the drone's moving speed. An additional motor is needed to implement the change of the drone's shape for the purpose of showing intention about its flight direction. We are still working on this feature.

We believe these designs would make the drone's behaviors more predictable, and people may feel more comfortable and are willing to use such drone for social events. Thus, we suggest researchers and designers to

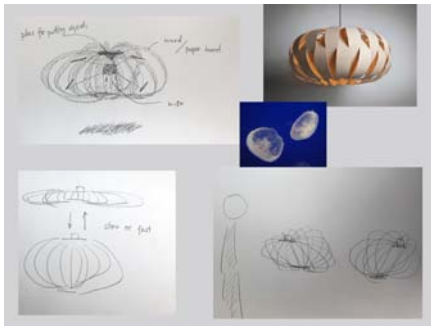


Figure 1 The sketch of the drone.



Figure 2 The first prototype of the drone.

consider the above factors for making more natural HDI.

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