Potential Usage of Mixed Reality Devices in the Field of Cartography

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CONTENTS

INTRODUCTION

- Tethered
- Immobile
- Low resolution
- Static

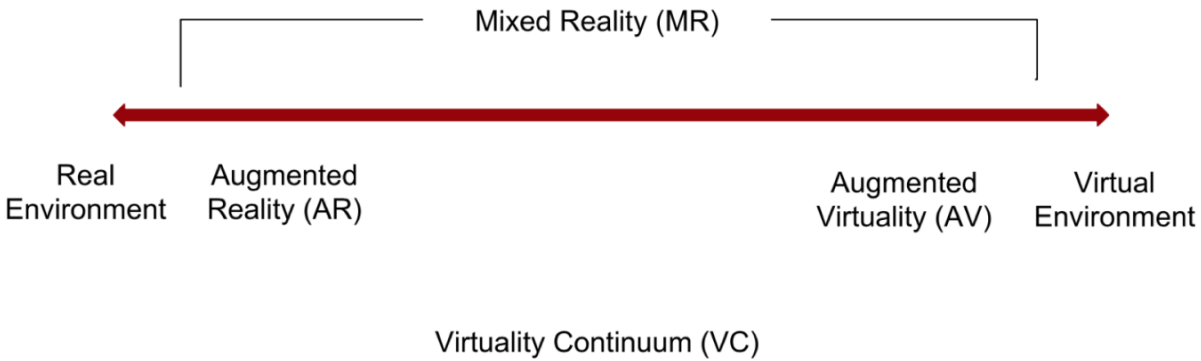
- Untethered
- Mobile
- High Resolution
- Dynamic
- Connected

RESEARCH QUESTIONS

- What are the characteristics of mixed reality devices?
- What are the possible cartographic applications that can be integrated with mixed reality devices?
- What is the probability of realization (i.e. feasibility) of these applications?

THEORETICAL BACKGROUND

Some Definitions



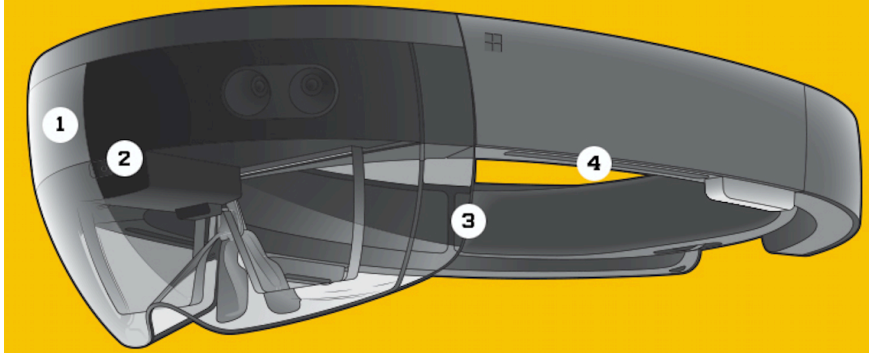
- Virtuality Continuum
- Mixed Reality
- Augmented Reality and Augmented Virtuality

Microsoft HoloLens

- 4 built-in microphones: 2 for ambient noise detection & 2 for recording the users voice
- Scans the room and creates a 3D mesh of polygons
- Uses 3 main methods of input: gaze, gestures & voice

Project HoloLens

Microsoft's augmented-reality goggles merge the physical world with virtual reality. —JASON KEHE



Inside the Headset

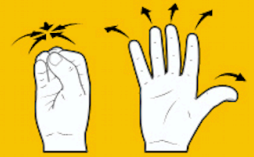
1 CAMERA
The Project HoloLens depth camera has a field of vision that spans 120 by 120 degrees, far more than the original Kinect, while drawing only a fraction of the power.

2 COMPUTER
As many as 18 sensors flood the brain of the device with terabytes of data every second. It handles the onslaught with an onboard CPU, GPU, and first-of-its-kind HPU (holographic processing unit).

3 LENSES
To trick your brain into perceiving holographic images at certain make-believe distances, light particles bounce around millions of times in the so-called light engine. Then the photons enter the two lenses (one for each eye), where they ricochet some more between layers of blue, green, and red glass before finally hitting the back of your eye.

4 VENT
The device is more powerful than a laptop but won't overheat—warm air flows to the sides, where it vents up and out.

