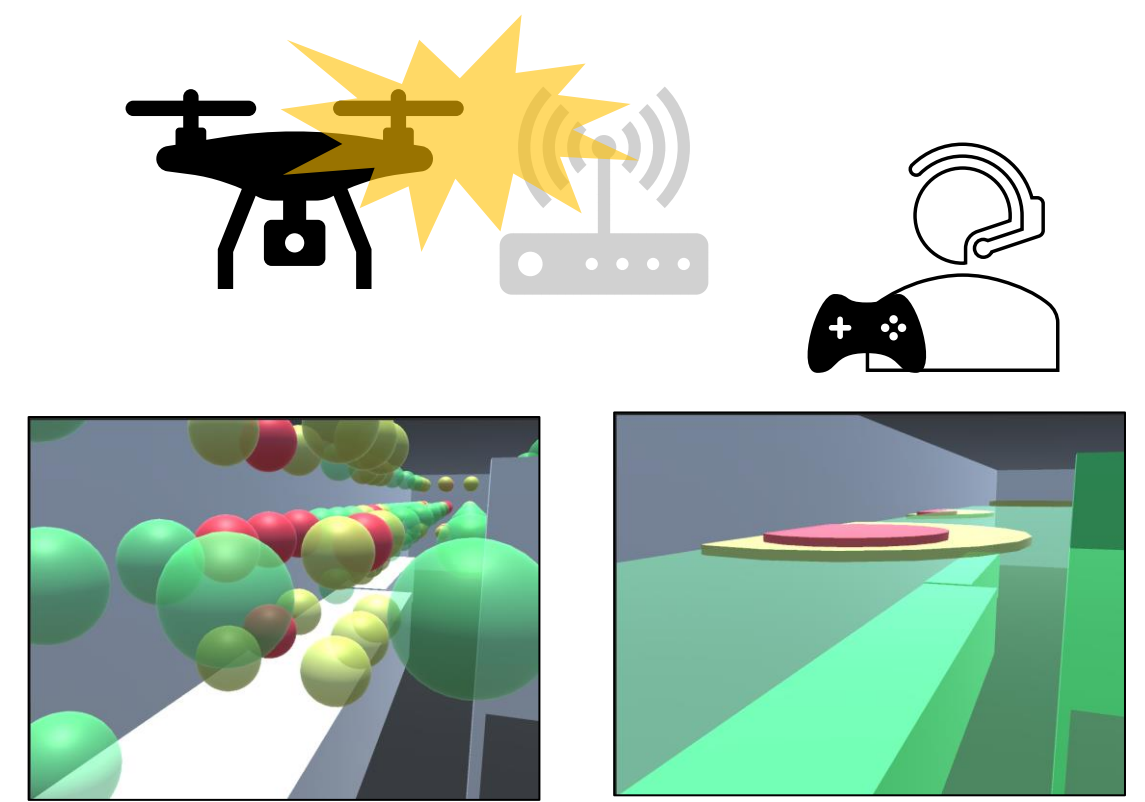


Visualization of three-dimensional radio wave conditions for indoor drone teleoperation support

Takumi Nagahara, Nattaon Techasartikul, Yuichi Ohsita, and Hideyuki Shimonishi
Osaka University, Osaka, Japan

