Navigation in Virtual Reality

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Navigation of 3D Models in VR

Over the past few years there has been an increased in the use of Virtual Reality technology for visualizations of 3D models in industry applications. [2] However, some of these models are too large or complex that **physical navigation in VR has become difficult**.

Our Research

Our research **aims to** :

- Explore different navigation techniques that may be used to navigate through large 3D models in VR by analyzing existing literature.
- Identify and justify the most relevant technique specific to industrial environments
- Implement a basic prototype to demonstrate the navigation technique in VR
- Evaluate overall effectiveness of navigation methods and implementation
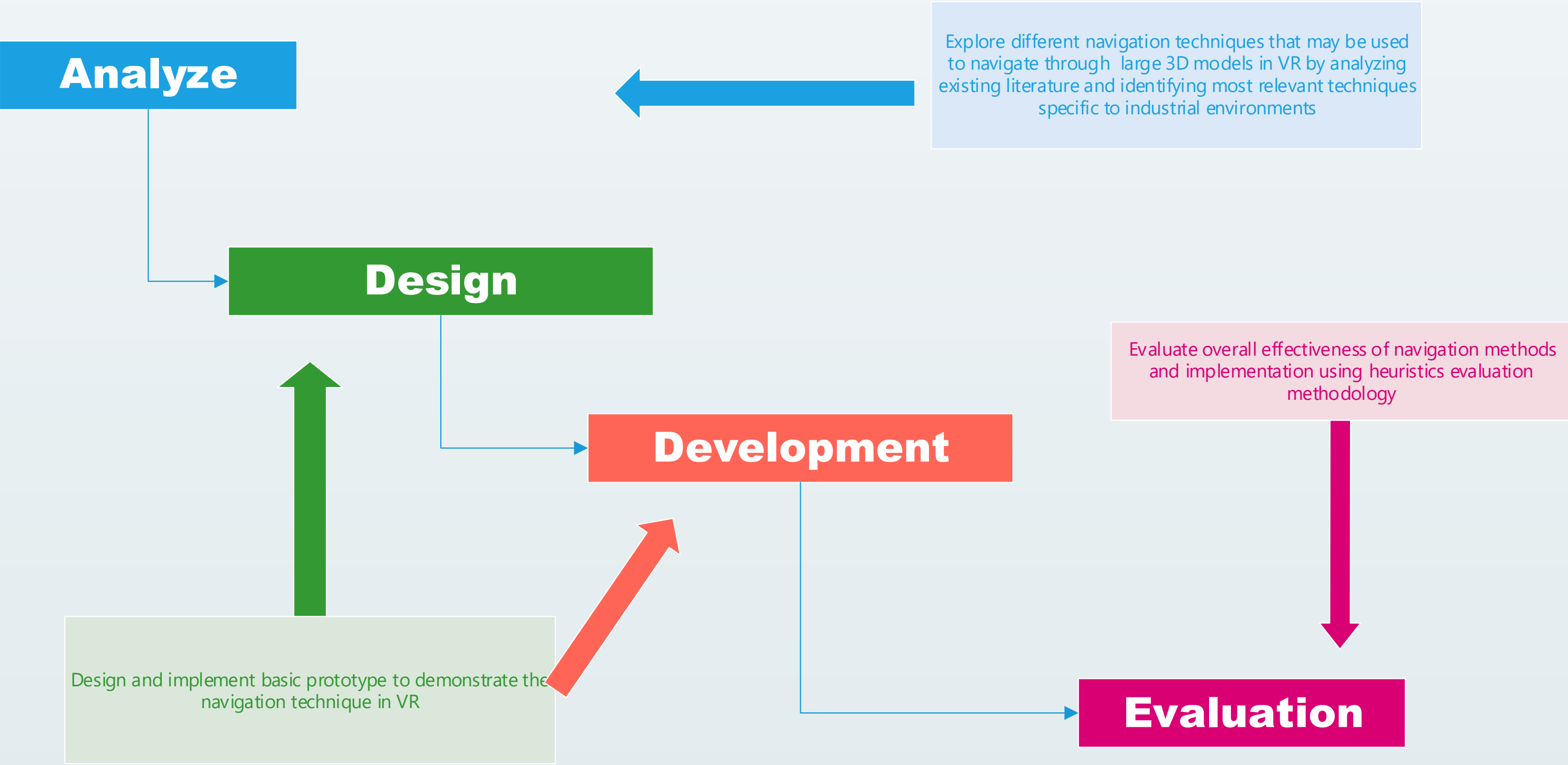
Introduction

Increased popularity in VR in the industrial domain has a range of applications such as production planning or training. Use of VR interfaces can enhance interaction and presentation quality [1] . However, it poses various limitations with navigating in this environment. Existing research only evaluate navigation methods in a broad scope rather than focusing on navigating in industrial settings.