Interface



Gestures
Engineers are fine-tuning a feature called "holding" that would allow you to grasp and manipulate holographic objects. Opening your hand would take you back to a home screen.

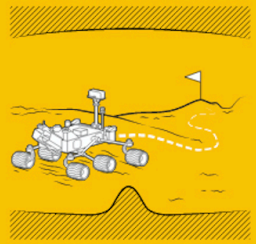
Voice
Microphones in the device capture voice commands.

Gaze
Sensors track where the wearer is looking and adjust the display.

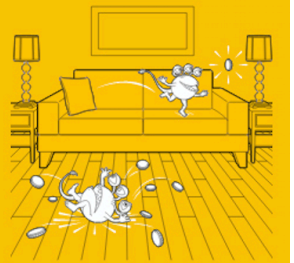
Uses

HOLOGRAMS
The device can project a hologram into a room and keep it locked in position—an essential feature its engineers call "pinning." Instead of the object moving relative to you, you can move around the object and view it from any angle. In the case of this holographic raptor, that means it's easy to stay just beyond its scary reach.

VIRTUAL ENVIRONMENTS
Project HoloLens can simulate a physical space—like the surface of Mars, complete with the Curiosity rover. Once inside the environment, scientists can interact with objects and overlay the space with virtual flags. For example: Placing a flag in the distance could, theoretically, tell the real rover to go there and collect a soil sample.

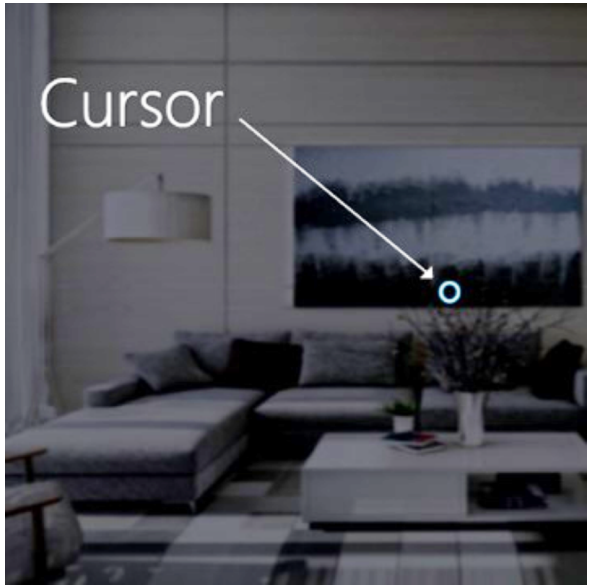


AUGMENTED REALITY
The device scans your environment and builds a digital model in real time. Then, if you're playing a game, a character from the game can frolic as a hologram around your living room. Project HoloLens not only knows the couch is there, it also sees that it's made of leather—and is much cushier than, say, your wood floor.



Gaze

- Center point of user’s perspective
- Uses orientation of the head
- The cursor is depicted as a small circle



Gestures

- Air tap gesture, hand must be within field of vision
- Air tap + Gaze = Gaze-and-commit
- Bloom gesture is used to go ‘back’ or ‘home’

1. Finger in the ready position

2. Press finger down to tap or click

Clicker and Xbox Controller

- Alternative for gestures, free from hand location
- Clicker functions as air tap
- Controller is used for more complicated applications

Voice control

- Used as an alternative to gestures
- Used to dictate words into the screen keyboard
- Used with Microsoft assistant Cortana to fulfill certain tasks (Start recording, take a picture etc.)
- Only supports English as of 2018

Spatial sound

- Very useful when objects are out of view
- Creates a 3D sound space so users can sense the location of objects by sound
- Uses a “Head Related Transfer Function”, in which, the way sound reaches the human ears is analyzed and simulated realistically.

Inside-Out Tracking

- Sensors are fixed onto the device, as opposed to outside-in tracking
- Fulfilled by two visible light low resolution cameras
- Advantageous since it does not limit the space of the user
- “World-scale experience”, highest level of mixed reality experience according to Microsoft

Holographic Remoting

- A way of overcoming constraints in CPU, memory and storage
- Applications are executed on a main computer
- Connection is achieved by Wi-Fi between the headset and computer
- Allows a wider range of applications to work
- Problems such as freezing, crashing or connection issues

METHODOLOGY

Minimum & Fundamental Criteria

Minimum

Does the application have a cartographic focus?

Does the application use methods of mixed reality?

