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1. Research Proposal

It can be observed that current city dashboard platforms are heavily reliant on traditional graph and map-based visualisation tools. While graphical communications have a long-established record of effective data communication, recent technological advances present scientists with new platforms to facilitate the exploration of city data by smart-citizens. This project proposes to investigate how scientists can build extensive and effective city dashboards by exploring emergent virtual environments (VEs) and virtual reality (VR) modalities for data visualisation.

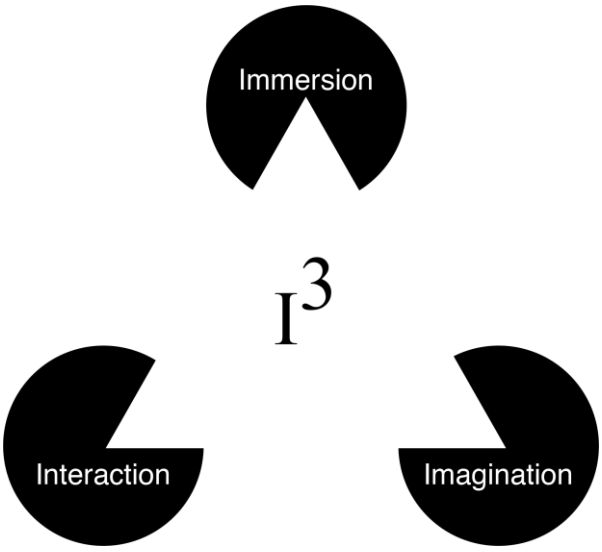

Fig 1: The Virtual Reality Triangle (Burdea and Coiffet 1994).

2. Relevance

We live in a technological epoch that seeks to seamlessly incorporate digital technology into everyday urban life. This includes: social networking, finance, healthcare, entertainment, education, and many other areas of contemporary urban routine. This is particularly relevant to urban-data researchers who are engaged in exploring human-computer relationships in contexts where the user can interact with not only text and imagery, but real-time multimedia also. Commercial technology providers have long explored the application of user-interaction metaphors for immersive VEs (Krueger 1991) (Pimentel and Teixeira 1993) (Burdea and Coiffet 1994). In this context, VR is again gaining popularity over traditional data visualisation methodologies as it can provide users with an immersive environment that integrates multiple communication modalities. These modalities include: stereoscopic displays, ambisonic surround sound, haptic feedback, and in some cases, simulated gustatory and olfactory feedback. By providing real-time sensory stimulation across multiple modalities, multimodal dashboards can potentially immerse a user in a simulated world of data, as opposed to allowing them to view one from the outside in.

3. Theoretical Basis

City models that facilitate exploration in VR lack the accuracy of Building Information Modelling (BIM) and other well-established Computer Aided Design (CAD) platforms. However, when regarding the VR triangle in this context, the effectiveness of a 3D model does not necessarily rely upon the accuracy of the visualisation but on the quality of the attributes attached to its features. This theoretically provides an effective communication platform that imparts important contextual information associated with the images and data displayed to the citizen. Therefore, it is proposed that a 3D city model requires only that the terrain and related spatial objects be provided for users to recognise or imagine a city location. In addition, the natural affordances of VR can be applied to provide citizens with an increased sense of immersion, encouraging further exploration of the data environment presented. Moreover, the amalgamation of 3D-GIS surface modelling and the semantic information of a BIM will facilitate a meaningful data interaction and the realisation of an explorable 3D city dashboard.

4. Methods

Currently, there is much interest in the development of VR content on gaming software. In this space, the Unity game-engine is gaining popularity as it can operate on multiple platforms and supports several different scripting languages; for example, JavaScript, C#, and Python. The use of multiple script types supports the underlying .NET libraries, enabling database access, XML mark-up, and multiple file type networking. These functionalities are integrated within the development environment, allowing researchers from various backgrounds to explore VR applications in their projects. Furthermore, commercial geographic information systems (GIS) that make use of 3D data visualisation are also exploring the potential application of VR.

5. Discussion

A VE is generally accepted as a digital environment in which a user is fully immersed. This synthetic world may mimic the real-world precisely, but more importantly it can also be used to exceed scientific boundaries by creating a sphere in which the accepted physicality of space, time, and other scientific constants can be manipulated. Because of this, multimodal approaches to city dashboard development hold within them the potential to augment the available systems for citizens to engage with urban data. Furthermore, the quantisation of urban life in smart-cities provides the opportunity for smart-citizens to self-interpret the complexities and challenges that governing bodies face when managing urban spaces. Therefore, it is proposed that multimodal systems, such as those that have the potential to be displayed upon VR technologies, can be applied in the creation of new data dashboards. However, multimodal, open, real-time city data dashboard designs are only one approach towards an inclusive and responsive system for smart-citizen engagement. By applying innovative and emergent technologies, the traditional platforms for urban-data visualisation and dissemination can be enhanced with the integration of immersion, interaction, and imagination elements that are innate to VR systems. It is expected that an immersive 3D city dashboard can act as an efficient, multifunctional, integrated city management information system to improve the overall efficiency of urban management by amalgamating city dashboards, GIS, and BIM into a citizen facing, urban-data project.

6. Conclusion and Future Work

Beyond immersive 3D city dashboards, multimodal platforms have the potential to exceed VEs and move into other emergent areas of visual display technology, including mixed reality (MR). MR platforms can be used to merge the real-world with the virtual, bridging the tangible environments of real-life with a computer-mediated digital world. MR technologies include: non-immersive “window-on-the-world” (WoW) displays, fully-immersive head-mounted displays (HMDs), HMDs with transparent displays, and other digitally augmented environments that expand user interactions beyond conventional display systems. If future urban routine will be shaped by means of data production and distribution, the communication of city data and its dissemination by citizens is perhaps one of the most important challenges smart-city developers face. By embracing pervasive technologies and applying them in this space, unified multimodal solutions can be developed. Thus, enabling cities to “*Improve the efficiency, equity and quality of life for its citizens in real-time*” (Batty, et al. 2012).

7. Acknowledgement

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