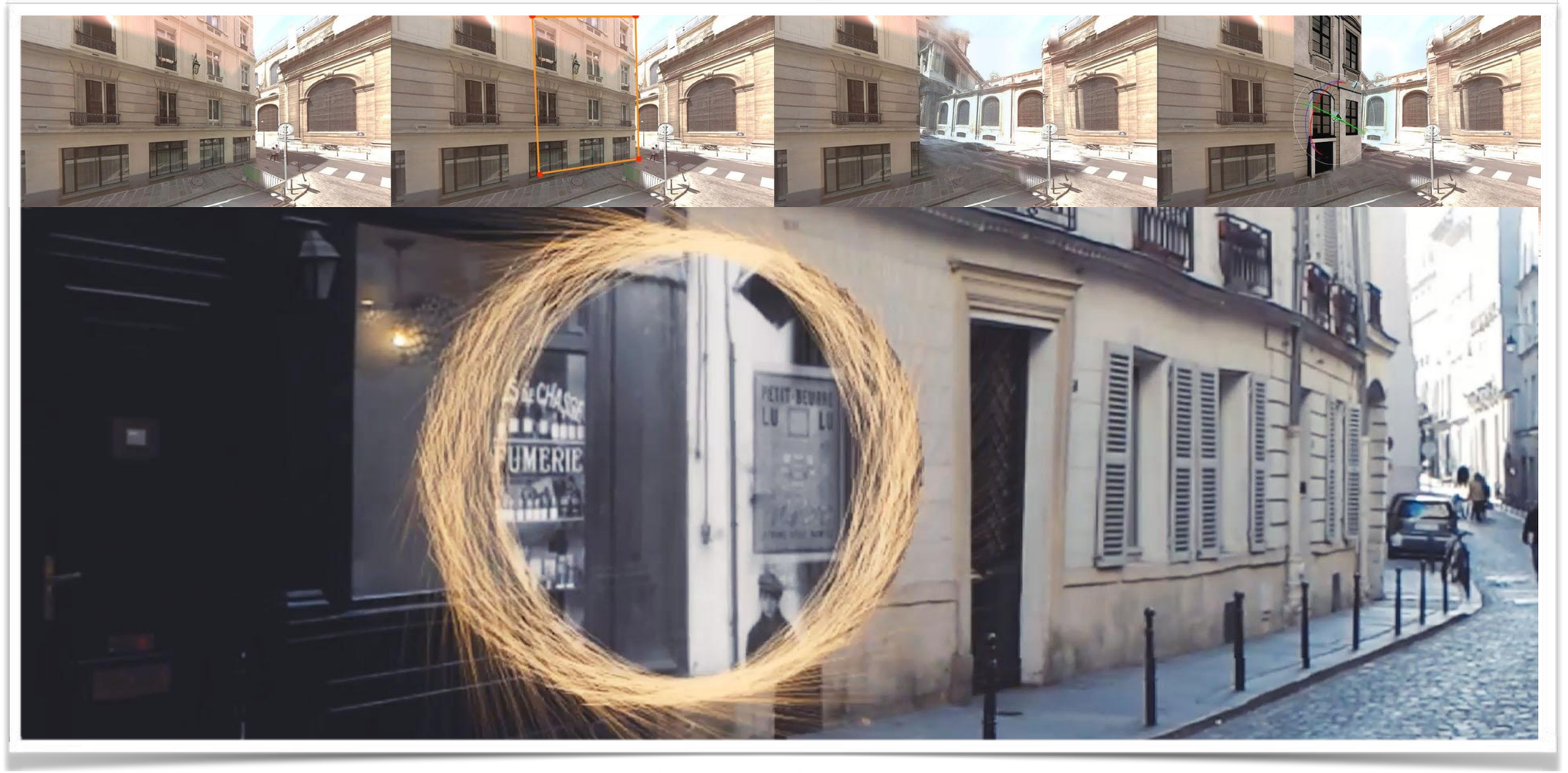
http://tiny.cc/3elkhz

3D Maps - today and tomorrow
From desktop to outdoor mixed reality



Alexandre Devaux

IGN-France Geographic Information Sciences Lab. (LASTIG), GEOVIS Team

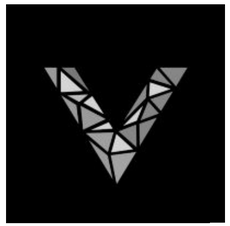
Plan

- Introduction, short State of the Art in web 3D applications
- Mixed Reality
- Geovisualisation challenges
- Experimentations:
  - See through the ground
  - Urban design
  - Time travel
- Conclusion / Future work

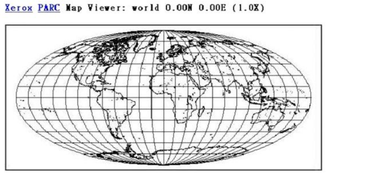
Introduction/ State of the art

- **What are the main 3D Web maps libraries today?**

Google maps
Kepler gl, Deck gl, ... -> vis gl
Mapbox
Cesium
iTowns
...



- What are the main 3D Web maps libraries today?



