

ASYMMETRIC INTERACTION BETWEEN HMD WEARERS & SPECTATORS WITH A LARGE DISPLAY

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INTRODUCTION

MOTIVATION

- HMDs provide a highly immersive experience to a single user, but they make it difficult to communicate with spectators in the real world.
- It is often not feasible to implement a multi-HMD solution just for spectating purposes.
- Display mirroring (the default solution) fails to convey the feeling of presence from VR.

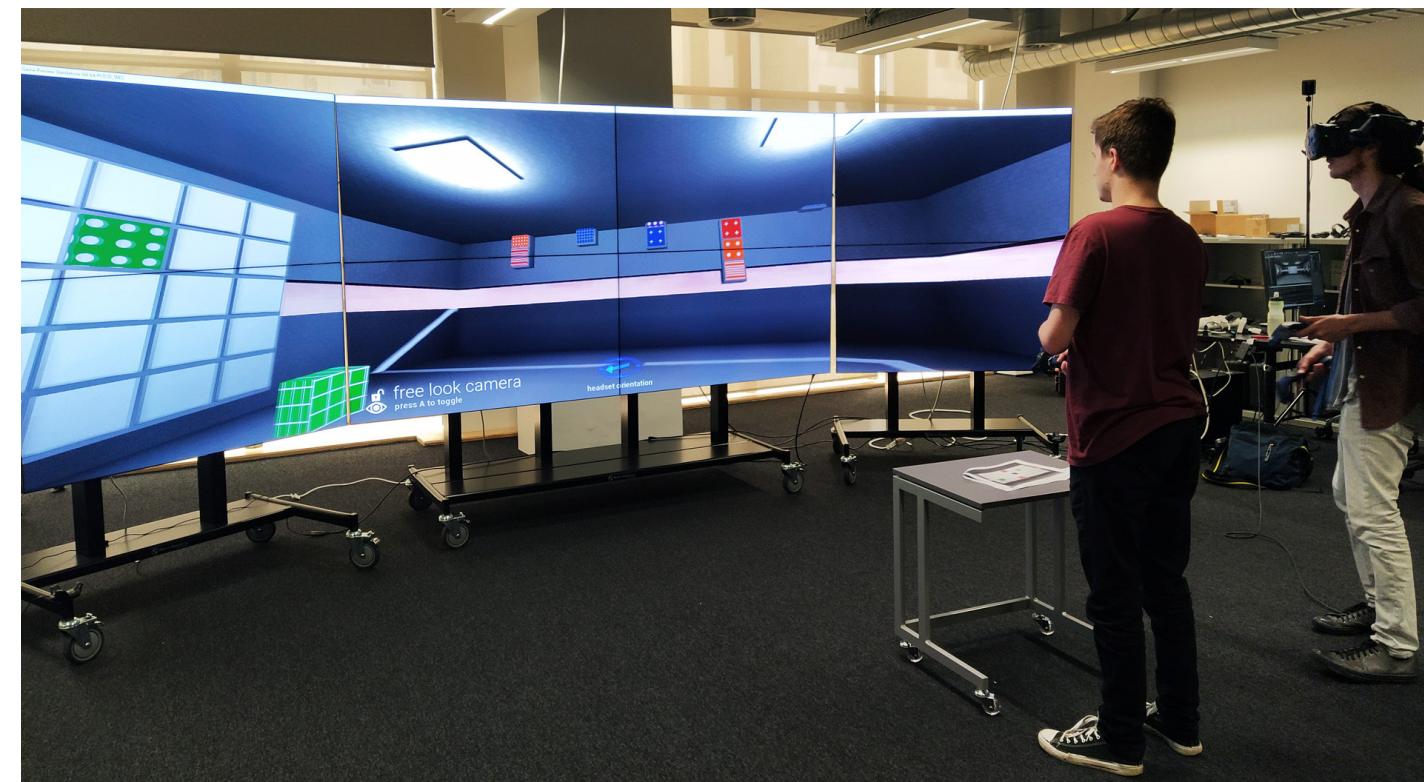
GOALS

- Create a better spectator solution which is easy to add to an existing single-player project and works with audiences of any size.
- Elevate the spectator's feeling of presence.
- Allow the spectators to interact with the virtual world in order to communicate and collaborate with the HMD user. Useful for demonstrations, collaborative projects, and training scenarios.

