Take K-12 Students for Global Field Trips by Interactive Droneography

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Figure 1: Example giving students a field trip by a teleoperated drone.

ABSTRACT

We build an interactive droneography system that emulates in-person field trips, letting students and educators see, learn and interact with remote places by flying drones at home. To guide students from missing directions or losing attention, a visual salience detector and an object recognizer through neural networks are also included.

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1 INTRODUCTION

School field trips give students and educators many proven benefits, add relevance to classroom learning and interrelationships, stimulate interest and motivation, and strengthen observation and perception skills [Behrendt and Franklin 2014]. However, educational inequality has been discovered in school field trips. Low-income schools or students living in marginalized communities can least afford travel expenses and teacher time. In fact, less than 33% students can have one field trip per semester and 90% of trips are constrained in locals. The local economy, lack of accessibility, border controls and quarantines are all causes to the loss of educational opportunity.

We help educators overcome the problem, letting students see, learn and interact with remote places and people by flying drones at home. Through our real-time droneography system, a web link would be generated and be shared to online trippers. By using a web browser of any mobile devices, students and educators are able to connect to faraway drone(s), receive live streaming from the drone camera, and command its maneuver. Also, to prevent remote pilots from unsafe operations or operational conflict, our system

has a collaborative mechanism. Such combination increases the engagement among students and educators during an online field trip [Kachach et al. 2020].

The implementation details are discussed in the following section.

2 TECHNICAL DETAILS

The implementation consists of two parts i) telecommunication systems, ii) drone hardware.

In i), the telecommunication is based on Mavlink, an open-source and international standard in unmanned aerial vehicles. For the third-party applications not designed using Mavlink, we use a translator to convert telemetry into Mavlink. To reduce latency, the webrtc architecture is implemented on google cloud. To make the system more accessible worldwide, network address translation (NAT) traversal is handled by both stun and turn servers located in different continents. We also set a web server running front-end, interfacing and processing user commands of teleoperation.

In ii), our hardware prototype, as shown in Fig. 2, consists of a third-party portable drone from DJI, an aerial unmanned vehicle, a mobile ground station consisting of RC telemetry system, and a 5G lte phone. The size is about 9.6" x 11.4" x 2.2" inch, and the weight is about 250g.

Figure 2: the drone hardware, the orange landing pad has the diameter of 30 inches

Due to the limited network bandwidth, there is a trade-off between spatial resolution and temporal response in existing online tour technologies. To understand how the user experience is affected by the trade-off, we set three configurations, i) teleoperated dronegraphy: the pixel resolution of 720p, the latency of teleoperation within 0.25s, ii) a walkthrough live streaming on youtube: the pixel resolution of 2k, the latency of 7s, iii) a set of 360 panoramic photos the pixel resolution of 4k, static contents can be preload without the worry of latency as the Street View and Matterport [Anguelov et al. 2010; Chen et al. 2018].

The physical site for experimenting the online field trip is a one-story mansion contains one lobby, one living room, one kitchen, several bedrooms and bathrooms. Given the same amount of time in 10 minutes, participants can explore the mansion using the three different configurations; participants are then asked to give satisfaction about the application by 0-5 stars. The user study can lead us to optimize our design, to be specialized for online education.

3 SUMMARY

To sum up, our early App prototype includes a drone hardware, a telecommunication software and neural networks as described in Sec. 2. The App is appropriate for students in grade 6 to 12 and their teachers, and undergraduates from architecture, real estate, science or interdisciplinary students.

By using the App, the user can be a remote pilot, flying drones at home; see, learn and interact with remote places and people, e.g. SF bay area, Taipei, etc, using their laptop or smartphone, leading to a higher engagement on interactive distance learning.

Furthermore, an object recognizer, privacy protection or hotspot predictor can be integrated[K. He and R. Girshick 2017; Min and Corso 2019; Xu et al. 2019] to guide students from missing directions or losing attention for future App iterations.

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