Xerox PARC Map Viewer 1993

Google maps

2005

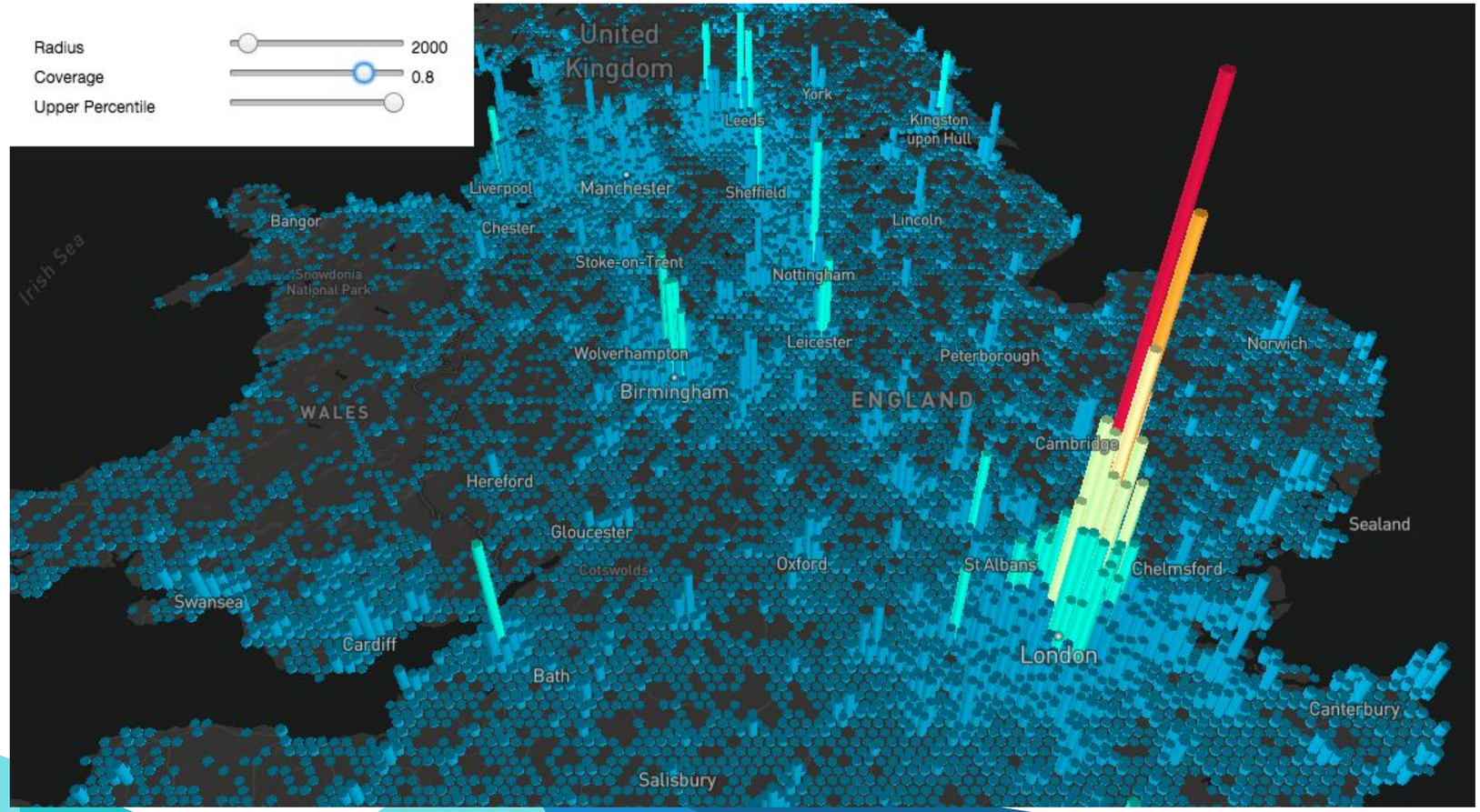
today

- **What are the main 3D Web maps libraries today?**

Kepler gl

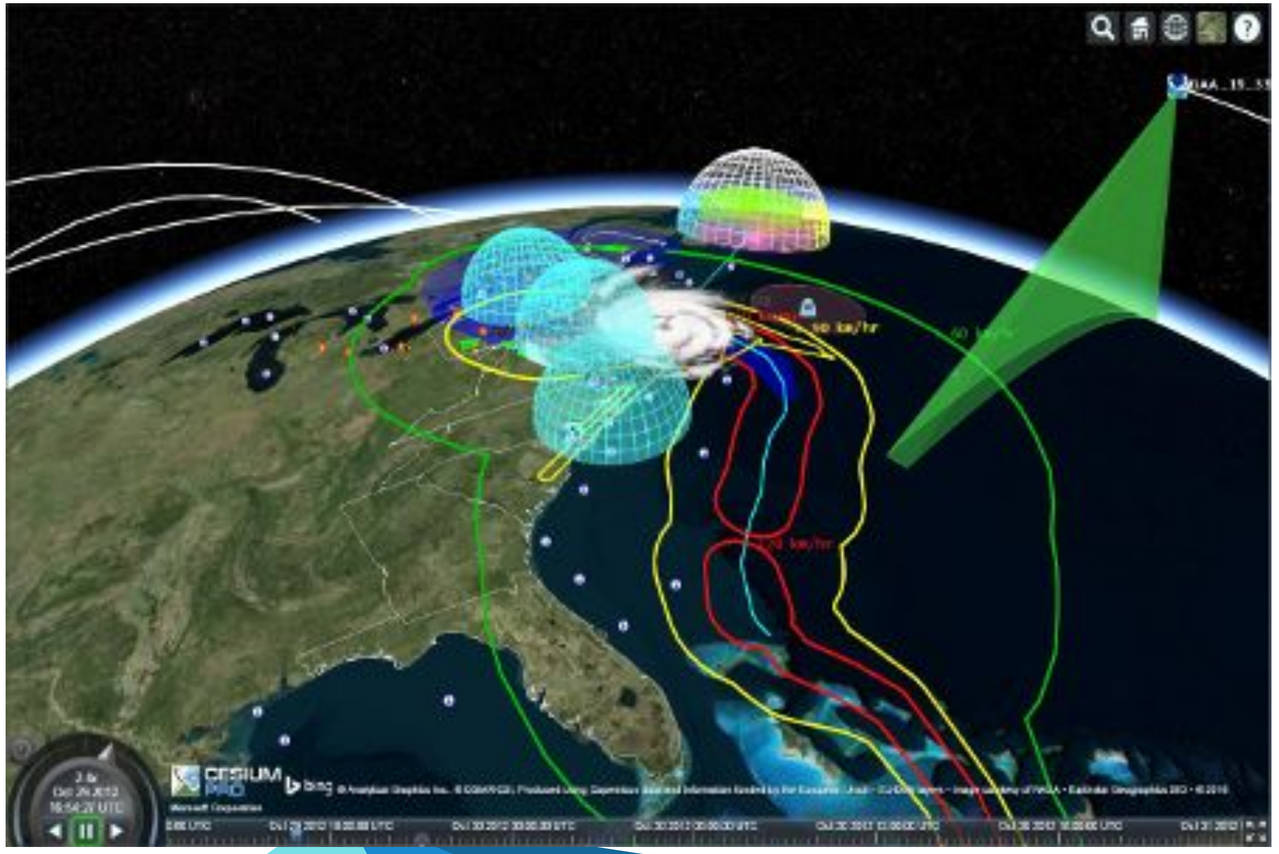
- **What are the main 3D Web maps libraries today?**

Mapbox



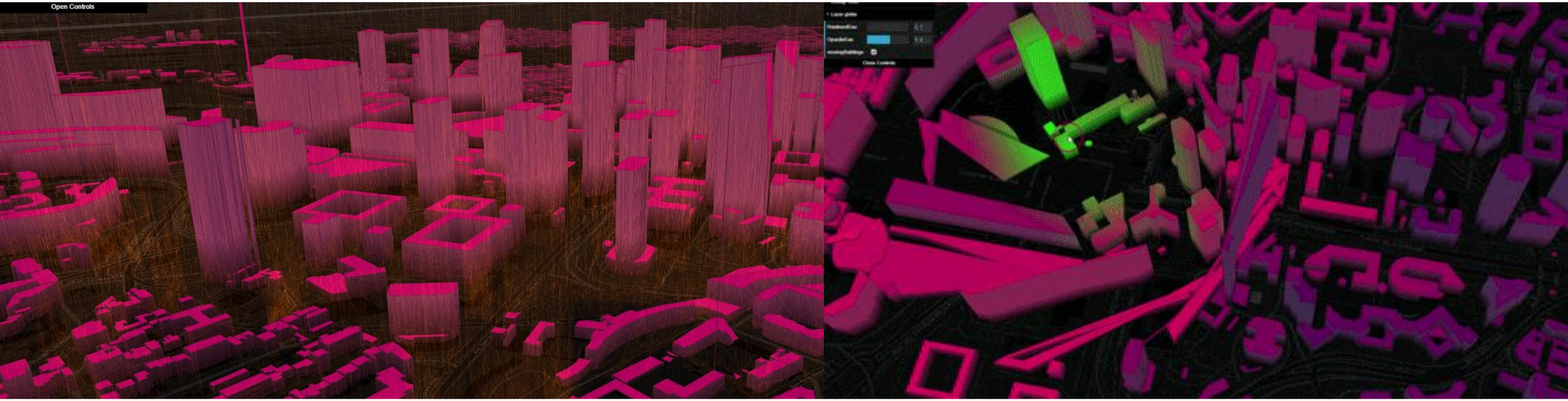
- **What are the main 3D Web maps libraries today?**