IMPLEMENTATION

IMMERSIVE DISPLAY

- The large-scale display was configured to maximise its immersive properties.
- This was accomplished by arranging the eight 55-inch displays in a 4×2 grid, increasing the spectator's horizontal field of view.
- The displays were also arranged on a slight curve, which has the benefits of increasing spacial presence and reducing viewing angles [1].



Left: The spectator's motion controllers (HTC Vive Trackers taped to PS Move controllers).

Right: Two participants in the user study interact with the system.

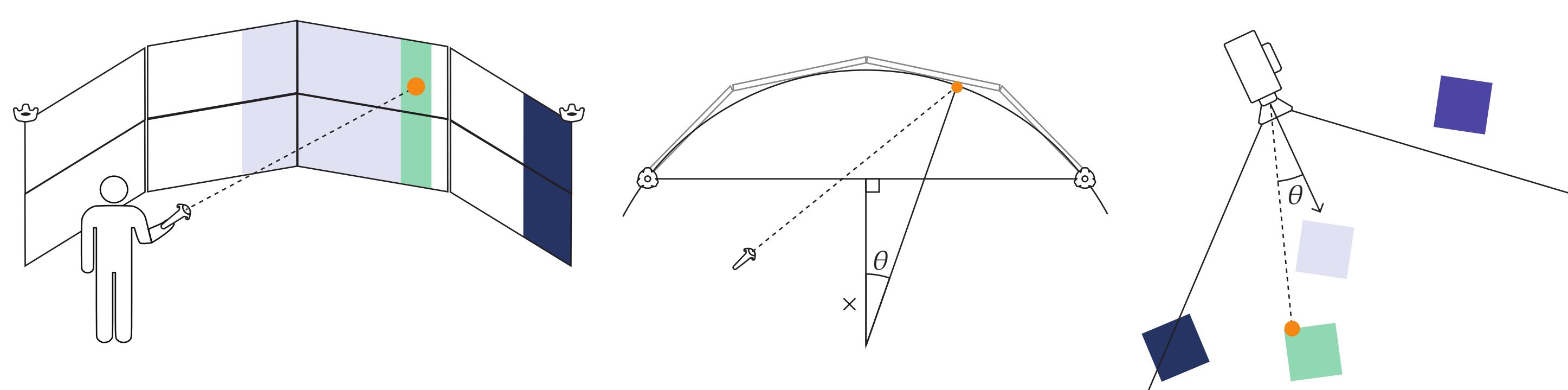
SPECTATOR CAMERA CONTROL & VIRTUAL INTERACTIONS

Camera Control

- When the spectator holds down the trigger on their left controller, the virtual camera's orientation is mapped to the orientation of the controller in the real world.
- This is called the "eyeball-in-hand" control metaphor [2].
- The large button on the controller toggles free-cam mode. If free-cam mode is disabled, the camera snaps back to follow the VR user's perspective when the spectator releases the trigger. If free-cam mode is enabled, the camera stays where the spectator left it.
- This allows the user to perform ratcheting motions to turn the camera around without having to maintain an uncomfortable hand position.

Interactions

- If the spectator holds the trigger on the right controller and points it at the display, a marker is spawned in the virtual world at the position they are pointing at.
- This means the motion controller can be used like a laser pointer into the virtual world.

