Virtual Environment Development using Unity Game Engine for Navigation Skills Assessment

UNDERTAKEN AT

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DEFENCE RESEARCH AND DEVELOPMENT ORGANIZATION (DRDO)

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About The Project

- How spatial learning perspectives support navigation through virtual urban environments. For this we took out two experiments in which participants briefly learned the overall layout of a virtual desktop environment, and then were taken on a simulated journey ending at a starting location within the environment.
- In Experiment 1, during the journey participants watched simulated video feeds either from the front of the player (route perspective), map view (survey perspective), both feeds simultaneously, or no video at all.

About the Project (Cont.)

- Participants then navigated between ten successive landmarks, and we measured distance and time efficiency.
- Results indicated that the route perspective supported a restricted range of local navigation whereas the survey perspective better supported far-space navigation.
- Experiment 2, demonstrated that the survey perspective also better supports navigation around unexpected detours.

Project Objective

- Though people typically navigate by using spatial knowledge acquired through direct navigation or extended experience with area maps, there are many cases where people must navigate environments on short notice and without comprehensive spatial knowledge.
- For instance, soldiers and emergency first responders are often expected to rapidly navigate remote and unfamiliar environments without ample study opportunities.

Project Objective (Cont.)

- In many cases, these people may have briefly viewed a map of the environment prior to beginning their journey.
- The present study examined the relative effectiveness of spatial learning perspectives during simulated transport for supporting eventual navigation of an environment.
- If an individual has the opportunity to view a computer-generated visualization of an environment immediately prior to navigating within it, how might the perspectives displayed on the visualization affect subsequent navigation?

Project Importance

- Cognitive enhancement by Navigation training in Virtual Environment can be a valuable project which can be used to train the soldiers because this project can improve the level of Navigation Skills, decision making, processing speed, accuracy, determination, memorizing the things, reaction time and ability to make and follow plans in Navigational tasks.

Oculus VR Headset

- Oculus DK2 VR (Head-mounted display) Resolution 2160×1200 (1080×1200 per eye).
- It creates the sensation of being entirely transported into a virtual (or real, but digitally reproduced) three-dimensional world, and it can provide a far more visceral experience than screen-based media.
- Positional Tracking [Near Infrared CMOS Sensor]
- Built-In Latency Tester
- Internal Tracking [Gyroscope, Accelerometer, Magnetometer]

Experiment 1

- Our first experiment tasked participants with navigating a large-scale virtual space after briefly studying a map and then viewing video-based information from either route or survey perspective, or both perspectives combined; a control group saw only the initial map.
- After this initial learning experience, participants were placed into a virtual urban environment and tasked to navigate between 10 successive landmarks.
- We measured the extent to which the perspective experienced promotes efficient navigation, and how this changes with increasing experience in the environment. We made three main predictions.

Hypotheses

- we made three main predictions :
- First, the route perspective would be better suited to supporting near – relative to far-space navigation.
- Second, the survey perspective would be better suited to supporting far – relative to near-space navigation.
- Third, both of these effects would diminish over time as a person becomes more familiar with an environment and builds a flexible mental model.

Grouping of Participants

- Participants were randomly assigned to one of four groups of our between-participants design with four video perspectives (Route, Survey, Route and Survey Combination, or No Video).

