Virtual and Augmented Reality: Applications and Issues in a Smart City Context

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Overview

VR and AR Fundamentals

How can VR and AR enable Smart Cities of the future?

Challenges of Human Vision for VR/AR

Other Challenges for VR and AR in Smart Cities

Our Research

Conclusions
VR and AR Fundamentals
Virtual Reality

Artificial content replaces the real world.
Augmented Reality

Artificial content is displayed in the context of the real world.
Mixed Reality

https://www.flickr.com/photos/caseorganic/4336163331

Artificial content is displayed in the context of the real world and is directly affected by the real world and might inform decisions about actions in the real world.
VR/AR Hardware

VR Gear

Tablets and Phones
How can VR and AR Enable Smart Cities of the Future?
Virtual and Augmented Reality: Applications and Issues in a Smart City Context

Tourism/Entertainment

Navigation

Education

Hạ Long Bay (Vietnamese: Vịnh Hạ Long, IPA: [vɪɲh ˈhàɭ long] (listen)) is a UNESCO World Heritage Site and popular travel destination in Quảng Ninh Province, Vietnam.

Data Visualisation and Urban Planning

Security

https://commons.wikimedia.org/wiki/File:Scale_model_of_2020_Shanghai_at_Urban_Planning_Exhibition_Center.jpg
Challenges of Human Vision for VR/AR
The vergence-accommodation conflict is a major cause of visual discomfort and is inherent to most existing 3D/VR/AR systems.

- Careful design of content and device can help, but not fix entirely.
- Motion makes it worse.
- Differences in individuals mean that it can’t be easily fixed for everybody!

Reproducing a Realistic Sense of Depth (I)

Reproducing a Realistic Sense of Depth (II)

Standard 3D systems such as 3D TV, VR headsets and CAVE systems exploit only stereopsis to produce the sense of 3D.

- But this is only a single part of a very complicated system of cues that humans use to create 3D images.
- Except for special cases stereopsis in humans only works up to about 6m.
- Within this range and beyond humans use a number of monocular and binocular cues to infer 3D structure.

Understanding these cues will help us to build better systems that create an accurate feeling of depth given the technological constraints.
Reproducing Complex Materials (I)

Material Appearance

• How do we realistically represent the complex interactions of materials and light in the real world?
• In augmented and mixed reality we need to have objects respond to a real environment.
Reproducing Realistic Materials (II)

The “uncanny valley”. The relationship between the similarity of an object to a human and the sense of familiarity or ease of our response to it.

https://commons.wikimedia.org/wiki/File:Mori_Uncanny_Valley.svg

https://commons.wikimedia.org/wiki/File:Repliee_Q2_face.jpg
Reproducing Realistic Colour

There is a lot about colour in 2D that we still don’t understand well.

These illusions are not clearly understood in 2D and they aren’t present in most 2D models of colour.

Do they happen in 3D too?
Reproducing Realistic Light

Lighting Virtual Environments
• How do we represent the range of lighting conditions in real life?
• How do we transition across environments with different light levels and colour temperatures?
Controlling Attention and Gaze

How does depth, texture, colour and 3D structure work together to attract attention and guide the reaction to content in VR/AR environments?

Salience and visual attention has an important impact on perceptions of quality, storytelling and the sense of immersion.
Other Challenges for VR and AR in Smart Cities
Interaction and Haptic Feedback

• How do we control and interact with VR/AR content?
• Pseudo-haptic illusions
• Avoiding fatigue

https://commons.wikimedia.org/wiki/File:ManusVR_Glove_2016.png

https://www.flickr.com/photos/bagogames/25845851880

https://commons.wikimedia.org/wiki/File:Tom_Cruise_(Not_really).jpg

https://commons.wikimedia.org/wiki/File:Tom_Cruise_(Not_really).jpg
Latency and Environment Complexity

Real life content can be extremely complex.

We need to compress content in ways that exploit perceptual aspects of the human visual system.
Content Creation

Creating artificial realistic 3D content is getting easier, but remains complex and time consuming.

How can we make this easier and more intuitive?
Importing Content

Still very difficult to capture objects with complicated structure, material appearance, or objects that may move during scanning.
## UTS: PILAB: Who are we?

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<th>Role</th>
<th>Research Interests</th>
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### Skills

- **Image and Multimedia Processing**
- **Object Detection and Recognition**
- **Colour Science and Human Vision**
- **Perceptual Quality and Material Appearance**
- **Psychophysics and Subjective Testing**
- **Machine Learning, Scene Understanding and Image Matching**
- **Salience and affective computing**
- **3D scanning, modelling and processing**

### Research Interests

- **Perceptual Quality**
  - Virtual Reality
  - Augmented Reality
  - 2D Image and Video Quality
  - Lightfield Technologies
- **Material Appearance and Perception in 3D**
- **Image Processing**
- **New 3D scanning technologies focused on the capture of material properties and dynamic objects**
- **Multimedia and Quality of Experience**
- **3D Geometry Processing**
- **Biomedical Image Processing**
UTS:PILAB VR/AR Current Research

PhD Project underway on developing technology for 3D scanning and mesh parameterisation of deformable objects

Examination options for projects in the area of VR for education

Modelling and Improvement of Quality of 3D Experience

PhD Project underway on 3D rendering of urban environments

High fidelity scanning of 3D Objects

Advanced Mesh processing

PhD project started on innovative scanning techniques to capture and render material appearance information.

Perceptually Pleasing Compression of 3D Content

Proposal for low-cost scanning solutions for everyday users

PhD Project underway for compression of 3D data for VR applications

Representation in JPEG PLENO point cloud Ad hoc Group

Proposal for low-cost scanning solutions for everyday users

PhD Project underway on data visibility and interaction in VR/AR environments

3D rendering of urban environments

PhD Project underway on developing technology for 3D scanning and mesh parameterisation of deformable objects
Conclusions

Smart Cities of the future should exist for humans, not machines.

VR and AR technologies have a role to merge the real and data worlds in ways that we can only imagine.

However, these technologies must consider the human element to be useful and effective.

If we don’t understand the human element, we will never be able to create a bright future for our children.
Thank you!