By exploring and implementing three different navigation methods:

Walking in VR

Teleportation by Pointing

Teleportation by Map and Portal

We are able to compare and evaluate the effectiveness of the techniques for navigating in industrial settings.

Methodology

Analyze

Explore different navigation techniques that may be used to navigate through large 3D models in VR by analyzing existing literature and identifying most relevant techniques specific to industrial environments

Design

Development

Design and implement basic prototype to demonstrate the navigation technique in VR

Evaluate overall effectiveness of navigation methods and implementation using heuristics evaluation methodology

Evaluation

Research Question: **'Which navigation methods are more suited to virtual reality environments in industrial settings?'**

Walking in VR

Users physical displacement is tracked and mapped in the VR environment at a 1:1 ratio. This mimics the most natural movements but it is constrained by the physical tracking space available. [3]

Figure 1. Walking in VR using the HTC Vive Pro

Teleportation by Pointing

User emits a raycast (visually represented as a pointer) by pointing the VR controller to the desired destination while holding onto the touchpad. When the touchpad is released, they are then teleported to that location.

Figure 2. Example of teleportation by shooting

Teleportation by Portal and Map

Users can select a destination by opening a map on the VR controller by holding the trigger. A portal can be spawned at destination by pointing the other VR controller at the destination and pressing the trigger. The user can then spawn an entry portal which they enter through by pointing the VR controller at a location and pressing the trigger. This method aims to reduce VR sickness by visually representing the destination before the user is teleported.
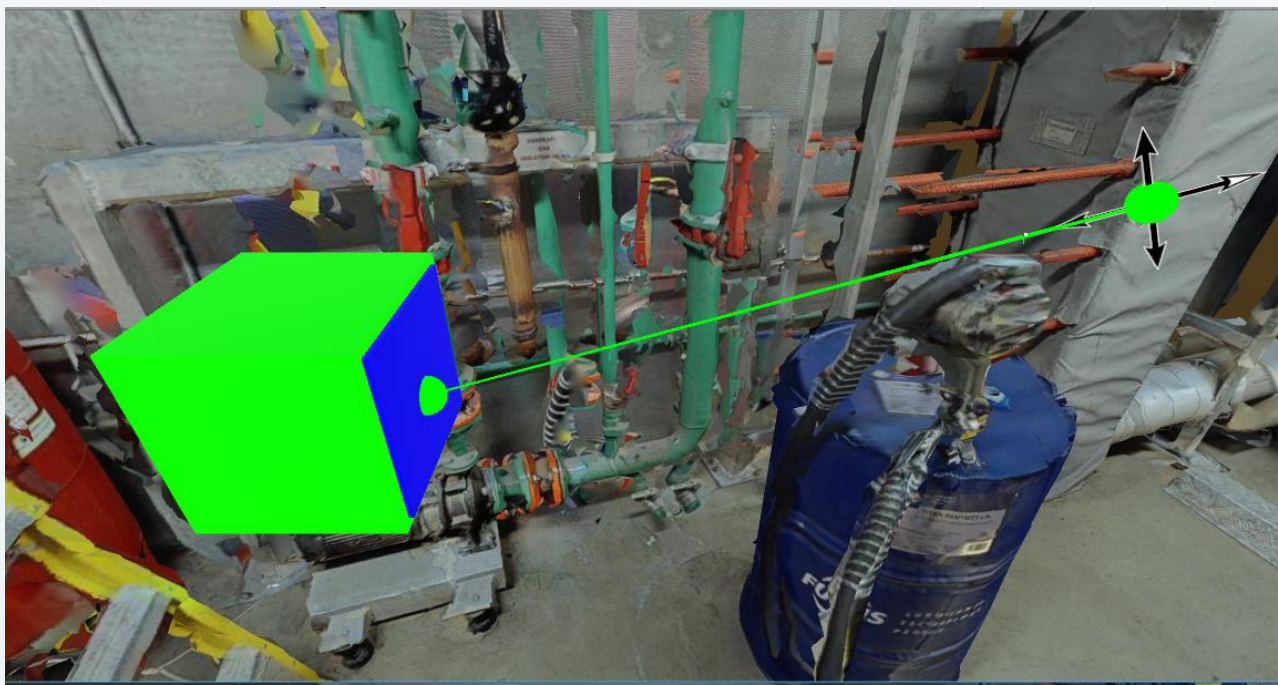