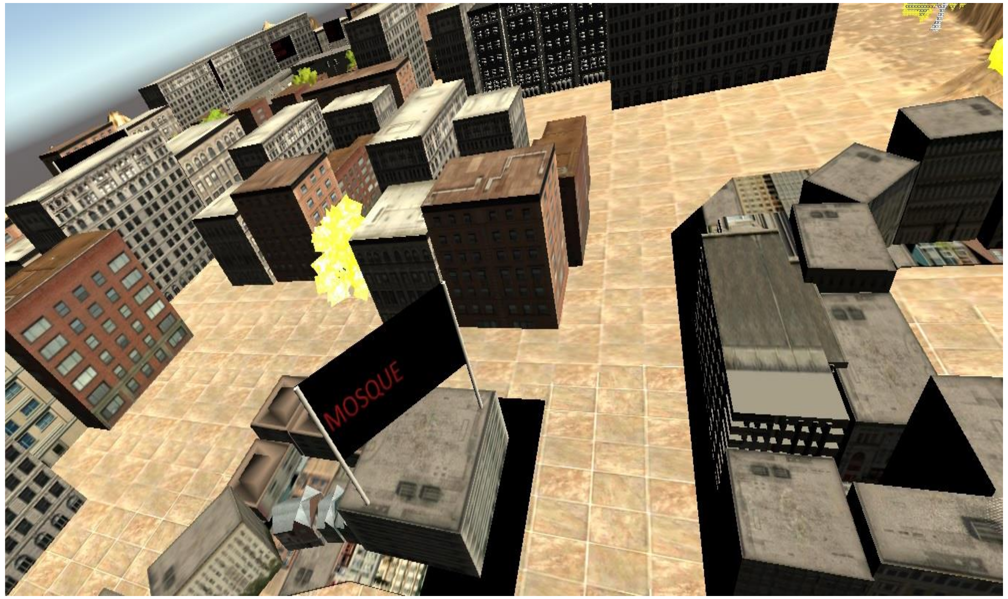
Virtual Environment

- We created a large-scale environment using the Unity Game Engine.
- The overall environment contained multiple landmarks, 17 of which were labelled.
- Only open space between landmarks (comprising approximately 43% of the environment) was navigable, participants could not enter buildings or navigate beyond the boundaries of the environment.
- The visual features of each prominently text-labelled landmark resembled its function.

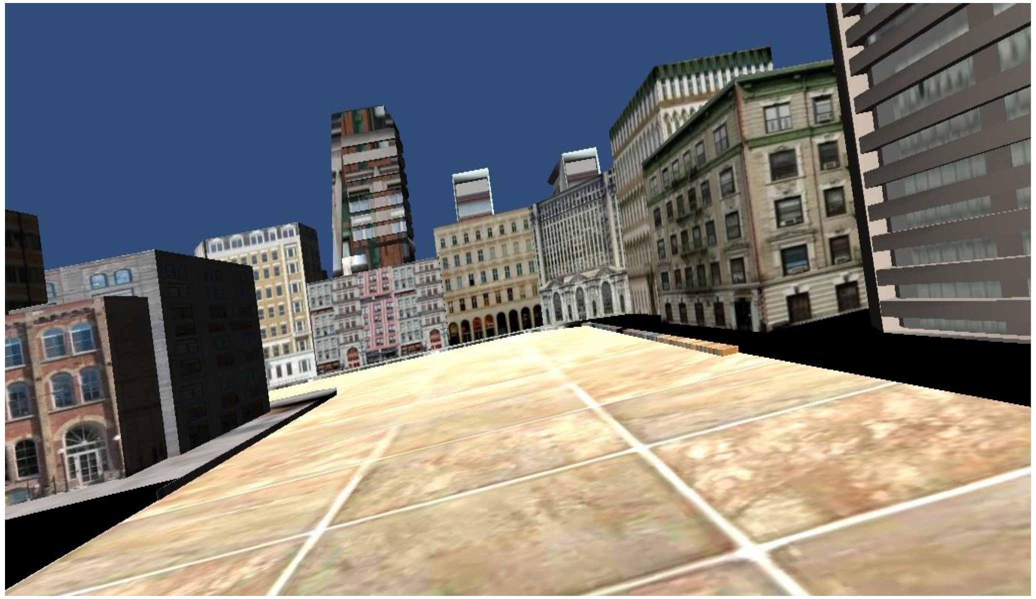
Environment View

- Three videos were created that adopted either a route perspective, survey perspective, or both perspectives simultaneously (combination).
- The route video depicted the forward-view of a character moving on a planned trajectory through the environment.
- The survey video depicted an aerial view of a character moving on the same trajectory as in the route video, starting at Bank and ending at Mountain Pass.
- The combination video combined the route and survey videos into a single temporally and spatially synchronized video, with the survey view on the left bottom of screen.

Environment View (Cont.)