Fundamental

Does the application have a working example that is shown to work on HoloLens?

Is there data available regarding our technical criteria?

Technical Criteria

- Internet connection speed
- Storage space
- Frame rate
- Battery life
- File formats
- File size limits

Human Criteria

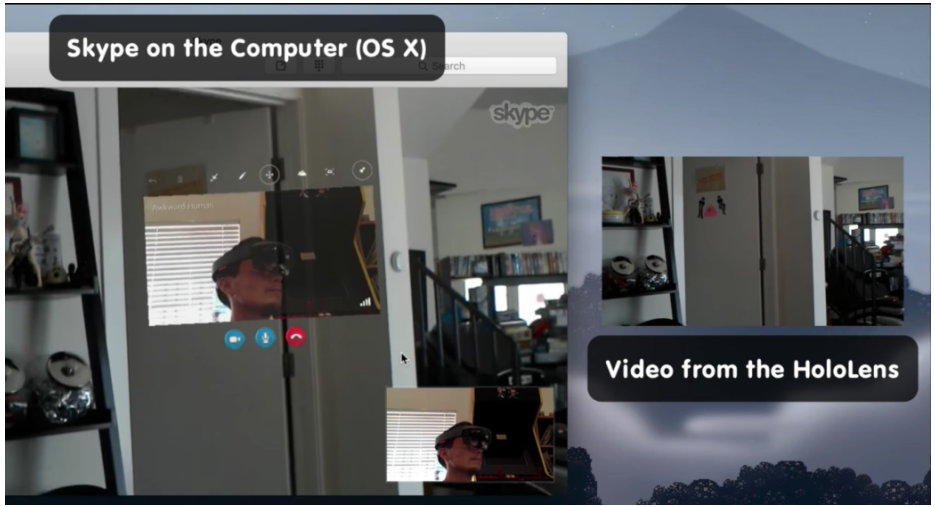
- Maximum duration of comfortable usage (MDCU)
- Maximum duration of possible usage (MDPU)
- Motion sickness
- Quality of user experience

POTENTIAL FIELDS OF USAGE

SKYPE FOR HOLOLENS

Features

- Allows connection between two HoloLens users or between a HoloLens user and traditional Skype user
- Sends the live feed of surroundings to the other user



Features

- Hand tracking - hand movements of one user is tracked and copied to the other user’s virtual space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Wed
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76°F

Technical Evaluation

	Minimum	Optimal	Real average value	Feasibility
Internet connection speed	0.7 kbps	2.1	41.18 / 8.43 Mbps	High
Storage space	60 GB (maximum)	Up to 12 GB	223.84 MB	High
Frame rate	30	60	Up to 60	High
Battery life	1 hours	2 hours	2-3 hours	High
File formats	.jpeg, .jpg, .png	.tiff, .shp, .slddrw	.jpeg, .jpg, .tif, .tiff, .dib, .bmp	Medium
File size limit	100 MB	2 GB	300 MB	Medium

