OpenStreetMap and Geo Augmented Reality

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Augmented reality (AR) is a live view of a real-world environment whose elements are “augmented” by computer-generated or extracted from real-world input such as sound, video, graphics.”
Augmented Reality Supports

Head Mounted Devices
Magic Leap One, ©Magic Leap

Smartphones/Tablets
iPad Pro, ©Apple
Geo Augmented Reality Approach
Geo AR Process Overview

Geo AR Framework

Geo Data Providers
- OSM, Wikimedia...

Authoring Tool

Geo Data

AR Format

Positioning Algorithms

Estimated Position

Features and POIs

Estimated Orientation

AR Viewer (Rendering)

Geo AR Browser
Geo AR Process Overview
Approaches

Outdoor:
- GNSS (GPS, GLONASS...) - Absolute
- Fingerprinting via Wifi (Google) - Absolute

Indoor:
- Trilateration - Indirect Absolute
- Fingerprinting - Indirect Absolute
- Step and Heading System (SHS) - Relative
- SHS + Map-Matching - Relative
- Vision based (SLAM) - Relative
Geo AR Process Overview

1. Geo Data Providers (e.g., OSM, Wikimedia)
2. Authoring Tool
3. Geo Data
4. AR Format
5. Positioning Algorithms
6. Estimated Position
7. Attitude Filters
8. Estimated Orientation
9. Features and POIs
10. AR Viewer (Rendering)
11. Geo AR Framework
12. Geo AR Browser
Attitude

Attitude is the orientation of an Object with respect to the Earth local frame. It is mainly expressed by a rotation matrix, a quaternion or Euler angles.

Many estimation algorithms/filters exist:

- **For different application domains:** aerospace, UAV, handheld, foot-mounted, robotics . . .

- **Using different approaches:**

  Inertial Measurement Unit fusion (accelerometer, gyroscope, magnetometer)

  or Computer Vision

© Zhou Pengfei, Youtube

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Geo AR Process Overview
How Virtual Scene works

Virtual Scene

Grand Palais

Seine

Invalides

Camera livestream
How is our Virtual Scene works

- A scene renderer (OpenGL, ThreeJS, SceneKit, Sceneform...) is used to represent virtual features like the reality (1 unit distance = 1 meter)

- Features and camera are placed using Earth-Centered, Earth-Fixed frame

![ECEF frame used for rendering](image1)

![ECEF (in green), OpenGL Camera (in red) and a 3D Model (in blue)](image2)
Geo AR Process Overview
OSM for Geo AR

Four examples of how OSM can be used for AR

→ Points of Interest (data)
→ Authoring (via JOSM)
→ Occlusions (data)
→ Itineraries (via OSRM)
Points of Interest

Points of Interest (PoI) with a given <lat, lng [,alt]> can be directly retrieve from the OSM database (eg. using overpass-turbo)
Authoring with JOSM

Venturi - European project (FP7):
A tour experience in Grenoble, France

Josm is used to:
- Retrieve useful information already mapped by the community (roads and POIs)
- Add extra geographic information (geofences, audio and app specific data)
Occlusions

Occlusion means that there is something you want to see, but can't due to some properties of your scene, or some event.

For indoor AR, thanks to wall positions, we are able to hide objects without image processing.

Same approach could be used for outdoor using buildings walls.
Itineraries using OSRM

AR Navigation became useful if an itinerary can be generated on the fly. This can be done using OSRM.

Here, chevrons are used to guide user along the route. In a future work, step by step instructions will be embedded in the AR scene.

Wemap Outdoor AR Nav
OSM for the Research

Four examples of how OSM can be used in the research field:

→ Visualisation (indoor maps)
→ Map-Matching (data)
→ Radio signal propagation with wall data
→ Pose Estimation in Urban Environments
Help for research on indoor localisation

Scoring formula of a dataset for a given technique:

$$\text{error} = \frac{1}{n} \sum_{t}^{n} \overbrace{P_{est}(t) - P_{ref}(t)}^{\text{euclidean distance}}$$

- $n$ is the number of reference points
- $t$ is the timestamp of a reference point
Map-Matching for Geolocation

Some geolocation techniques (mostly indoor) can be improved using map information.

Two well-known techniques:

- Particle filter
- Point-to-curve
Radio signal propagation using wall data

Walls impact the radio propagation in a building. A precise map with wall annotations from OSM can be used to generate radio signal propagation model.

Wall attenuation relative to material used

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Thanks !