Survey video



Route video

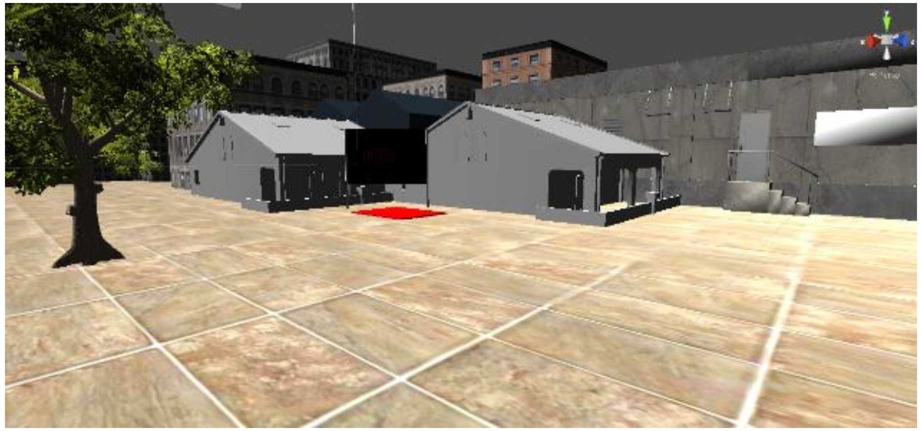
Environment View (Cont.)

Combination Video

- A given participant viewed either the route, survey or combination video, or no video at all. All videos were 2 min 03 s in duration.
- At video end, participants were immediately spawned into the virtual environment at the video-end location, oriented towards the Bank.
- In the No Video condition, participants waited for 2 min 03s prior to beginning navigation, but saw no video.

Navigation Tasks

- Each participant performed a sequence of 10 successive first-person navigation trials, beginning their first trial at the Bank ending at Theatre.
- Each navigation trial had at least two possible paths, with one being more optimal in length.
- In front of each landmark was a red square that served as a trigger to inform the participant of the next navigation trial.



Landmark Learning

Prior to viewing the perspective-based video, each participant briefly studied a labelled aerial map of the environment to ensure knowledge of landmark names and approximate positions. The map was produced by adopting a bird’s-eye overhead perspective on the virtual environment.

Procedure

- The experiment began with the participant briefly viewing an aerial map of the environment to ensure landmark knowledge, then continued with the participant arriving (being ‘spawned’) to next level at end.
- Once the participant completed each of 10 successive navigation trials, the experiment ended. We describe each of these procedural phases in turn. As seen in Figure below.

Virtual Navigation

- When participants arrived in the environment, they came in contact with the first navigation instructions. Each successive instruction appeared on the screen in 24-point font, signalling their arrival at an objective (You have reached the City Hall) and providing the next navigation instruction (Proceed to the Hotel). The navigation instruction stayed on the screen for until player hit Enter on keyboard.
- Participants navigated until they located the objective; no time limits were enforced. Once they reached the final navigation trial's objective (Theatre), they received a message that they have reached their final destination and the experiment end. Throughout navigation, automated measures were collected in real-time.

Experiment 1 Conclusion

- When participants were tasked to navigate between their principle reference landmark (the spawn point) and a proximal objective during Trial 1, they showed superior performance after learning from the Route video relative to the other three conditions.
- This effect is likely due to gaining ground-level information regarding the visible landmarks and paths that guide them towards their destination.
- The Route perspective promoted navigation through this relatively local and constrained space.
- On average, this trial was executed with about 30% higher path efficiency following Route perspective learning; time efficiency showed a similar effect.

Experiment 1 Conclusion (Cont.)

- During Trial 2, however, a different pattern emerged :
- participants showed the lowest path and time efficiency after learning from the Route perspective.
- For this distal navigation trial through relatively unconstrained space, we expected participants to switch from their ground-level perspective and recruit a mental map of the environment in order to plan a route.
- Those who learned from the Route perspective showed difficulty with such a task, whereas those who were exposed to the Survey perspective showed relative fluidity.
- suggesting that this perspective switch was supported through the Survey perspective video.

Experiment 1 Conclusion (Cont.)

- Trial 3 showed a similar pattern of results:
- With performance decrements occurring only in the Route condition.
- Further, in Trial 3 the No Video condition patterned closely with the Survey and Combination conditions, suggesting that the brief map viewing experience may have provided some support for a later perspective switch.
- By Trials 4–5 participants were navigating with relative ease and high efficiency (this pattern continued through Trial 10).