Cesiumjs



- **What are the main 3D Web maps libraries today?**

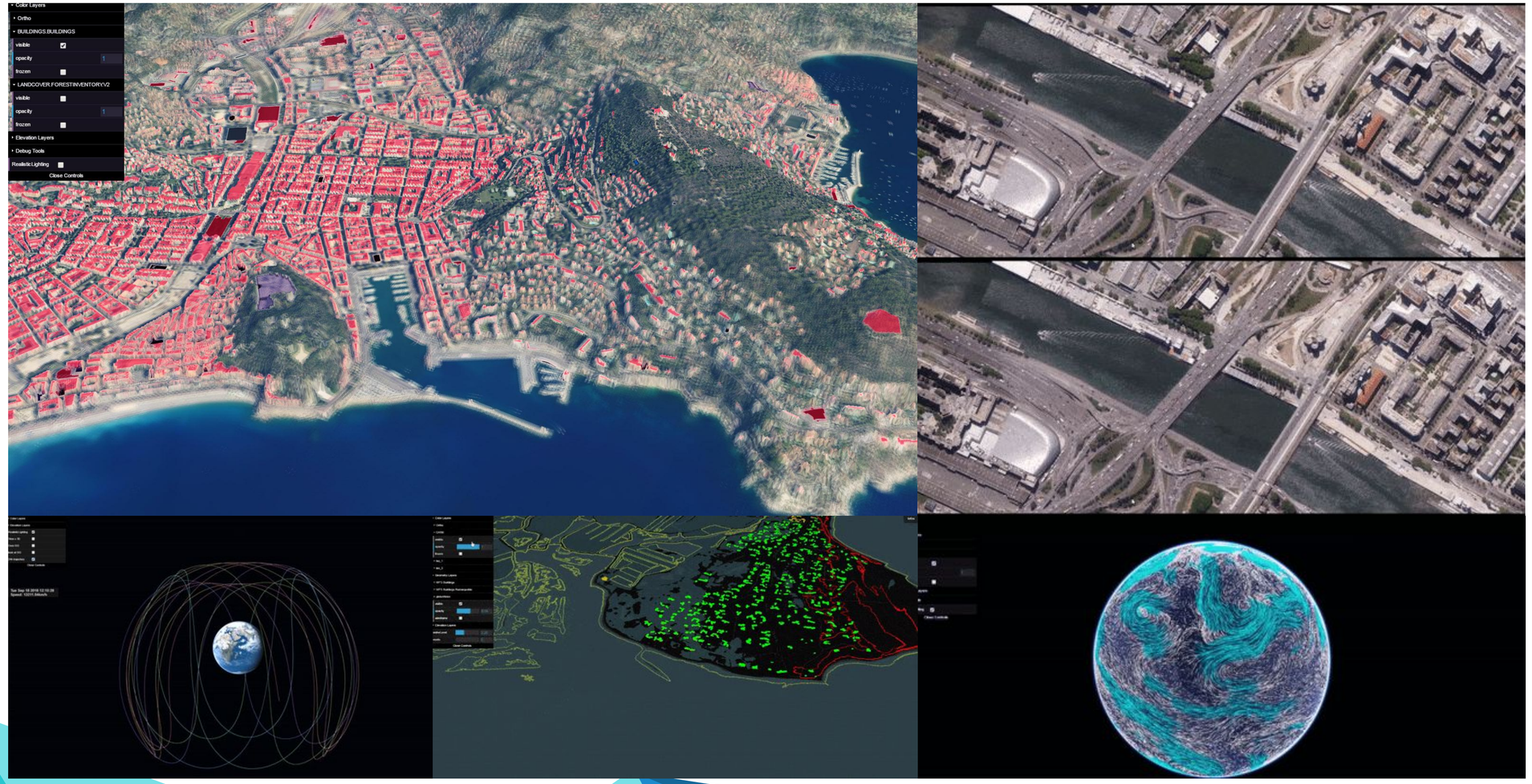
iTowns



- iTowns in short:

Opensource Webgl geovisualization library based on THREEJS
https://github.com/iTowns/itowns
http://www.itowns-project.org

Mixing abstract style with realistic



Recap

Thanks to WebGL introduced in 2011 and other advances in web development, 3D maps on the web are getting very powerful, allowing Data Science, Navigation and more.

What is the next big move in mapping?

Mixed reality

VR / AR: A relatively old concept

Hugo Gernsback

Tele-eyeglasses 1963

Ivan Sutherland

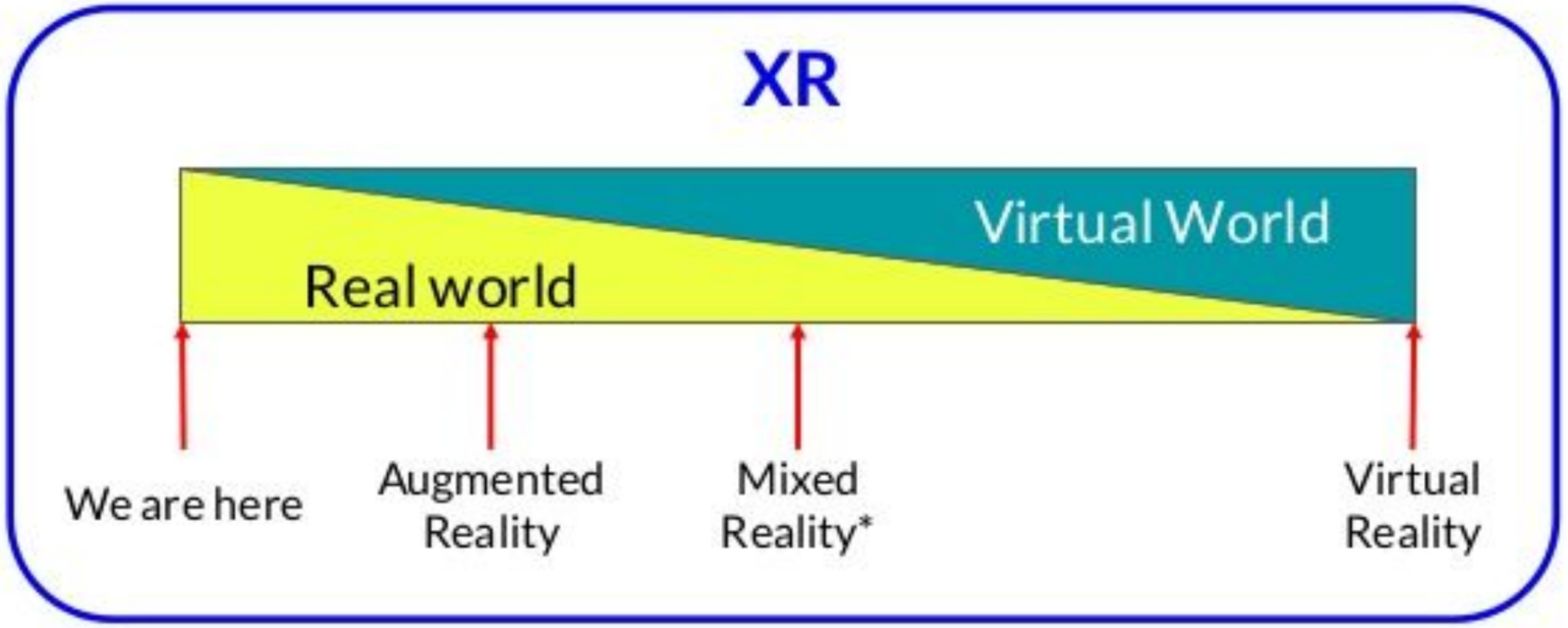
The Sword of Damocles (1968)

1985

1995

“

VR, AR, MR, XR, OMG, WTF, BBQ?!



@g33konaut

VR

Digital environments
that shut out the real world.

AR

Digital content on top
of your real world.

MR

Digital content interacts
with your real world.

- Started on tablets

- Since 2015 -> Holographic glasses

Microsoft Hololens (I)

Meta glasses

Magic Leap One

Project North Star

nReal

Contexts

Use cases: Geographic Information Science, Learning/Simulation, Entertainment, Architecture/BIM, ...

