MARKER-LESS MOBILE AUGMENTED REALITY APPLICATION
FOR MASSIVE 3D POINT CLOUDS AND SEMANTICS

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INTRODUCTION
DEVELOPED METHODOLOGY
AR IMPLEMENTATION
RESULTS AND DISCUSSION
FUTURE WORK
CONTEXT

Emergence of dedicated AR devices (Video See-Through, Optical See-Through)

Powerful Software Development Kit (e.g. ARCore for android and ARKit for iOS)

New sensors integration (e.g. LIDAR for iPad Pro)

More advances in computer vision (e.g. Occlusion, Scene Understanding)

Video See-Through

Optical See-Through

Apple iPad Pro Lidar Scanner (2020)
<https://www.apple.com/befr/ipad-pro/>

Advanced Scene Understanding in AR
<https://developer.apple.com/documentation/arikit/world_tracking/visualizing_and_interacting_with_a_reconstructed_scene>

ARKit 4 By Apple (2020)

ARCore By Google
<https://arvr.google.com/arcore/>

Optical combiner (Semi-transparent)

Virtual world

Real world

Virtual world

Screen (opaque)

(e.g. Your Smartphone, Gear VR)

(e.g. Hololens, Meta 2, Magic Leap)

Camera

Real world
GOALS

To open on new AR applications and investigates new ways to better integrate massive 3D datasets and semantics through web-based mobile AR.

→ Investigate challenges linked to point cloud data structure and semantic injection?
→ Cross platform AR solution?

High-level 3D models
(point clouds & semantics)

AR
METHOD

1. Point cloud processing
   - Segmentation
   - Classification
   - Structuration

2. Immersive AR session creation and 3D tracking
   - Compatibility checking
   - Pose estimation
   - 3D Sensing
   - 3D Raycasting
   - Plane Detection

3. visualisation and interaction
   - Point cloud Anchoring
   - Point cloud Data streaming
   - Field of view calculation

Figure 1. A general workflow of the followed methodology
Method

Segmentation was done semi-automatically on CloudCompare, assisted by the following automatic plugins:

- RANSAC Shape Detection (Schnabel et al., 2007),
- CSF based on the cloth simulation filter developed by (Zhang et al., 2016),
- Histogram filtering,
- Label Connected Components,
- and CANUPO.

Figure 2. Classification results: a piece with different objects.

Figure 3. Potree’s octree structure explained in 2D (Potree, 2020)
AR Implementation

1. Sensors-based
Based on the mobile device sensors
- Such as GPS, gyroscopes, magnetometers, compasses, accelerometers, and so on.
- Works in an open-loop way, which will result in an unavoidable cumulative error, since the tracking error cannot be evaluated and corrected in real time.

2. Vision-based
Based on the camera
- The camera on the device captures the surrounding environment.
- It further provides the basis for vision-based object recognition, feature detection, and tracking.
- Uses feature correspondences to estimate pose information to align the virtual content with real-world objects and is analogous to a closed-loop system.
- Heavy computational pressure on mobile devices

3. Hybrid
Based on sensors and camera
- This is a compromised solution. It overcomes the weaknesses and limitations of the individual methods

Figure 4. Mobile Augmented reality simplified process
Figure 5. Mobile Augmented reality implementation mechanisms
AR Implementation

Three.js is a cross browser JavaScript library used to create and display animated 3D computer graphics in a web browser.

WebXR is the successor to webVR.

- Hybrid tracking mechanism
- Inside-out tracking
- Marker less method
- Computation outsourcing approach

Prototype
Device: Samsung Galaxy A7(2018)
**Results and discussions**

(a) Creation of augmented reality session

(b) Hit-test to choose the anchor point

(c) Point cloud displayed in real color

(d) Point cloud displayed in classes color
Results and discussions

The results gives research directions concerning the dependence and delay related to the quality of the network connection, and the battery consumption since device sensors are used all the time.

<table>
<thead>
<tr>
<th>Mobile</th>
<th>Exploitation system</th>
<th>Navigator version</th>
<th>RAM</th>
<th>Battery Capacity</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Android 9</td>
<td>Chrome/Mozilla</td>
<td>4Go</td>
<td>3300mAh</td>
</tr>
</tbody>
</table>

Table 1. Technical characteristic of the device used

Challenges:

- Computational efficiency of browsers
- Networking
- Energy efficiency
Future works

- User Interface for querying and interaction (UI)
- 5G connectivity (mainly depends on 5G coverage)
- Annotation and real-world alignment tools
- Support more spatial format (BIM, CAD, LiDAR, photogrammetry and GIS)
- Measurement tools
THANK YOU FOR YOUR ATTENTION
References


References


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