Experiment 2

- Our second experiment examined whether participants would show differential ability to efficiently update planned routes during navigation as a function of their initial learning perspective.
- Participants learned from the same route and survey perspective videos as in Experiment 1, and then navigated the same sequence of 10 trials. On two of the trials, however, a temporary detour appeared along the trial's optimal route, forcing participants to update their route plan.
- Updating a route plan requires a dynamic perspective switch from the current ground-level perspective to an overhead view that allows the participant to reassess the path options towards an objective.

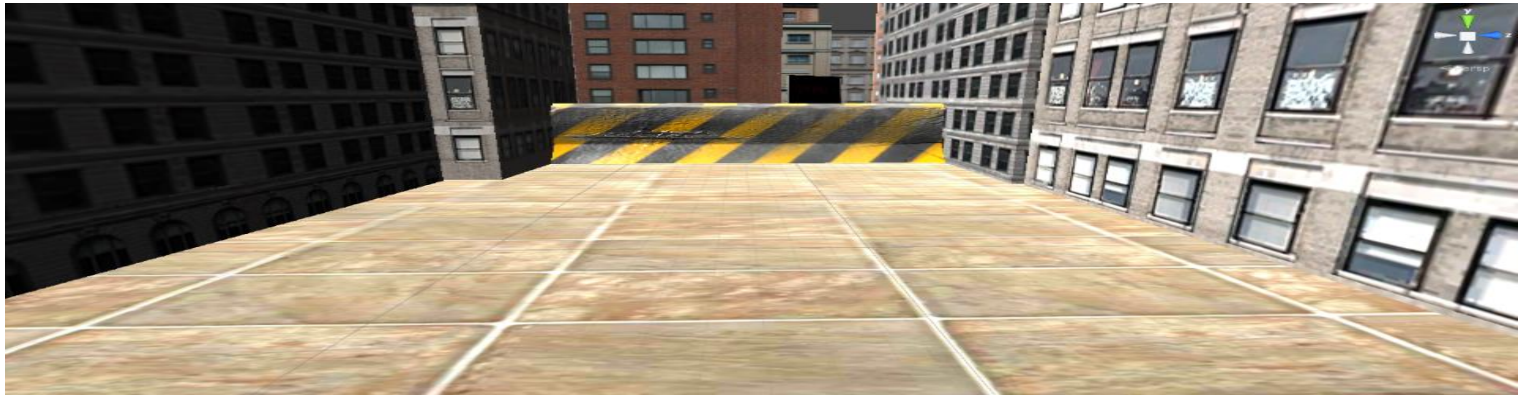
Hypotheses

- We expect that, in accordance with Experiment 1 results, higher navigation flexibility will be demonstrated following Survey relative to Route learning. To examine this possibility, we embedded two detours into the series of 10 navigation trials; the first detour occurred during the first navigation trial (between the City Hall and the Hotel), and the second detour occurred during the eighth navigation trial (between the Police Station and the Record Store).
- We expected higher navigation efficiency in the face of a detour following the Survey relative to the Route perspective, but only during the first detour. The second detour trial occurs following substantial learning opportunity, and thus navigation performance is likely to show no differences as a function of perspective.

Procedure

- All materials and procedures matched those of Experiment 1 with the exception of two detours that automatically appeared during Trials 1 and 8. Recall that Trial 2 began at the City Hall and ended at the Hotel, and Trial 8 began at the Police Station and ended at the Record Store.
- The detour appeared outside of participants' field of view immediately upon arrival at the City Hall (Trial 1) and Police Station (Trial 8), and disappeared immediately upon arrival at the trials' destinations (Hotel and Record Store, respectively).
- The detours were placed along a trial's most efficient route and consisted of a realistic yellow barrier blocking passage.

Detour's



Detour at Trial 2

Detour at Trial 8

Conclusion Experiment 2

- Our second experiment examined the relative effectiveness of Route versus Survey spatial perspectives in providing participants with flexible spatial memories that efficiently guide route planning around unexpected detours.
- We find evidence that viewing the Survey perspective translates to higher navigation efficiency in the face of an early unexpected detour relative to the Route perspective.
- This effect, however, was not found when a detour was placed during Trial 8, demonstrating that extended environmental experience culminates in a flexible model that is no longer bound to the initially learned perspective.al memories.

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