Figure 3. Player chooses their destination by selecting the position (in this mock map prototype)
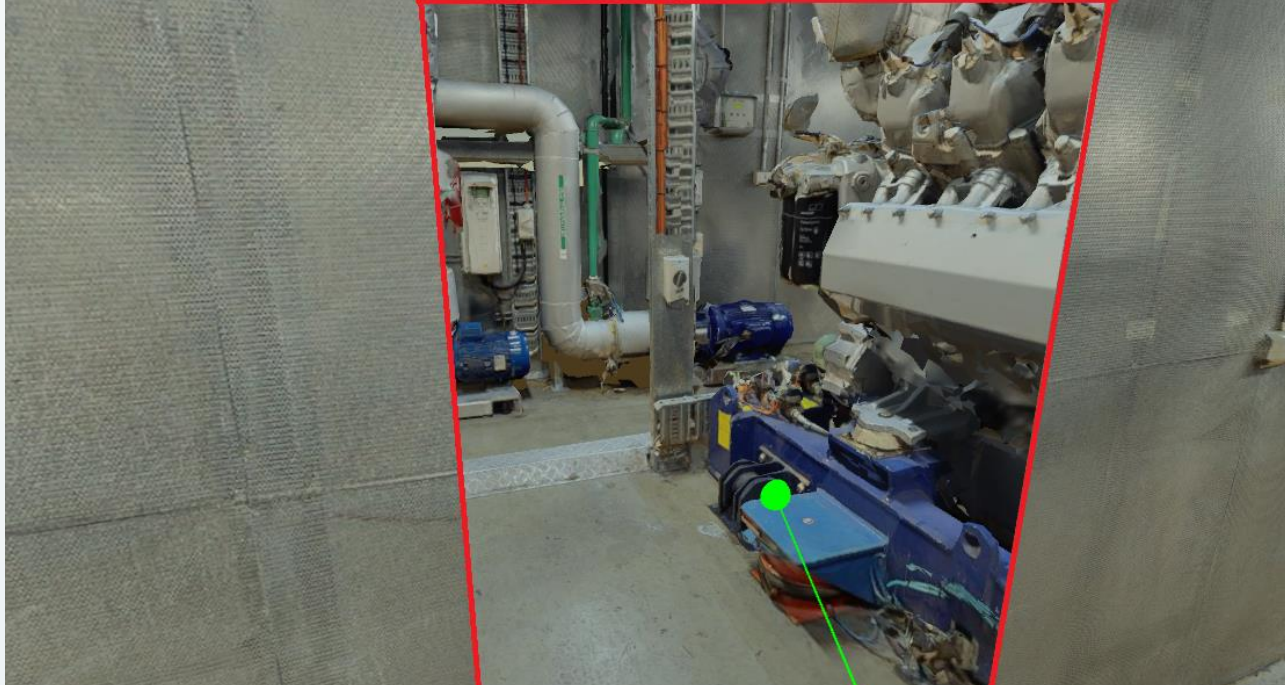

Figure 4. A portal is spawned by the player where they can enter to teleport to destination

Evaluation

A heuristic evaluation based on a modified version of Nielsen's usability heuristics [4] was used to evaluate the usability of the different navigation methods. Three participants were asked to rate 7 different statements relating to usability on a scale 1 to 7 where **1= strongly disagree and 7= strongly agree.**

The heuristics evaluated are:

1. The navigation methods were intuitive
2. Controls for navigation felt natural
3. There was a sense of presence
4. Feedback for navigation methods were intuitive
5. The viewpoint was faithful
6. Navigating is non-disorientating
7. Navigation was quick to execute

