

Emotional Drone: Expressing Human-friendly Emotion through Drone Movement and Appearance

CPSC 490

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Abstract

As drones are becoming more popular and entering our everyday environments, it is critical to ensure that humans feel safe and comfortable around drones. Drones should not pose any threat to humans, not only physically but also emotionally. While some people can easily interact in close proximity with drones, others may be frightened by their size, noise, and abrupt movements. The goal of my project is to enhance human-drone interaction by adding an emotional component to drone movement and appearance. By manipulating and encoding various flight motions and changing the appearances, drones will be able to express emotions. As a result, drones may be seen as more friendly and personal. I implement emotional intelligence on a lightweight nano quadcopter, called Crazyflie. I utilize the Crazyflie Python Library and the Crazyflie Firmware to manipulate and adjust different drone control parameters (e.g., speed, orientation, time of flight). I program a set of Python scripts to make the Crazyflie emulate how real-life, human-friendly animals, such as dogs and cats, behave and express emotions (e.g., flip, wiggle, nod). I combine several simpler drone movements to create more complex and unique drone movements. To investigate what kinds of emotions can be conveyed to users through drone movements and appearances, I design and conduct a drone-emotion experiment. The experiment involves taking surveys, analyzing various motion graphic animations made with Adobe After Effects, and interacting with both a simulated drone and a physical drone. I test how drone movement, color, physical appearance, and human interaction can affect emotional perceptions in users. From the result of the experiment, I categorize drone movements and appearances based on the associated emotions. I conclude that certain characteristics of drone movements and appearances do enable the drone to express certain emotions that can be perceived by users. Such phenomenon may lead to improvement in human-drone interaction.

Introduction

- Section 1: introduction to drone and Crazyflie
- Section 2: the set-up of the development environment for creating new drone movements
- Section 3: the theory of drone movement and the Python scripts that I program to fly Crazyflie
- Section 4: the experimental design for the drone-emotion experiment
- Section 5: the results followed by an explanation of the findings
- Section 6: concerns limitations, related works, and future work
- Section 7: Conclusion

Crazyflie Python Scripts

<https://youtube.com/playlist?list=PL380KUT9aUQU12qfo6EWG54lhdc-S2twC>

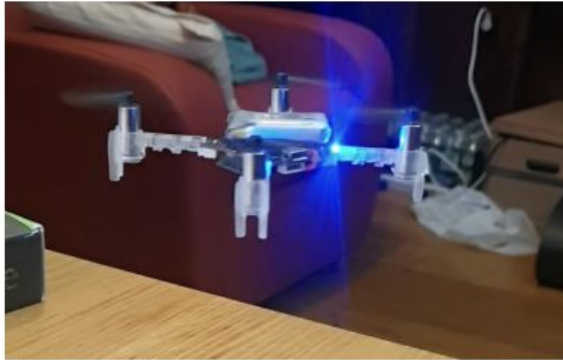


Figure 14: Basic hover.



Figure 15: Spin.



Figure 16: Stairs.



Figure 17: Flip.

Experimental Design

1. Drone Movement
2. Drone Color
3. Drone Physical Appearance
4. Human-Simulated Drone Interaction
5. Human-Physical Drone Interaction

[Drone-Emotion Survey](#)

Drone Movement

<https://youtube.com/playlist?list=PL380KUT9aUQXuJ61DQvUfogFU4mjzL7QZ>

Table 1

Emotion	Drone Movement
Joy	<ul style="list-style-type: none">• Position: spreads out, takes up entire space• Speed: high• Jerk: none• Common movements: flip, spin, turn, up-down, curved path
Sadness	<ul style="list-style-type: none">• Position: low altitude, one corner• Speed: low• Jerk: none• Common movements: sloppy, goofy, drops, heavy and slow
Anger	<ul style="list-style-type: none">• Position: mid altitude, moves around in space• Speed: high• Jerk: yes• Common movements: aggressive, push forward, direct
Fear	<ul style="list-style-type: none">• Position: low altitude, one corner• Speed: low• Jerk: yes• Common movements: hover, shiver, retreat, stiff path, twist
Disgust	<ul style="list-style-type: none">• Position: mid altitude, transition from one side to another• Speed: high• Jerk: yes• Common movements: turn, jerk, fleeing, avoidance