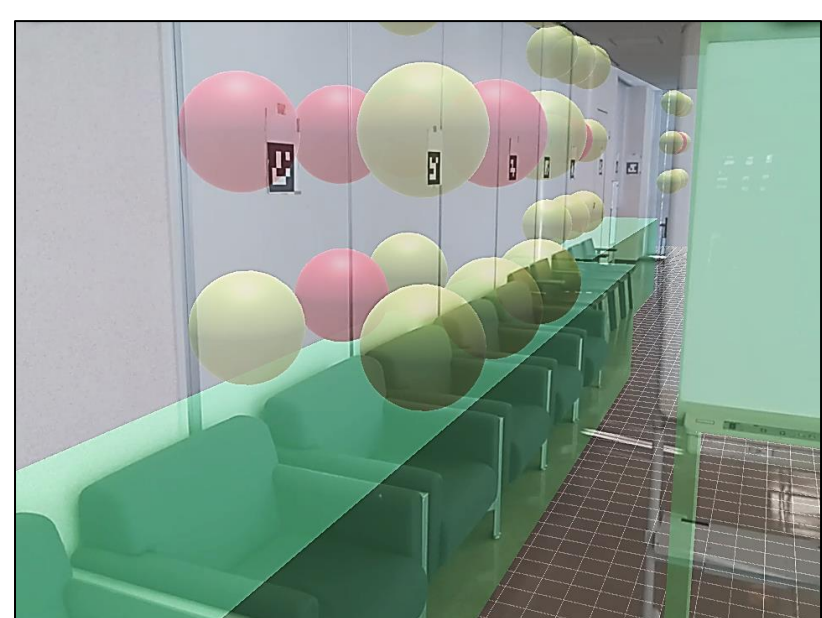
BACKGROUND & OBJECTIVE

- Drone accidents can occur due to unstable radio communications, which are invisible and unpredictable to operators.
- Visualization of radio conditions has been studied, but ...
 - 2D visualization: lack of depth or height information for drone teleoperation
 - 3D visualization: reduce the visibility of the real environment



→ We conducted comparative experiment with three visualization designs to explore the relationship between the amount of information and human cognitive.

