# Drone Proxemics

**Mehmet Aydßn Baytaß**
Affiliation not available

**mohammad.obaid**
Affiliation not available

**fjeld**
Affiliation not available

## ABSTRACT

Lorem.
To Do

- Give control of drone to people. They can push button to make it go higher, as it is approaching them. Have them do some training. See what distance they push it to.

## INTRODUCTION

X vars:

- Height (X discrete divisions)
- Angle (X discrete divisions)

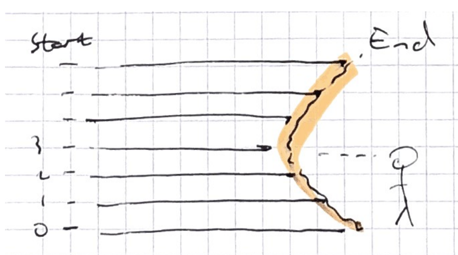


Figure 1. height

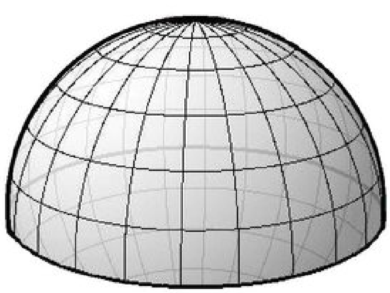

Figure 2. This is a caption



Y var:

Comfortable distance

[?]:

In the near future, robots of different types are expected to populate urban environments with the purpose of supporting human activity. While there is ongoing research addressing so- cial ground robots [10, 12, 23, 25], such robots are still limited when it comes to perceiving, understanding, and interacting in a crowded environment [23], [27] (pages 335-356). Today drones are widely used for aerial video recording, first-person view racing, or military surveillance, but are not yet consid- ered as something humans would socially interact with, but rather control. In order for drones to approach humans, the latter's acceptance of the former needs to be better understood.

As shown in Fig. 1, we assume three advantages drones could have over social ground robots:

* A drone can maneuver unobtrusively above the ground to- wards a target user without disturbing human movement in

busy and densely crowded areas.

* From a drone's-eye view, it has a better capacity to recog- nize humans who need help. The drone's perception also

benefits crowd tracking and robot path planning. Social ground robots suffer from occlusion.

* Humans can easily recognize a drone and interact with it from a far distance.

Based on these assumptions, we introduce a concept of social drone which we propose as a suitable solution to the question of what type of robot is best fit for a crowded human environ- ment. We explore the possibility of using a drone as an agent in human crowd environments by pioneering fundamental components such as social drone design, human acceptability and proximity between drones and humans. Our intention is to decrease the acceptable distance between a social drone and humans by conducting proxemic studies. This paper offers a design study section, followed by a focus group section, a prototyping section, and a two-part proxemic study section (Fig. 2).

## RELATED WORK

1. [?]
2. [?]
3. [?]
4. [?]
5. [?]
6. [?]
7. [?]
8. Recent MA thesis with user approaching drone

## METHOD

### Participants

30

### Apparatus

Bitcraze Crazyflie 2.0 drone (dimensions approx. 10 cm x 10 cm x 3 cm) with infrared-reflective motion capture markers

Qualisys motion capture system with Miqus M3 cameras and Qualisys Track Manager (QTM) v2.17

Wired mechanical trigger connected via dedicated sync unit to motion capture system

Figure 3. https://www.flickr.com/photos/danieltoschlaeger/23867006729/in/photostream/

### Aim/Questions

What is the "comfort zone"? => @ a particular speed, angle

Drone approaching standing user (from particular angle) to give info, deliver package/coffee, etc. -

1. At what point should it stop, at different heights?
2. At what height are people comfortable with the drone flying over them?

### Procedure

1. Drone moves out to certain points on cylindrical grid
2. Drone moves in horizontally towards participant at constant speed
3. Participant must keep position and body/feet orientation static - body/feet orientation can be confirmed from mocap
4. Participant presses button to make drone stop at minimum comfortable distance

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Variables

- Horizontal angle = X steps
- Height = X steps
- ? Posture (sitting / standing)
- ? Color (lights)

Speed = constant

Size = constant

Direction = constant

. . .

### Measurements

Objective:

- Distances

- 

Subjective:

- Negative Attitude towards Robots Scale (NARS)
- Robot Anxiety Scale (RAS-S2)
- Individual Dif- ferences in Anthropomorphism (IDAQ)

### Analysis

Models:

- Just look at the data and take means/medians etc.
- Fuzzy logic

## RESULTS

Lorem.

## DISCUSSION

Lorem.

## CONCLUSION

Lorem.