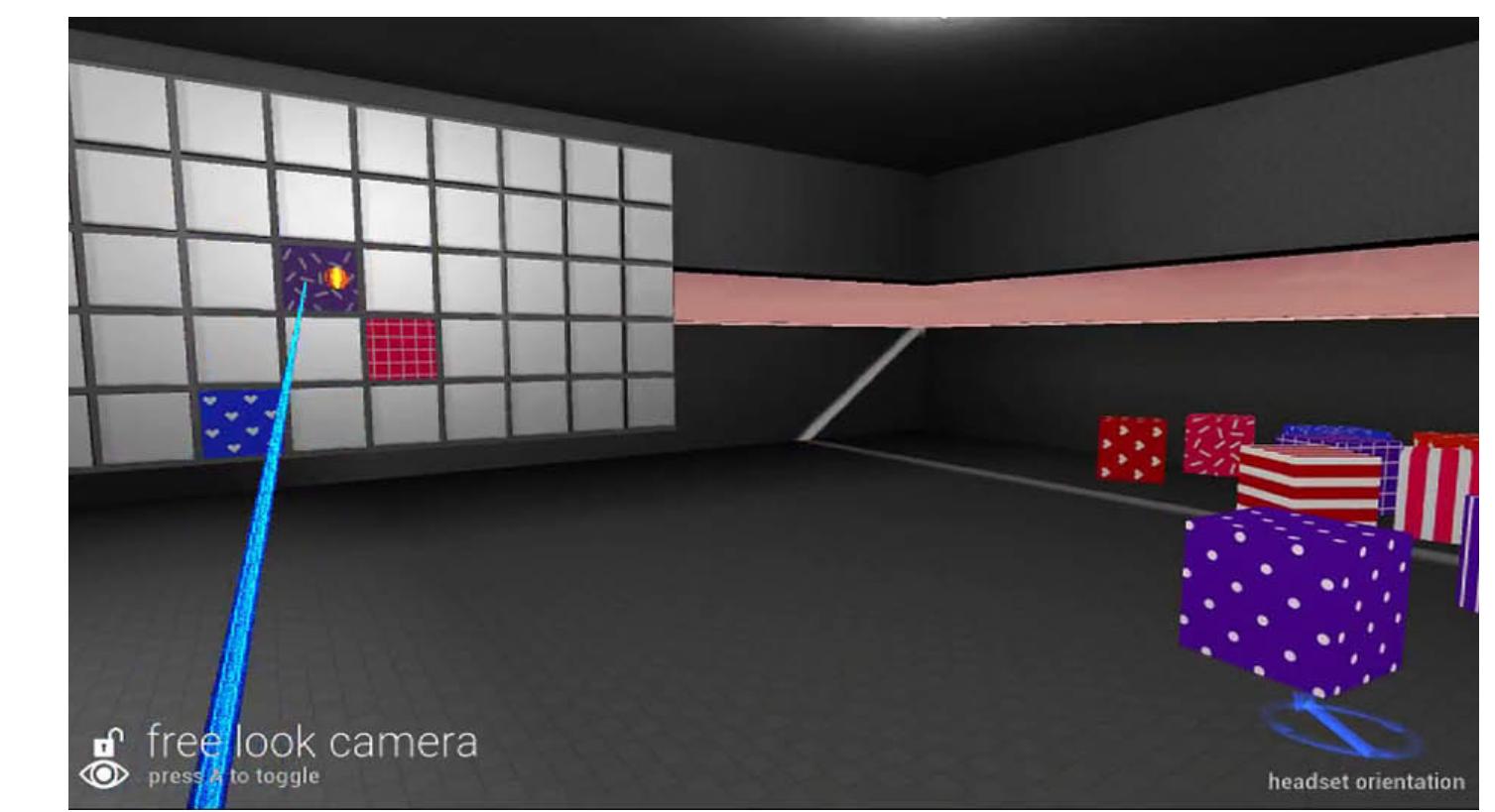