PROPOSED VISUALIZATION DESIGN



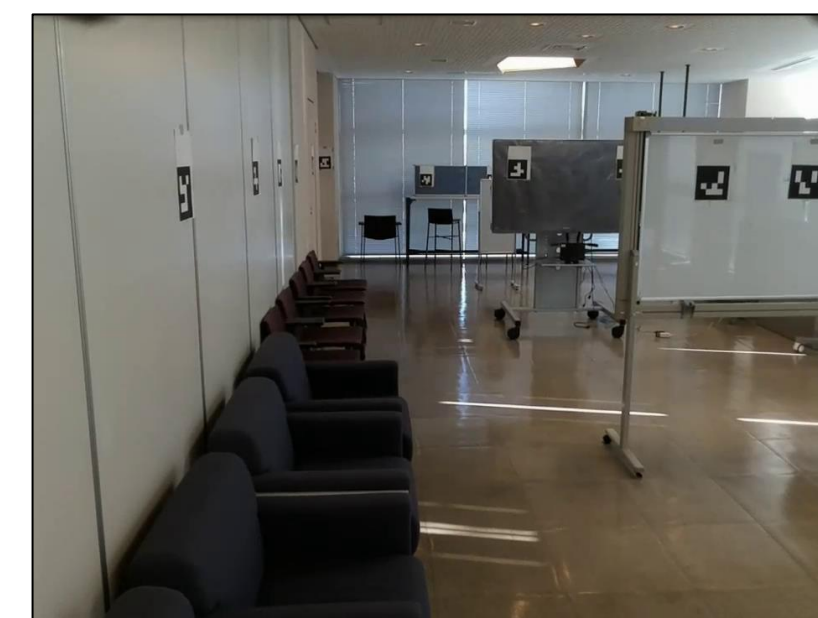
3D Sphere display



Adaptive 2D ripple display



1D Binary warning display



No display



Demo Video

Information

Visibility

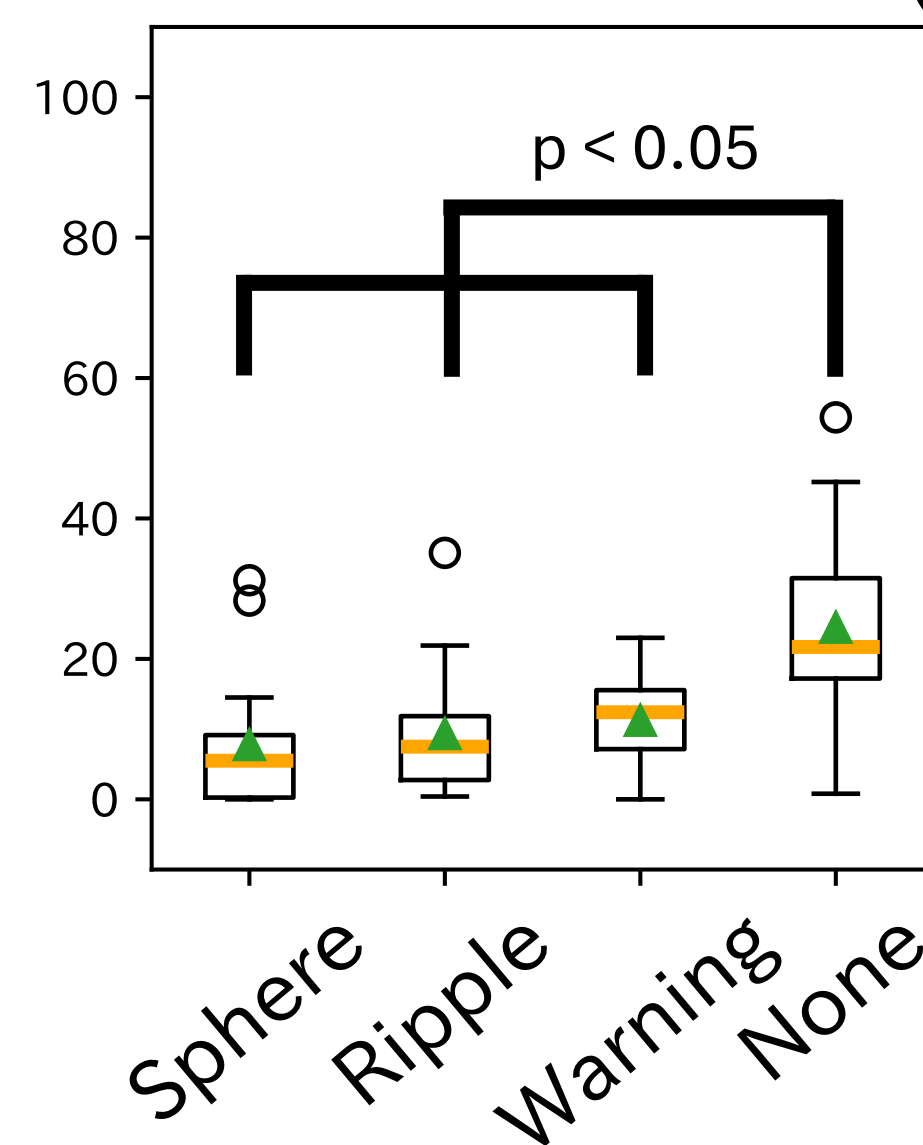
EXPERIMENT

- 15 subjects (11 males and 4 females)
- Guide the drone while avoiding obstacles and areas with poor radio conditions
- Performs 4 tasks, using each visualization