Drone Color

<https://youtube.com/playlist?list=PL380KUT9aUQWkqx1nT3sqjDiY0jWUtk2t>

Table 2

Emotion	Drone Color
Joy	• Yellow
Sadness	• Blue
Anger	• Red
Fear	• Purple
Disgust	• Green

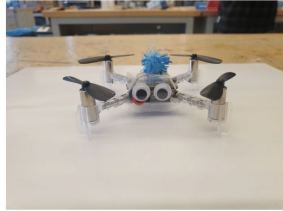
Drone Physical Appearance



"I'm so happy!!!" text.



"I'm so angry!" text.



Blue accessory.



Yellow accessory.

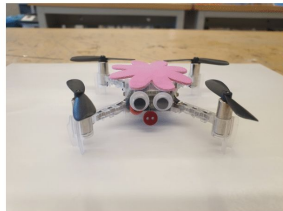


Figure 31: Pink hair.



Buttoned accessories.



Tilted eyebrows.



Steep eyebrows.



Crazyflie with medium-sized googly eyes.



Crazyflie with small-sized googly eyes.



Crazyflie with large-sized googly eyes.



Medium-sized eyes + mouth.



Small-sized eyes + mouth.

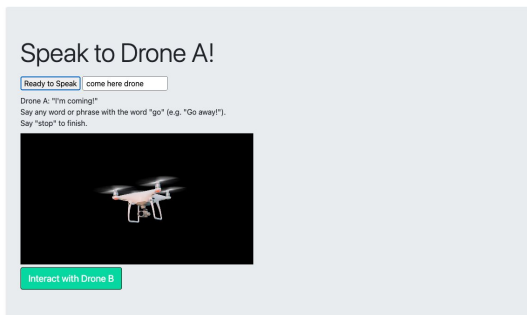


Large-sized eyes + mouth.

Human-Simulated Drone Interaction

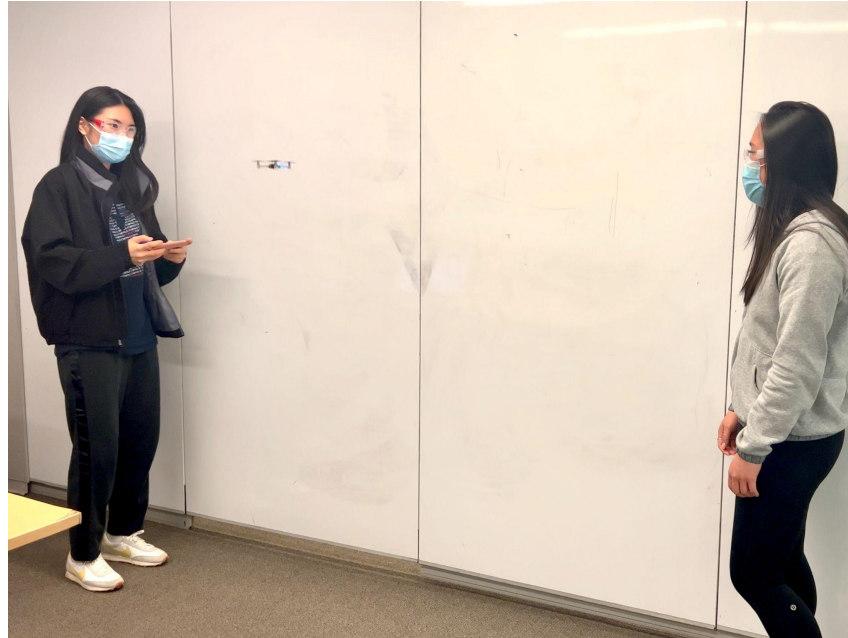
<https://human-drone-interaction.netlify.app/>

<https://youtube.com/playlist?list=PL380KUT9aUQXIHxM1OFgvXoCZMS4J8cGF>



Human-Physical Drone Interaction

<https://youtu.be/M2QzaP8WWSw>



<https://zoo.cs.yale.edu/classes/cs490>