Strong benefit in GIS

-> **Navigation support**

Globe, paintings -> Paper maps -> Smartphone map apps -> Mixed reality -> ...

Contexts

Strong benefit in GIS

> **Navigation support**

> **Data visualization / Support**

3D Visibility (real stereoscopy), multi scale (not limited by the a support size), collaborative/shared

Natural interactions HANDS FREE

Contextes

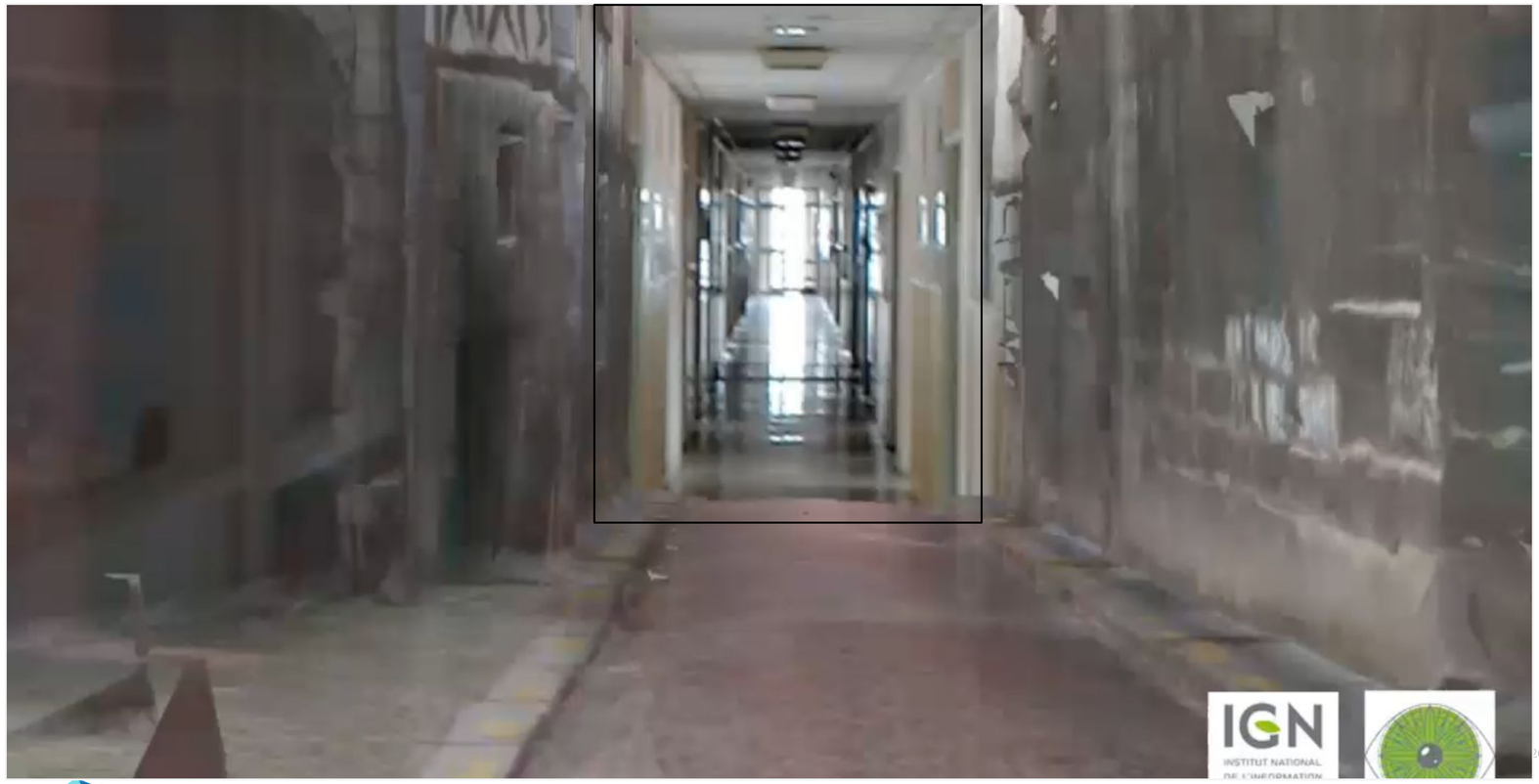
> **Data visualization / Support**

Ex: Photogrammetric model visualized in two scales, relative position/absolute position allows to see through walls