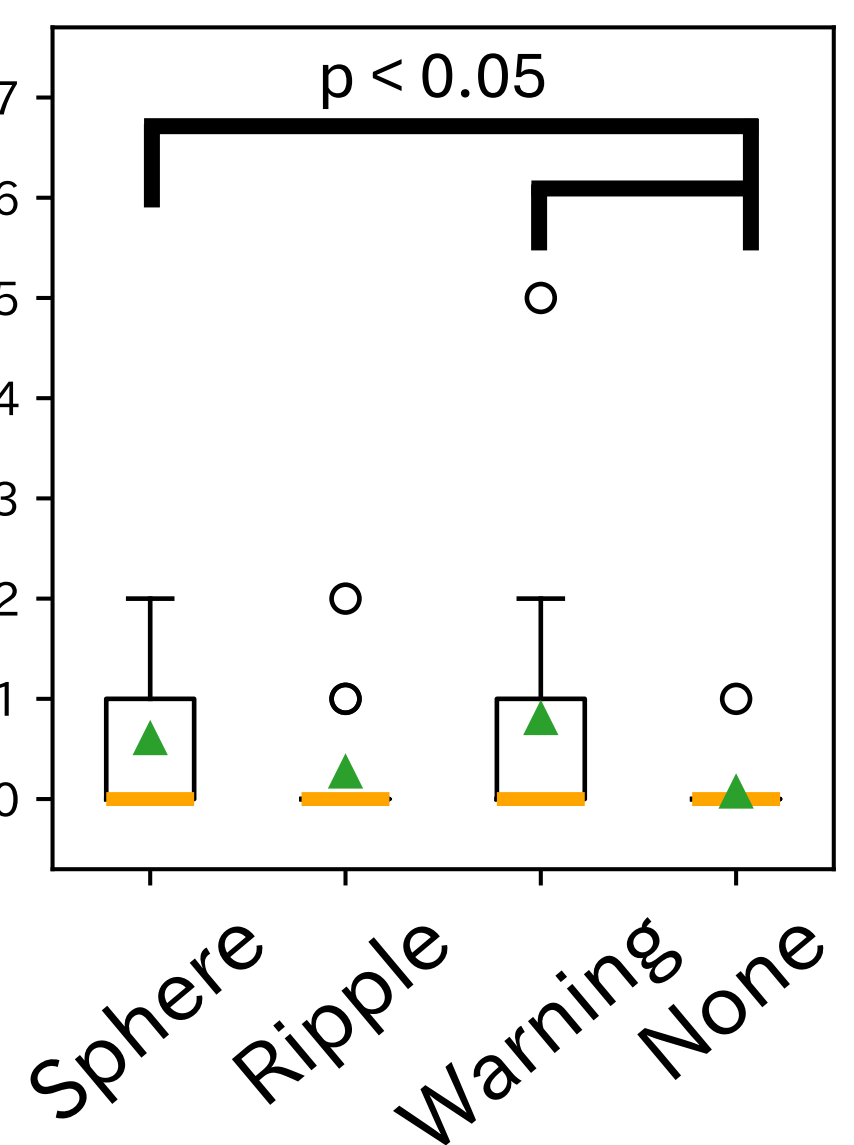
RESULTS & DISCUSSION

- As the amount of information increases, the percentage of time in bad radio conditions areas decreases.
 - The visualization may have diverted attention from obstacles in the real.
- The 2D ripple display has a good balance between information richness and cognitive burden.
- Most participants feel that the visualization is obstructive, but the usefulness is almost the same.

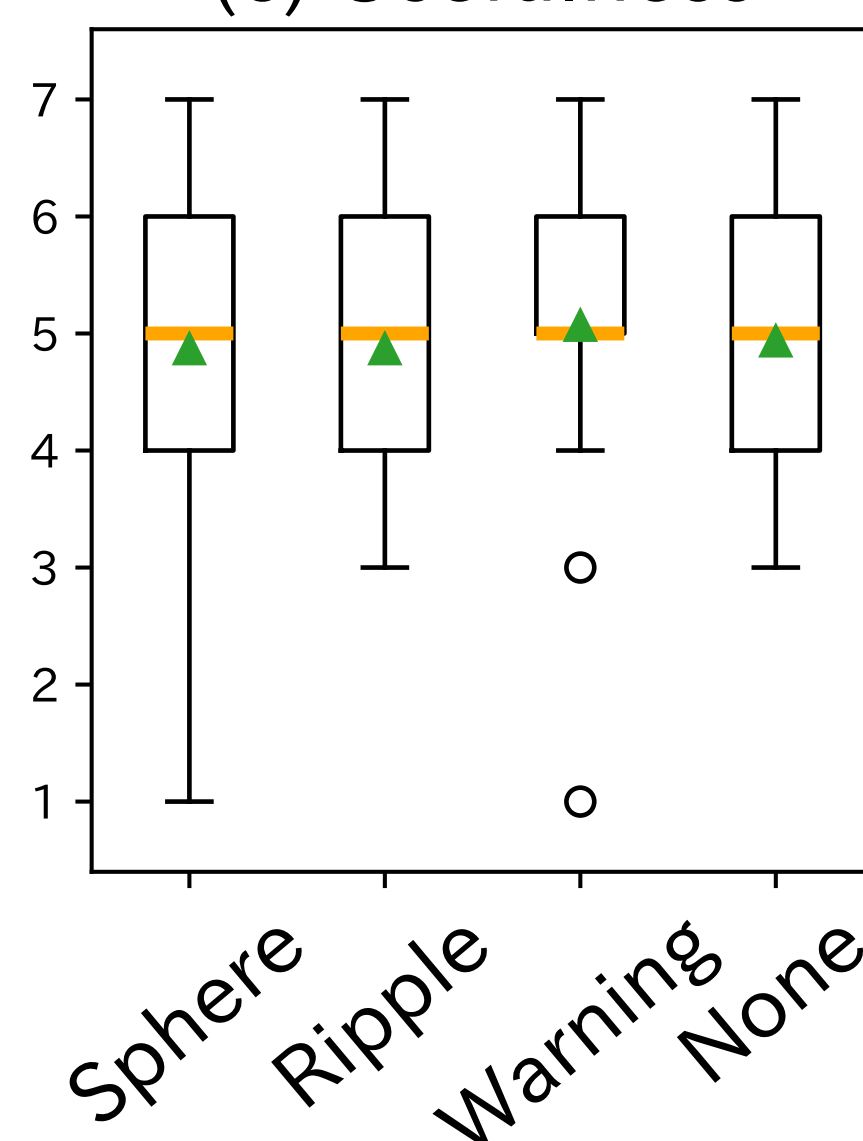
(a) Flying time in bad radio condition areas(%)



(b) The number of collision



(c) Usefulness



(d) View obstruction

