

## Introduction

- There has been an increased need for skilled unmanned aerial vehicles (UAVs) pilots to cope with the rapid rise in UAV deployments for military and civil applications like infrastructure inspection.
- However, research on effective and efficient training of UAV pilots has lagged behind the demand. The increased but not well-considered onboard autonomy has added uncertainty to current training outcomes.
- To help fill this gap, this project examines the fundamental question of how UAV pilot skills develop with various training programs.

## Experiment Design

In the experiment, subjects were given an inspection mission to fly a UAV in a simulated disaster response environment.

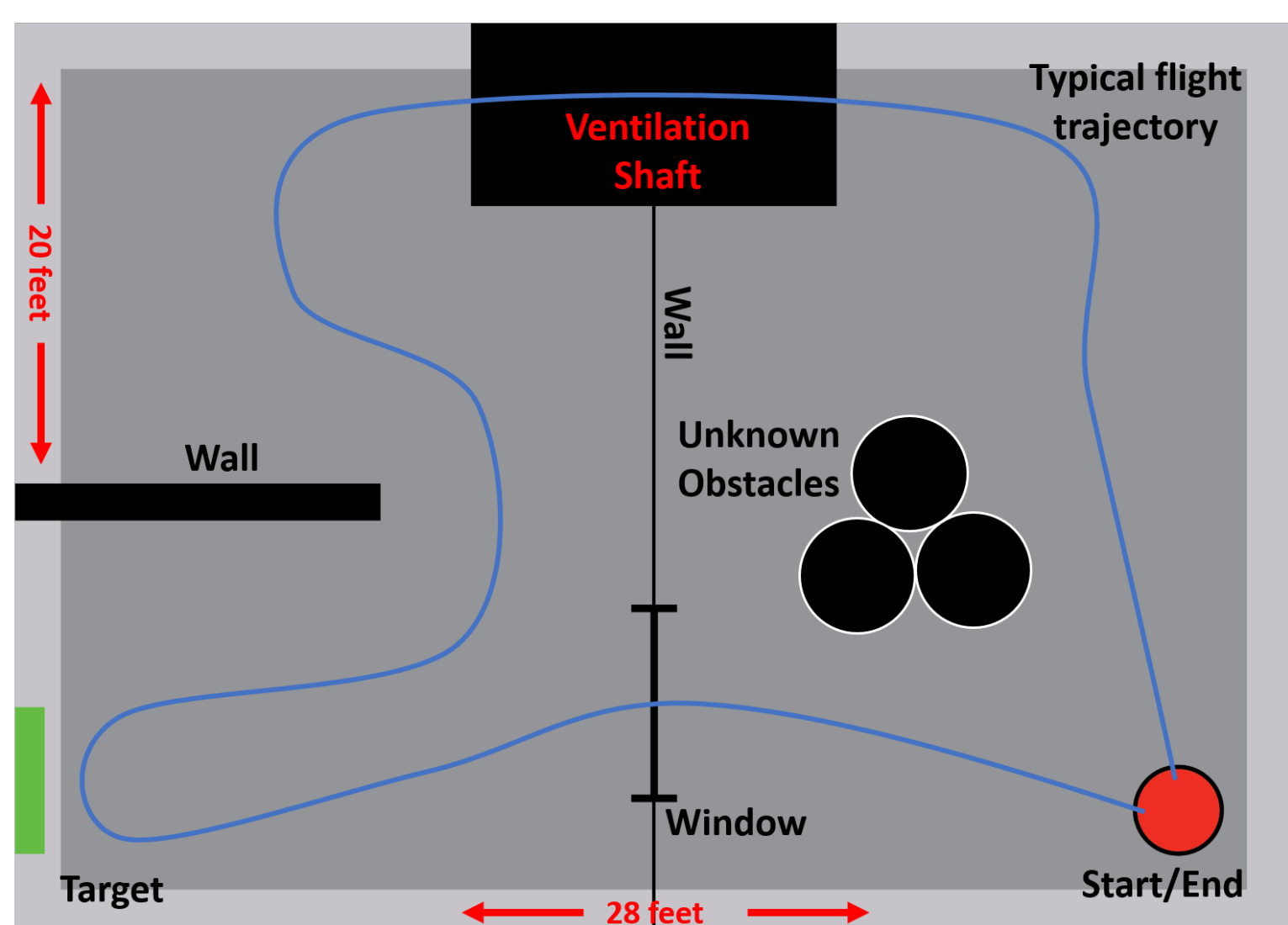
### Control:

Two control modes were developed corresponding to two levels of autonomy, and their interfaces were developed separately.

- Manual control: no autonomy built in.
- Supervisory control: the subject can define a flight trajectory using waypoints and supervise the UAV execute the trajectory autonomously.