Contextes

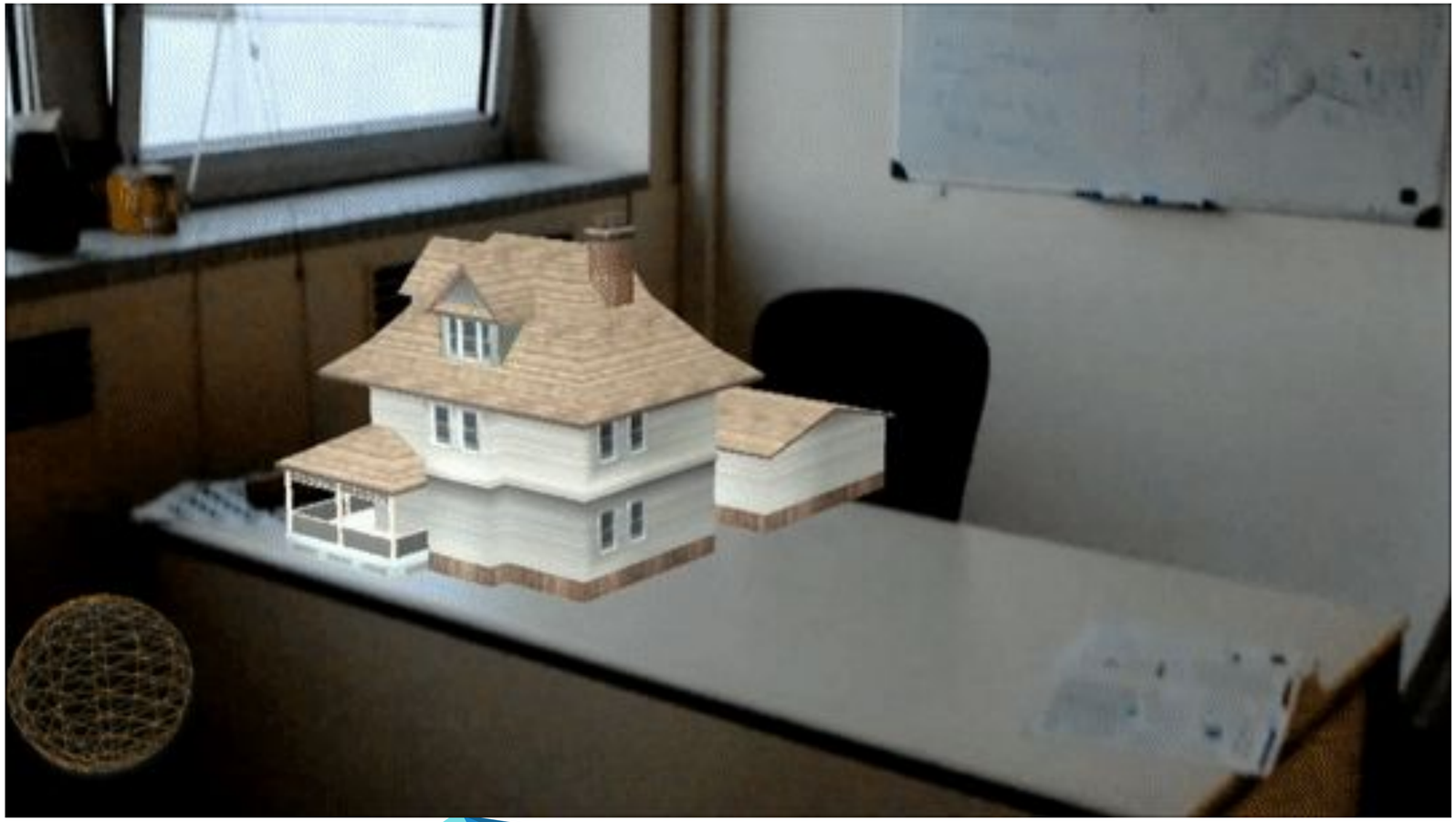
Adapting the virtual to the real

Example of morphing a city street numerisation (Rouen) on a corridor

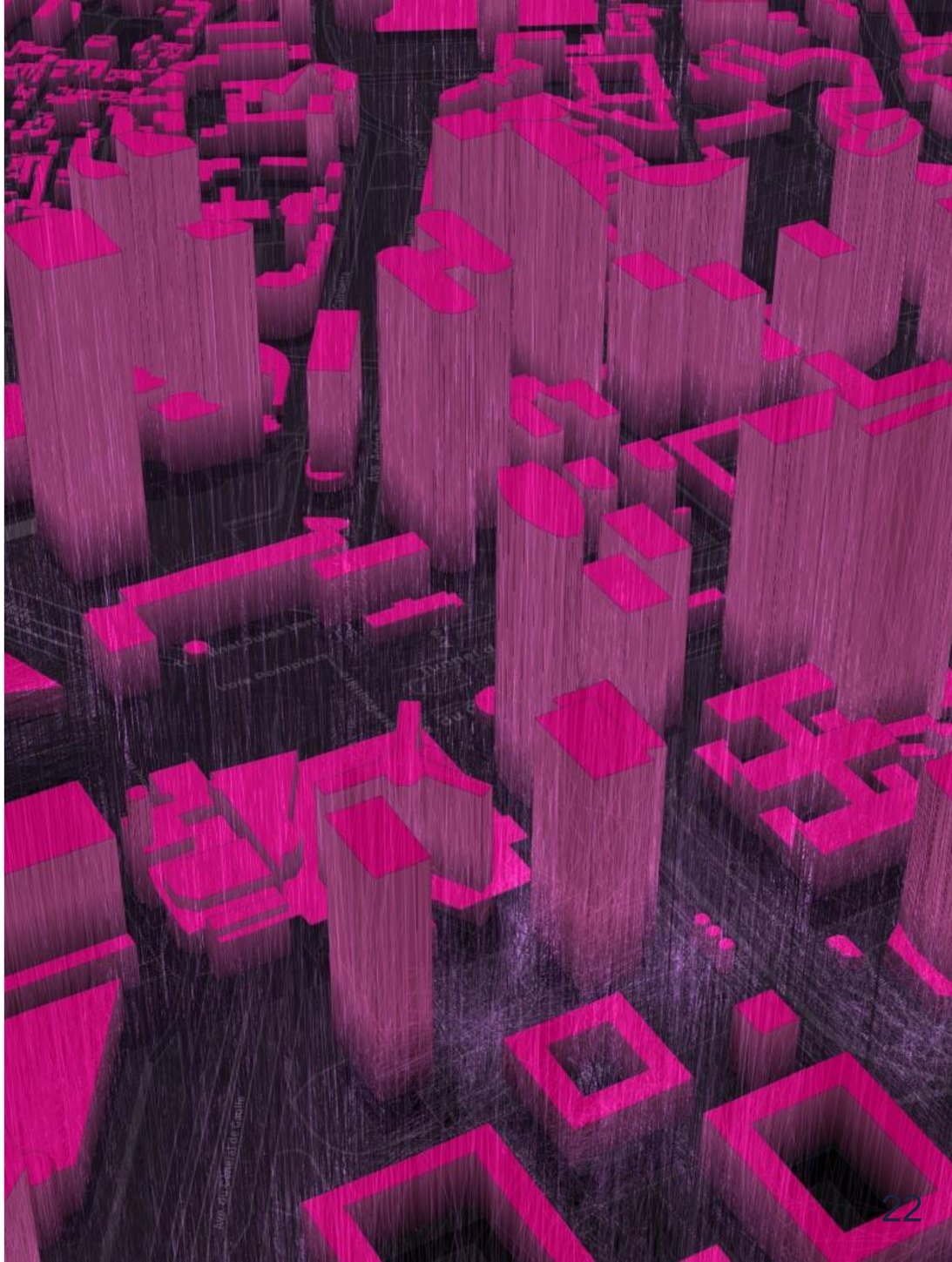


Contextes

3D model manipulation

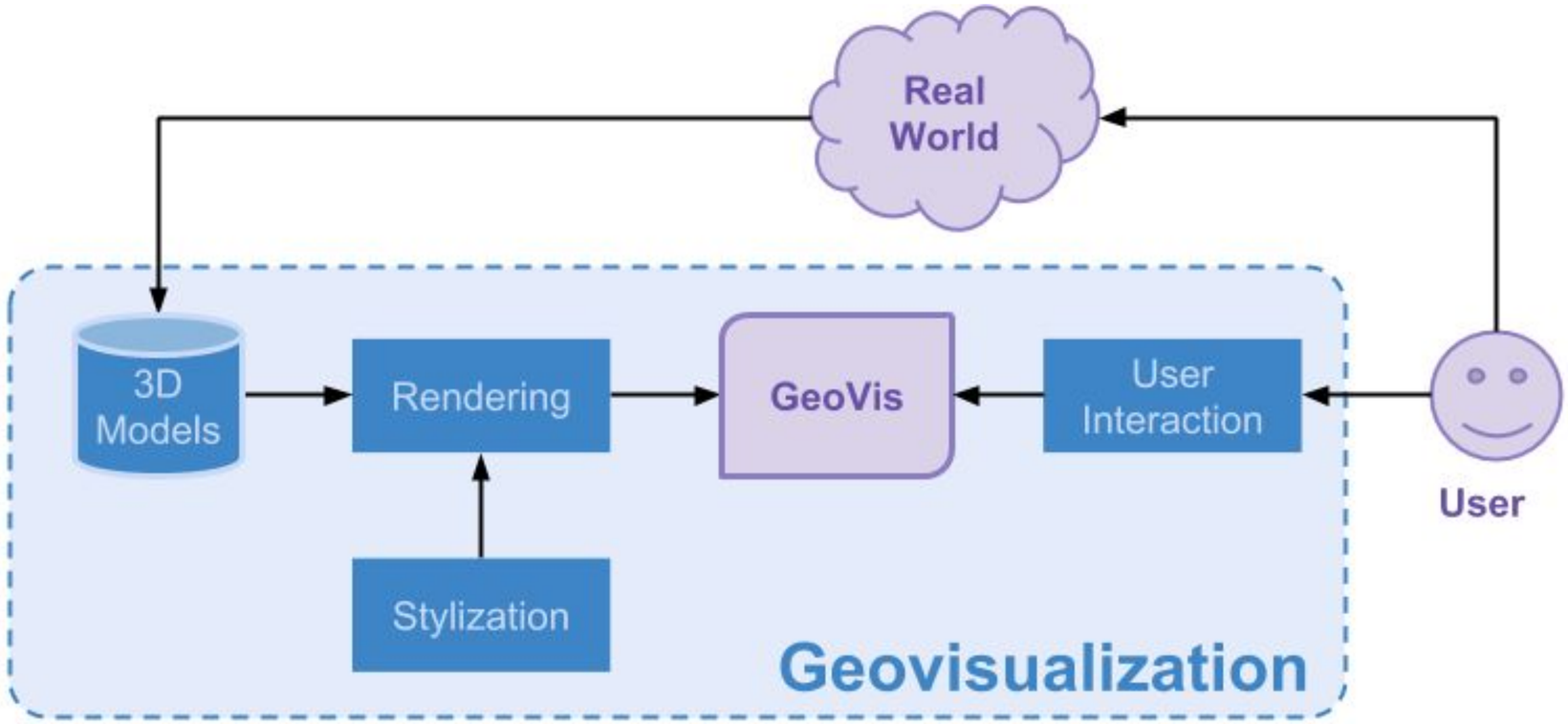


Geovis Challenges



Geovis challenges

GEOVIS: Allow diverse users to conceive graphical representations of spatio-temporal phenomenon