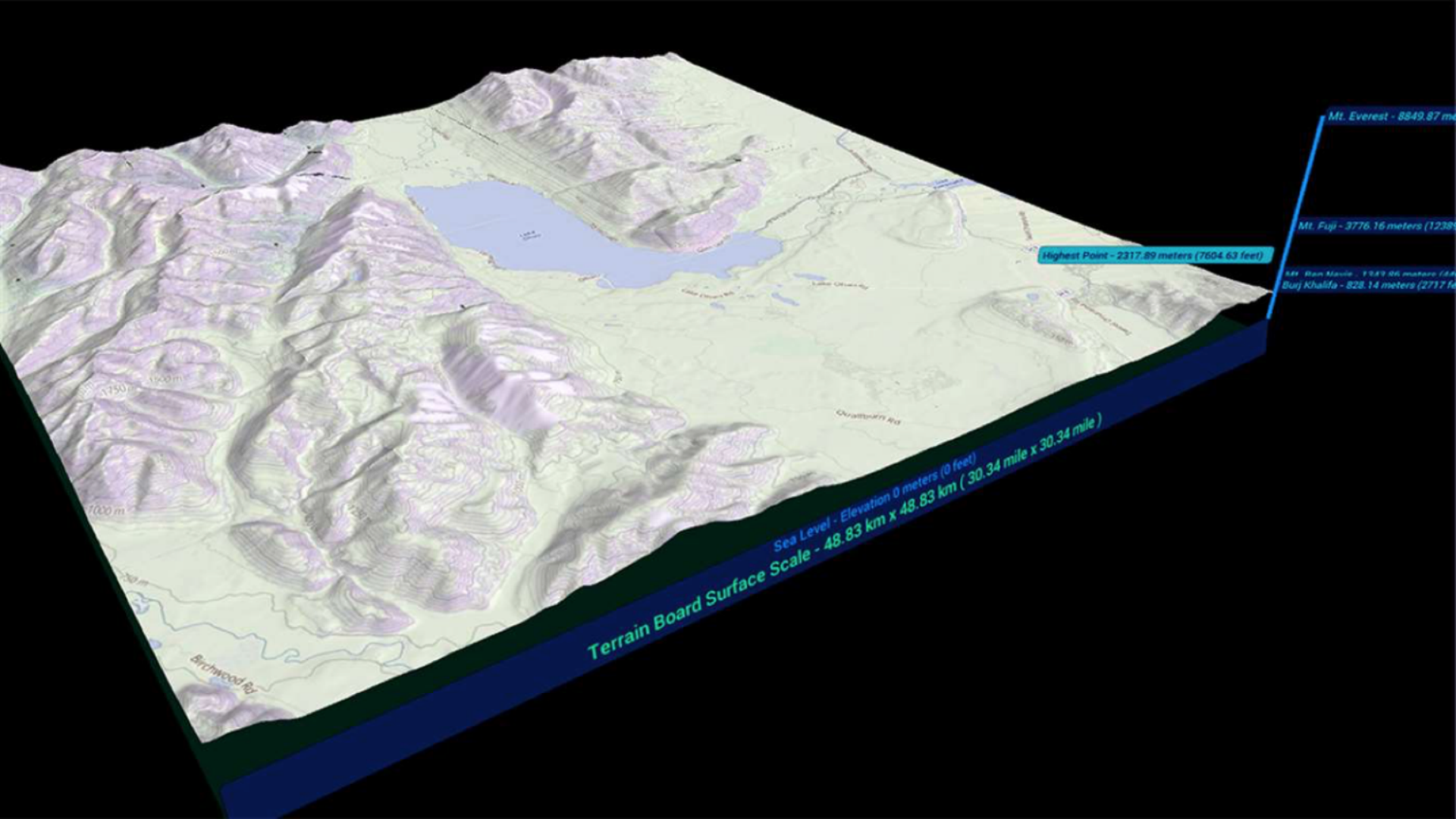
Human Evaluation

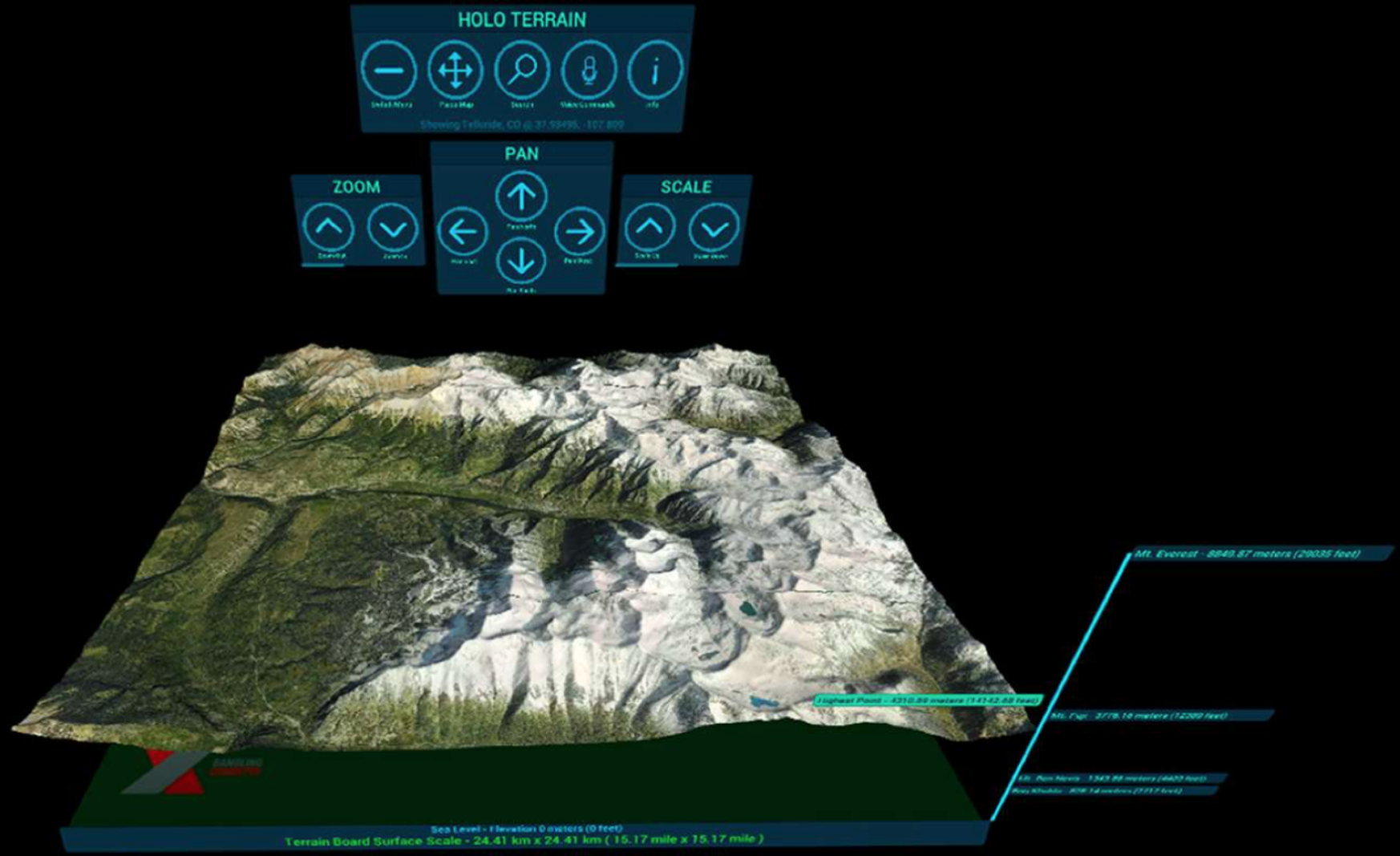
	Acceptable value	Surveyed Value	Feasibility
Maximum duration of comfortable usage (MDCU)	7/11	7/11	Medium
Maximum duration of possible usage (MDPU)	7/11	8/11	High
Motion sickness	<3/10	1.8/10	High
Quality of user experience	7.5/10	6.7/10	Medium

3D HOLOGRAPHIC MAP VIEWING (HOLO TERRAIN)

Features

- Users can see a holographic 3D relief map
- 4 zoom levels are available (from 3.8 sq miles to 40 sq miles)
- Panning function - navigating through the map
- Scaling - size can be changed
- Search functionality
- Shared holographic session with up to 4 devices


Mt. Everest - 8849.87 me
Mt. Fuji - 3776.16 meters (1238
Highest Point - 2317.89 meters (7604.63 feet)
Burj Khalifa - 828.14 meters (2717 fe
Sea Level - Elevation 0 meters (0 feet)
Terrain Board Surface Scale - 48.83 km x 48.83 km (30.34 mile x 30.34 mile)
Birchwood Rd


HOLO TERRAIN
PAN
ZOOM
SCALE
Mt. Everest - 8849.87 meters (29035 feet)
Sea Level - Elevation 0 meters (0 feet)
Terrain Board Surface Scale - 24.41 km x 24.41 km (15.17 mile x 15.17 mile)

