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World-Scale Immersive Spatial Display

SKYMAP

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This immersive spatial display technique presents a **world-scaled and world-aligned map** above the user - evoking a mirror in the sky.

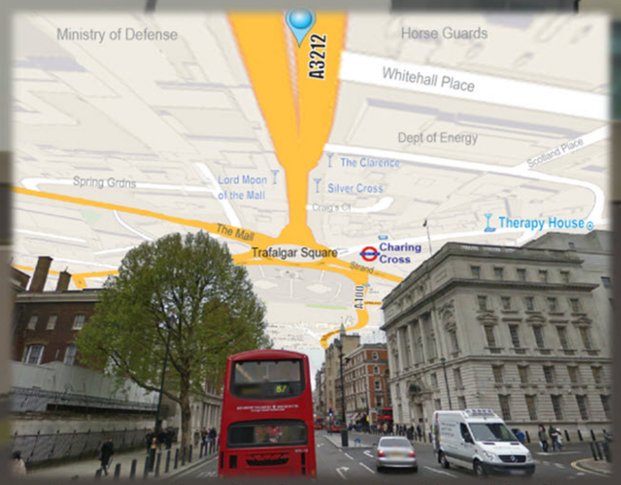
Geospatial features are represented at a similar **scale, distance and orientation as their corresponding real-world features**. To the viewer, map features are situated **above their corresponding real-world locations**.

During navigation, users orient towards an objective's map representation **without need for exo-to-ego-centric cognitive translation**.

Map features can be rendered at real-world distances, **eliminating need for vision accommodation and vergence transitions** when switching attention between the real world and scaled maps.

Mirror in the Sky (MITS) Testbed

Due to AR device limitations, a VR testbed using the Oculus Rift and Unity game engine was developed to simulate an AR SkyMap display. It places the user in a virtual environment below a 3D surface with a texture-mapped image of the environment below.



Concept Sketch of an AR SkyMap Display

Formal Human Factors Evaluations

Evaluations comparing SkyMap to familiar survey maps in various task situations are underway at University of Toronto, or in peer review. Initial results based on our MITS prototype are encouraging. Evaluation task scenarios include;

- **Route suitability evaluation in threat-laden environments**
- **Route following navigation in stress-induced environments**
- **Landmark learning performance**
- **Comparison of SkyMap projection variants**

Key Challenges and Investigations

"You-Are-Here" Marker Placement. Shifting the self-marker forward in the FOV is a key area of investigation. It requires continuous transformation of the mirror map image, and introduces distortions and alignment issues as users move and change head-pose.

Map visibility near tall structures. Nearby structures obscure the sky, however an AR image can be placed in front of structures, behind, or combined to make structures appear transparent.

User adaptability to reflected maps. A mirrored map may affect a user's cognitive map of space. There may also be a cost to switching between survey and mirrored versions of maps.

Complex space of design trade offs. Key factors include;

- Emphasis on distant vs. local ranges
- Preservation and consistency of feature geometry
- Alignment of map features to real world depends on mirror shape, scale, altitude and other parameters. Some variance seems acceptable but alignment at horizon appears necessary to maintain the effect