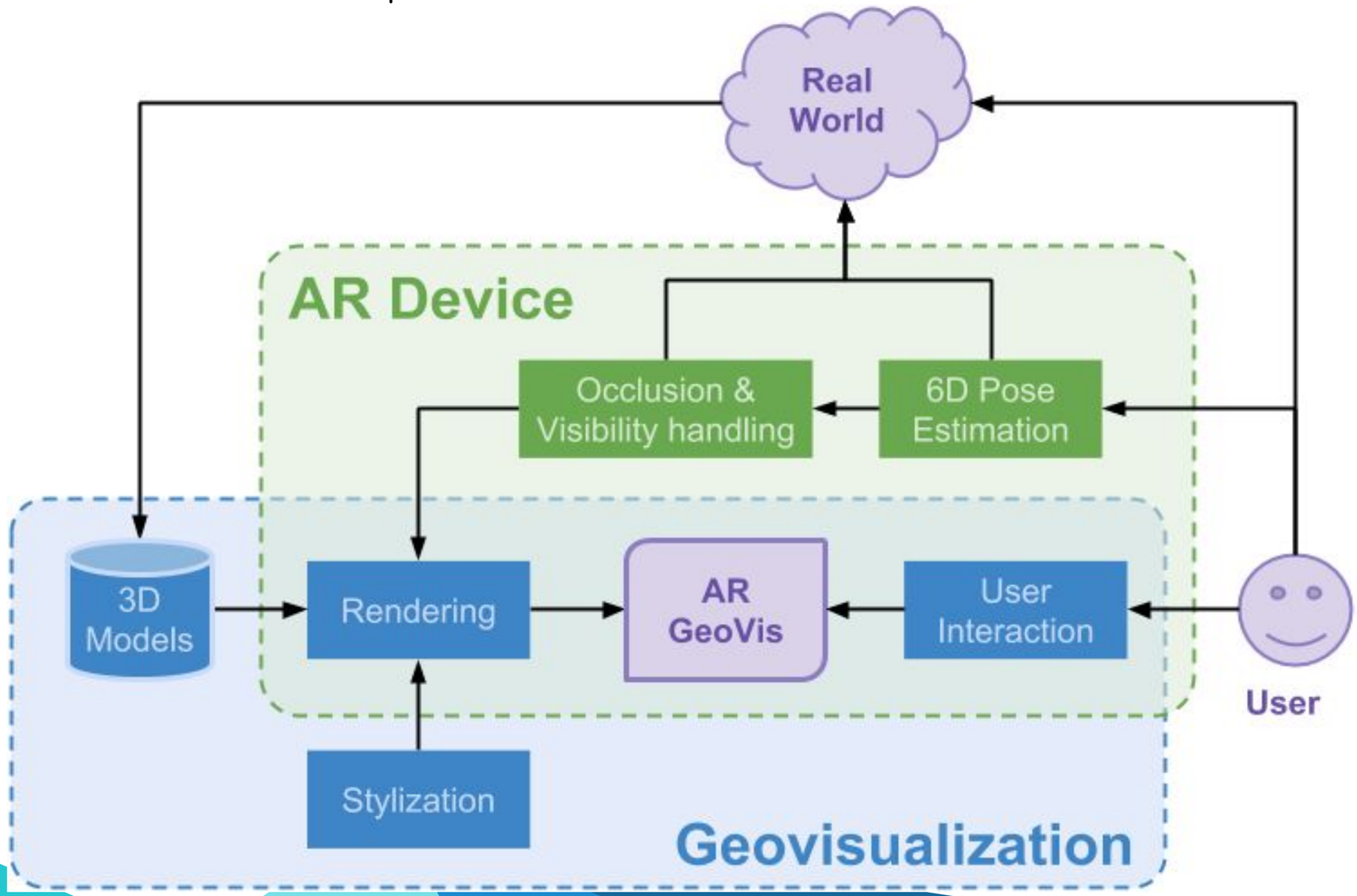
Devaux, A., C. Hoarau, M. Brédif and S. Christophe (2018) 3D urban geovisualization: in situ augmented and mixed reality experiments. ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences.

Geovis challenges

- What is the contribution of Augmented/mixed reality for geovisualisation?
- What are the new challenges?

Geovis challenges

Goal: Transfer and enrich our actual desktop methods to MR devices



Experimentations

- I. Underground visualisation
- II. Urban design
- III. Time travel

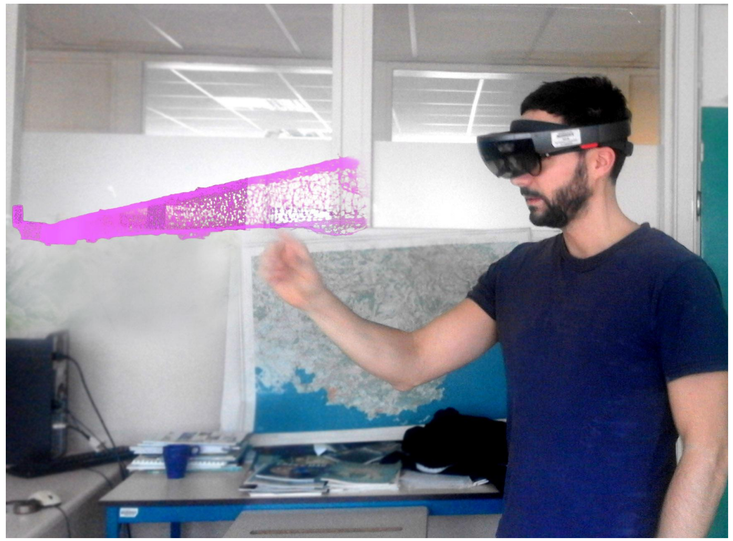
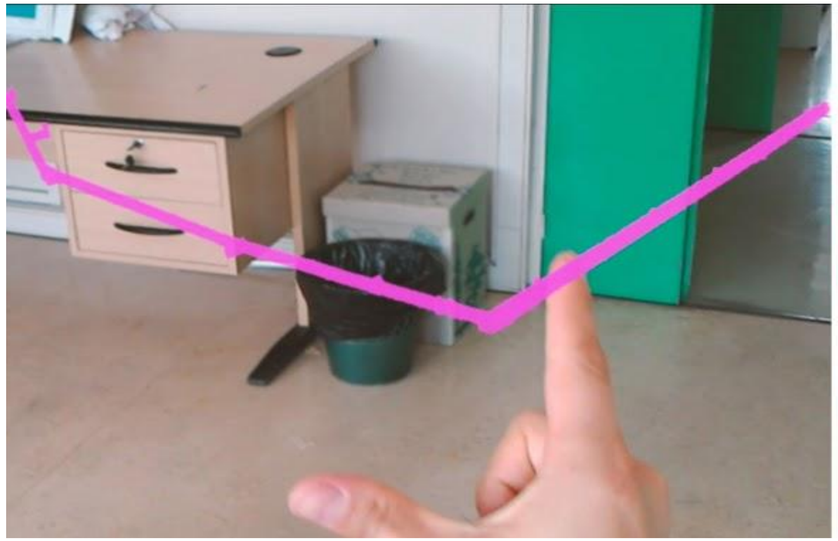
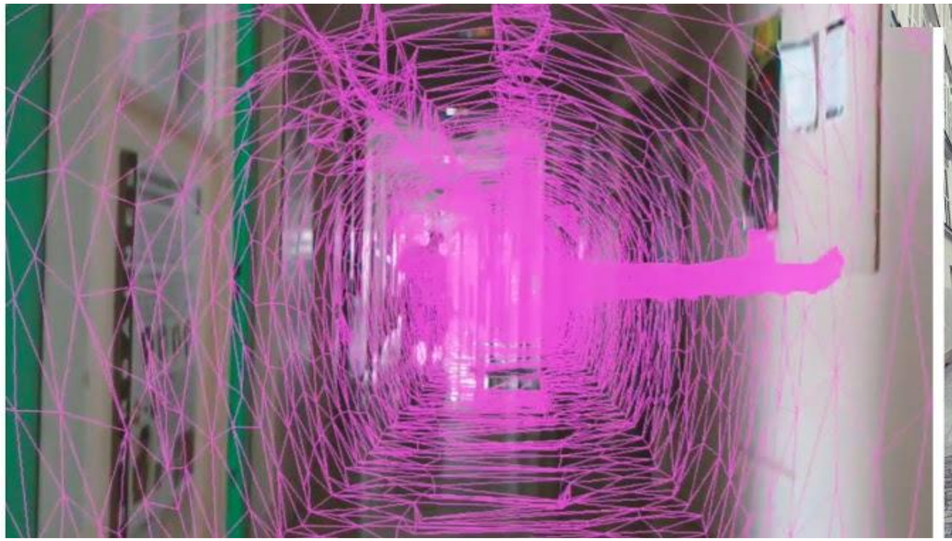
I. Underground visualisation