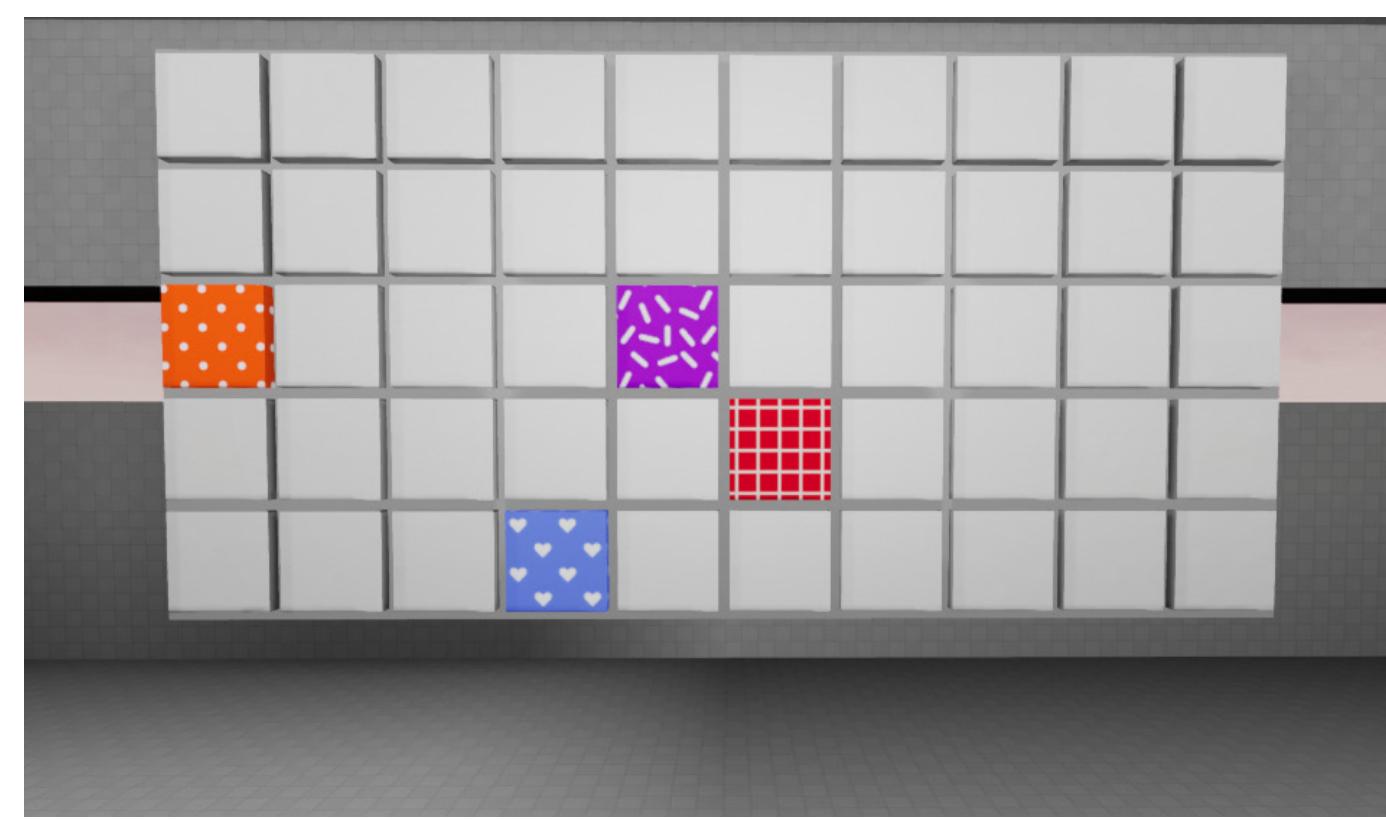