Technical Evaluation

	Minimum	Optimal	Real average value	Feasibility
Internet connection speed	700 kbps	2.1 Mbps	41.18 / 8.43 Mbps	High
Storage space	60 GB (maximum)	Up to 12 GB	16.6 MB	High
Frame rate	30	60	Up to 60	High
Battery life	2 hours	5 hours	2-3 hours	Medium
File formats	.obj	.3ds, .blen, .fbx, obj	.fbx, .obj	High
File size limit (MB)	-----	-----	N/A	High

Human Evaluation

	Acceptable value	Surveyed Value	Feasibility
Maximum duration of comfortable usage (MDCU)	7/11	7/11	Medium
Maximum duration of possible usage (MDPU)	7/11	7/11	Medium
Motion sickness	<3/10	2.27/10	High
Quality of user experience	7.5/10	7.8/10	High

HOLOTOUR

Features

- Users can explore sites such as Machu Picchu and Ancient Rome
- 360 degrees of field of vision
- Consists of pictures formed by 360 degree cameras
- Uses augmented reality features


Agrippa was here
M·AGRIPPA·L·F·COS·TERTIVM·FECIT
"MARCUS AGRIPPA, SON OF LUCIUS MADE THIS
BUILDING WHEN CONSUL FOR THE THIRD TIME"

Features

- The method presented in this application can also be used for navigation.
- Augmented features can be used on images of real world.