App originally developed for the web

Web mapping application for co-visualization: View from the streets or directly in the underground

I. Underground visualisation

Visualisation Ex-Situ multi scale

A. Devaux, M. Brédif, C. Hoarau, S. Christophe. Underground visualization : Web-app, Virtual Reality, Ex Situ and In Situ Augmented Reality. *ISPRS Technical Commission IV Symposium, The international Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences*, Delft, The Netherlands, 2018.

Features

- **Collaborative view, multi scale with free point of view**
- **Immersion possibility for training and simulation**
- **See through the ground**

I. Underground visualisation

Simulation of real time mapping using drones sent underground

I. Underground visualisation

In Situ, See through

Urban design

Edit the real world

Need to show what the users should see it the building was not there -> Mobile mapping data + Relighting

Interaction & immersion In Situ to support urban planning

a. Real environment observation On site (in Situ) with Mixed Reality glasses
b. Selection of an existing building (or part of)
c. Possible removal *diminished reality*
d. Add a virtual building (3D model, BIM, ...)

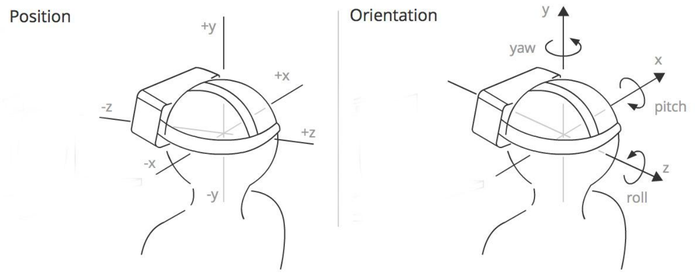
Devaux, A., C. Hoarau, M. Brédif and S. Christophe (2018) 3D urban geovisualization: in situ augmented and mixed reality experiments. ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences.

Urban design

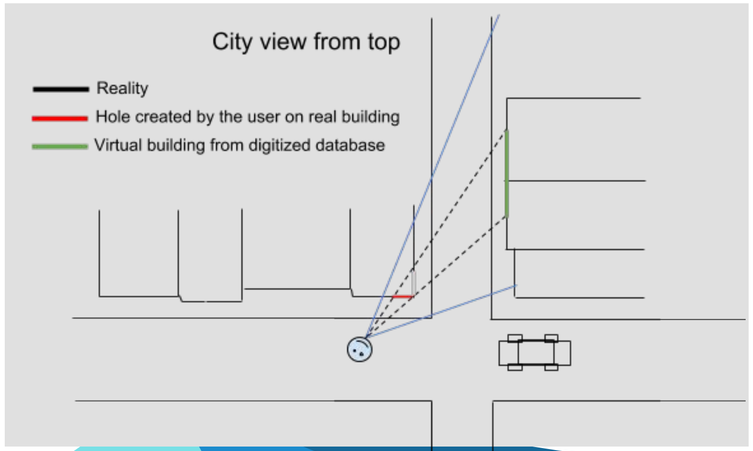
How to design this experience ?

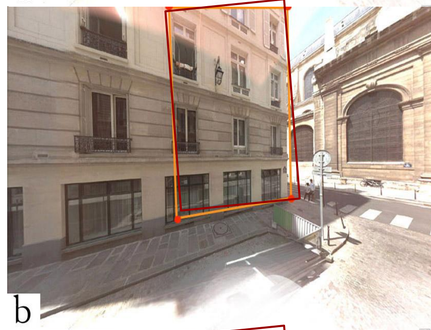
- Absolute positioning of the user 6D: Position(x, y, z), Orientation(roll, pitch, yaw)

  -> Natively relative + Absolute alignment by the user at the initialisation



- Occlusions handled thanks to realtime mesh created by the Hololens + BD TOPO IGN + Mobile Mapping IGN





Remove reality: User field of fiew and how to replace reality

Urban design

Outdoor AR/MR challenges

Interactive suggestion of new models
Facilitate in situ interaction
Relighting
Need very detailed models (geometry and textures)

Limited by the space size with actual technology

TODO

- Evaluate with final users (urbanists, architects, etc.)
- Explore visualisation capacities in support to urbanism and decision:
  - Thematic data: energy, meteo, traffic.
  - Rendering style: abstract, photorealist

(Brasebin et al. 2015)

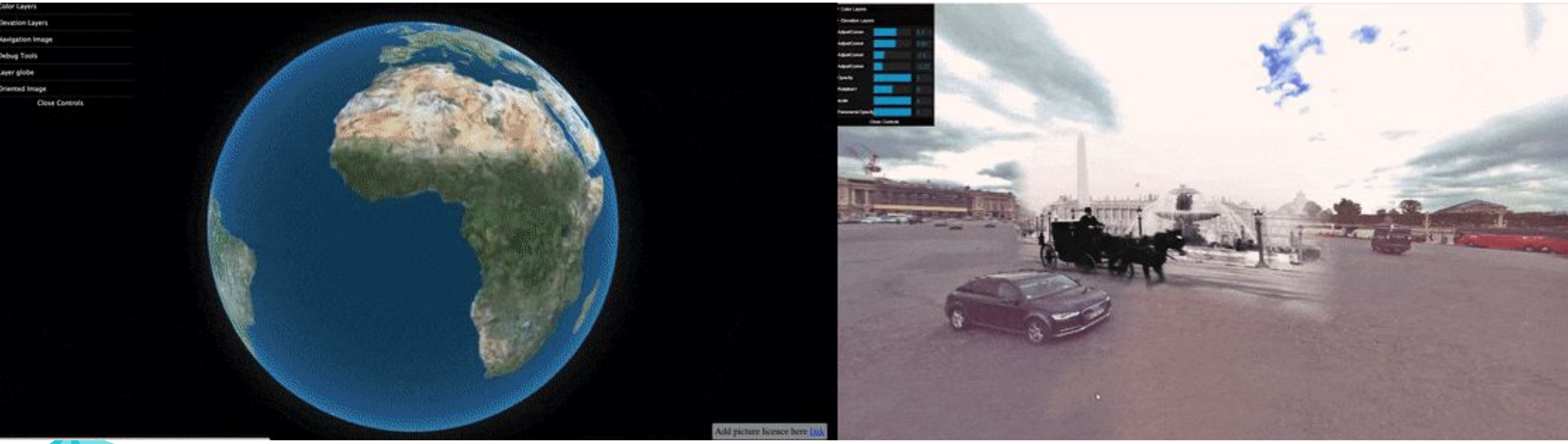
(Bouyer 2009)