Results

Walking in VR has the highest rating of usability in all aspects of the heuristics compared to other methods. Teleport by pointing is rated higher generally for the ease of use heuristics but teleport by portals can give a better sense of presence and is less disorientating for users. It seems that the teleportation methods have lower usability than walking but can overcome physical constraints of it. However, further work needs to be done to improve the teleportation methods and reduce the number of bugs that impacts usability.
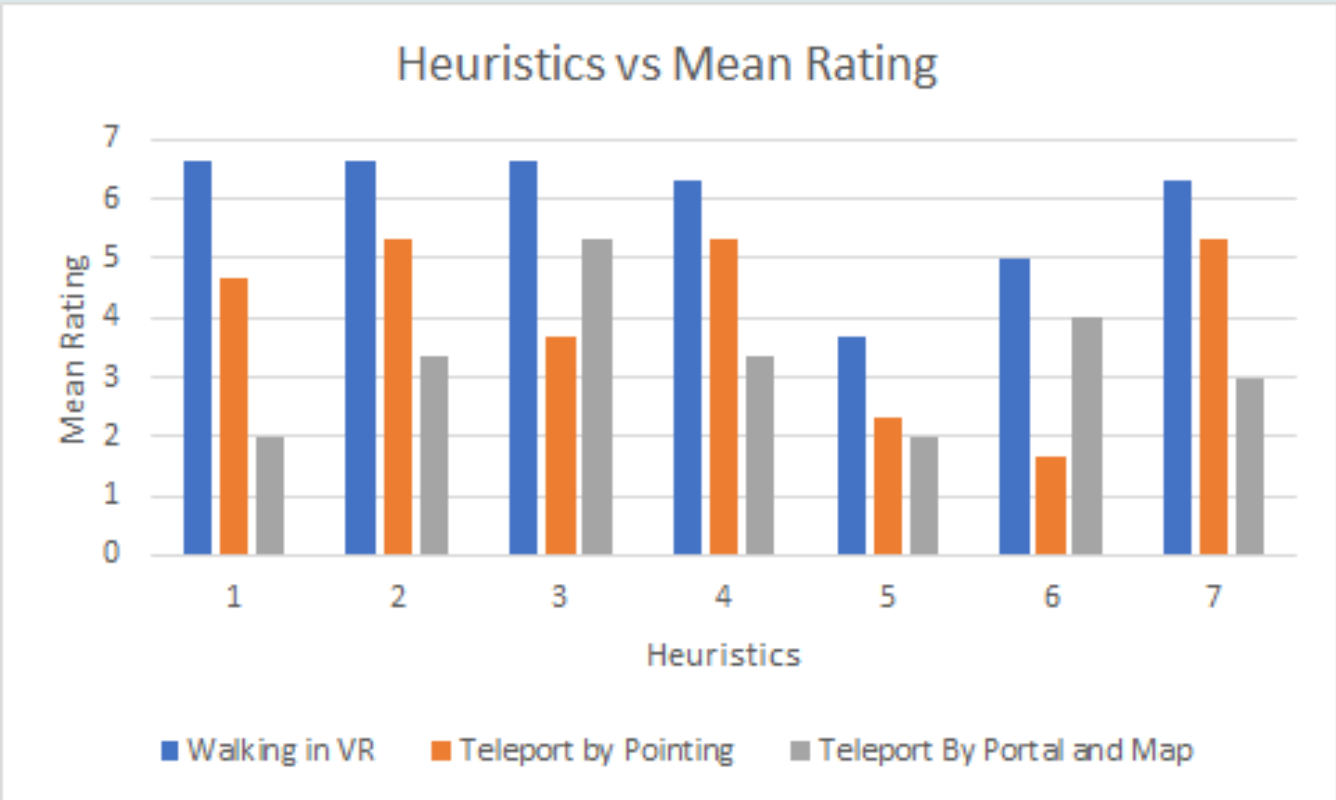

Figure 4. Graph showing results of Heuristics evaluation

Further Research

- Improve prototype to improve navigation methods and reduce the number of bugs that is currently impacting usability
- Incorporate other navigation methods such as redirected walking so that comparison can be done [5]
- Conduct evaluation on larger sample size to obtain more accurate results

Acknowledgements

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[5] 15 Years of Research on Redirected Walking in Immersive Virtual Environments - IEEE Journals & Magazine
Ieeexplore.ieee.org. (2018). 15 Years of Research on Redirected Walking in Immersive Virtual Environments - IEEE Journals & Magazine. [online] Available at: https://ieeexplore.ieee.org/abstract/document/8255772 [Accessed 16 Oct. 2018].

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