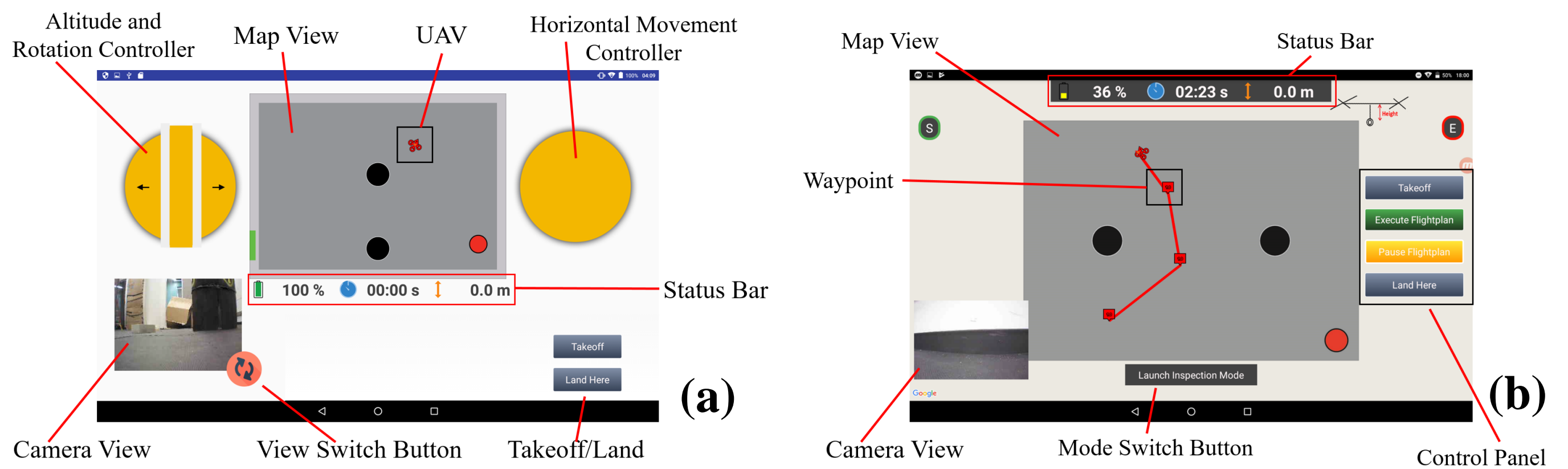
### Experiment treatments:

- Two comparison groups were trained with two different training strategies.
- Subjects were trained five times during a 7-week period.
- In each week, subjects from two groups were tested to complete the mission with the supervisory control.



Simulated Disaster response environment

## Experiment Design

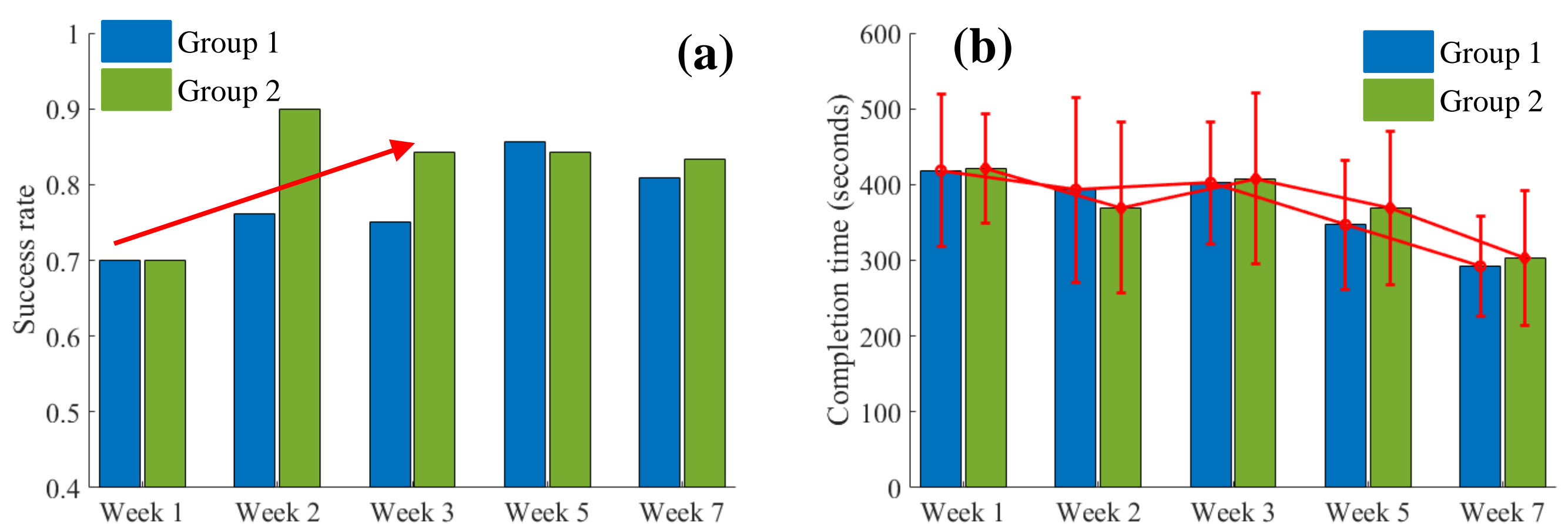


Two control interfaces for two control modes with different levels of autonomy. (a) Manual control and (b) Supervisory control

Two comparison groups with different training strategies. SC: Supervisory Control, and MC: Manual Control

Group #	Training					Tests	Subject Number
	Week 1	Week 2	Week 3	Week 5	Week 7		
Group 1	MC+SC	MC+SC	SC	SC	SC	SC	21
Group 2	SC	SC	SC	SC	SC	SC	20

## Results



(a): Success rates of two groups in each week.

(b): Average times used to successfully complete the mission in each week with one standard deviation as the error bar.

- Subjects (Group 2) with high-level autonomy initially outperformed others (Group 1) with training of both levels of autonomy, but they were outperformed by Group 2 in the last two sessions.
- Group 1's performance was also more consistent.

## Discussion and Future Work

### Discussion:

- Training pilots with low- and high-levels of autonomy is beneficial over training with only the high-level autonomy. However, this benefit shows up in the later stage with extra costs.
- Selection of training strategies for a UAV agency should be based on the long- and short-term costs and performance outcomes.

### Future Work:

Modeling subjects' skills, cognition, and trust development processes during this recurrent training.

## Acknowledgements

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