Technical Evaluation

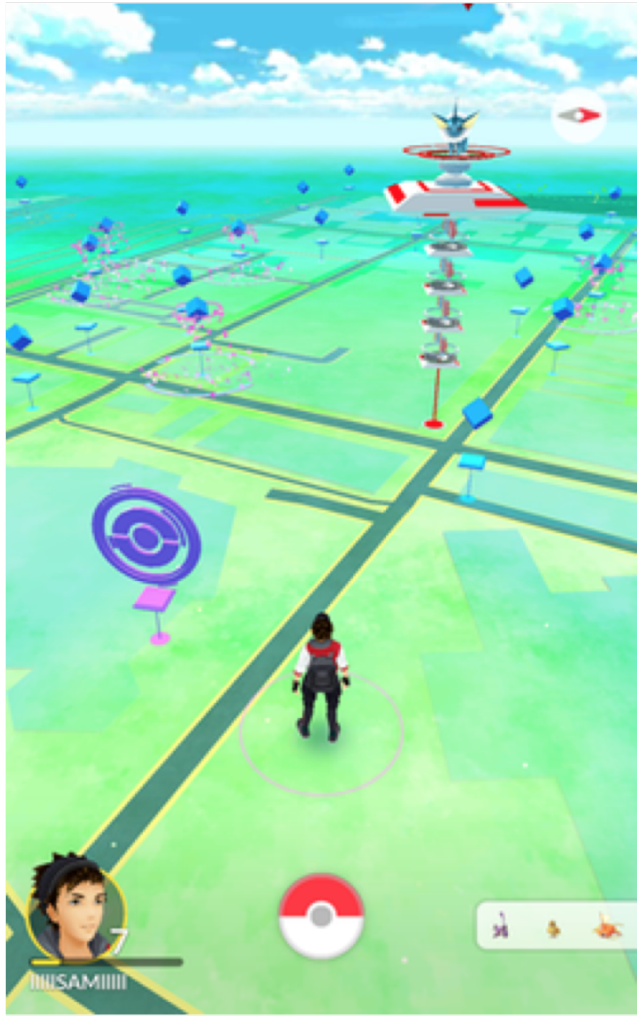
	Minimum	Optimal	Real average value	Feasibility
Internet connection speed (Mbps)	Not required	Not required	41.18 / 8.43 Mbps	High
Storage space (GB)	60 GB (maximum)	Up to 12 GB	5.52GB	High
Frame rate (fps)	30	60	Up to 60	High
Battery life (hrs)	1 hours	2 hours	30-60 minutes	High
File formats	.jpeg, .jpg, .png	----	.jpeg, .jpg, .png	High
File size limit (MB)	No limit	-----	Various	High

Human Evaluation

	Acceptable value	Surveyed Value	Feasibility
Maximum duration of comfortable usage (MDCU)	7/11	7/11	Medium
Maximum duration of possible usage (MDPU)	7/11	4/11	Low
Motion sickness	<3/10	5/10	Medium
Quality of user experience	7.5/10	6.09/10	Medium

Further Applications

- Pokémon GO style augmented reality game
- Integration with Google Street View
- Usage with UAVs/Drones



Pokémon GO style augmented reality game

- Uses mobile phone map application
- Augmented reality
- Tracks user location

Integration with Google Street View

- Gaze and head tracking is used
- 360 degree immersion

Usage with UAVs/Drones

- Useful for hard to reach places
- Aerial images
- Wildfires
- Disaster response


SR 131
131
131
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Railway St
Bridge St

Future Work

- More application can be tested
- Potential of other mixed reality devices can be investigated
- Number of criteria can be extended for both technical and human
- More comprehensive surveys can be conducted
- Long term feasibility can be assessed

CONCLUSION

Conclusion

- All 3 applications obtained an acceptable score from the majority of our criteria.
- Certain limitations exist in many current mixed reality applications
- There are further examples that may develop into real world products rather than ideas.
- Future work can be built upon the ideas presented in this thesis.