The pointing tool projects a marker into the virtual world by calculating the angle between the spectator camera and the marker. This requires the position of the display to be mapped into the virtual world – which was achieved using Vive Trackers.

EVALUATION

TASK DESIGN

- We designed a task to be completed by a HMD user and a spectator to measure the effect the system has on efficiency in collaborative tasks.
- The virtual test environment contains 40 unique cubes have been randomly placed on the walls. They slowly move in and out of view.
- The VR user is able to put these cubes in the large grid on the wall. The spectator is provided with a printed screenshot of a solution: a grid with several cubes in it.
- The goal for the subjects is to find the cubes which are displayed in the solution and place them in the grid in the correct locations.

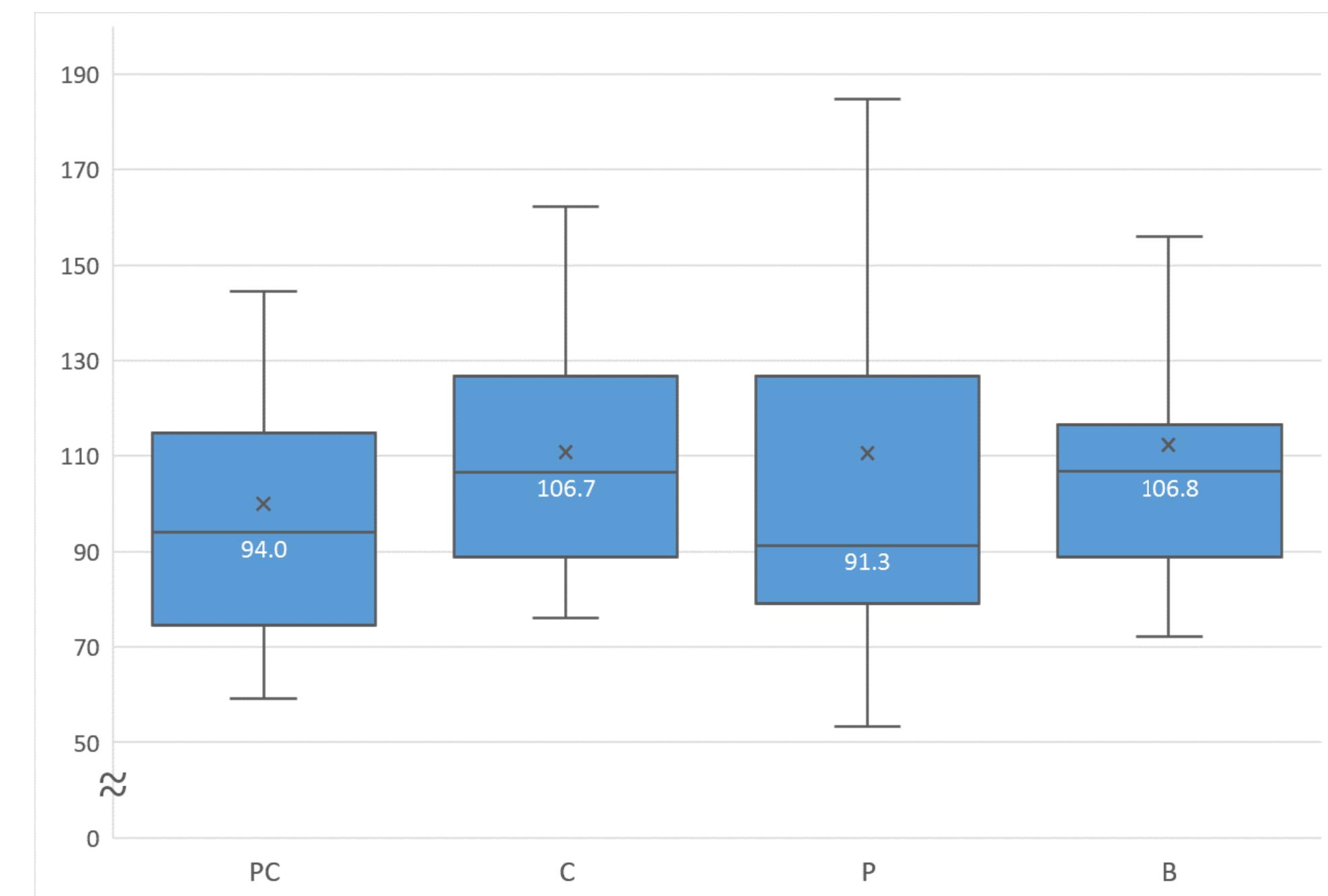


Left: An example of a solution grid which was given to a spectator.

Right: The HMD user places a cube into the grid.

RESULTS

- We measured the duration of each trial and how much each tool was used. The study had 24 participants (75% male, age range of 20-30 except one above 30).
- There were two independent variables which were either enabled or disabled in each condition: the spectator's independent camera (C = enabled) and the pointer tool (P = enabled). In the baseline condition (B) the spectator used basic display mirroring. Each participant completed one trial for each condition in each role.
- We found that users were able complete the task on average 13% faster when the pointer tool was enabled. We also found that users put the available tools to use, averaging at 31% of the time (7% standard deviation) throughout all conditions.
- We asked the users to complete a qualitative survey after each trial, and the responses showed that the tools were considered to be useful from the perspective of both spectators and HMD users.



CONCLUSION

- We presented a spectator system in an asymmetric VR scenario with a single HMD user. The spectator can freely look around, decoupled from the HMD user's view. They can also point and place virtual markers to communicate with the HMD user.
- Our study showed that the system enabled effective communication, allowing each user to focus on different areas of the environment to complete a collaborative task.
- In future work, we will further explore the user interface with the aim of increasing each user's awareness of where their partner is looking.

REFERENCES

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