(Petit 2015)

Time travel

Goal: Navigate through registered historical photographs

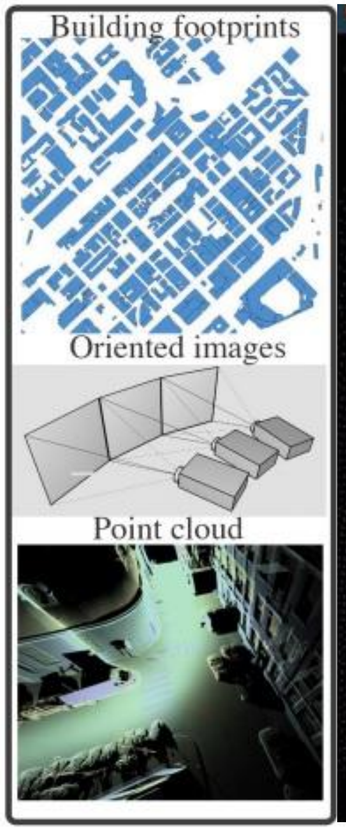
Through the web:



Semi automatic resection* (micmac) and 3D web visualization (iTowns) *project* ANR Alegoria, *Archives Nationales/Fonds LAPIE*

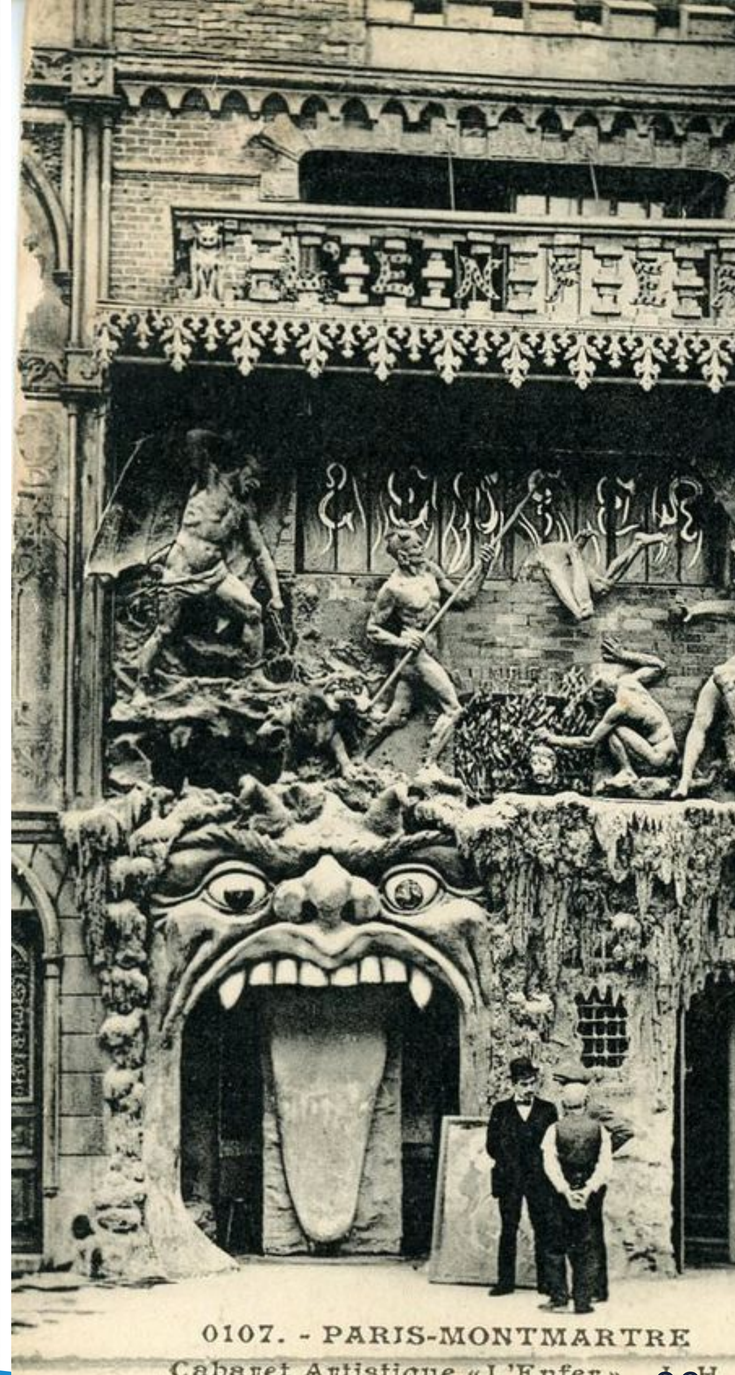
Voyage dans le temps

At street level: old photographs registered on street level imagery (Mobile Mapping IGN)*



***Reference frame** -> IGN Databases with street level digitization

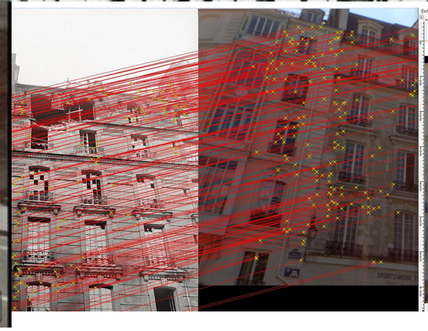
POSTALE GALERIE. — 186, Rue de Rivoli.

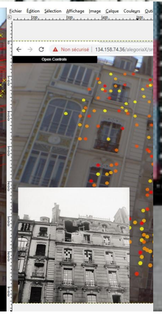


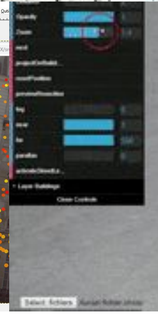
0107. - PARIS-MONTMARTRE
Cabaret Artistique «L'Enfer»

Expérimentations III/III

Automatic and semi automatic image resection
online visualization







Video capture of what is seen by the user in the streets

Conclusion / Future work

CONCLUSION

Pose estimation

Native capacity for relative pose estimation but still need human intervention for absolute.

Occlusion

Imprecise on small objects

Hardware limitation

- Field of view limited
  -> Reduce the immersion
- Tiring, heavy device
- 3D rendering capacities limited
- Luminosity light outside

Need for evaluation

Our different experimentations need to be tested by more users

Mixing virtual with reality changes completely the perception of details and precision

Need for a precise 3D georeferenced frame

For many subjects, Detailed 3D city models are needed (geometry and textures)

Abstract representations can help!

Future work

Navigation rendering

- Allow the user to navigate through city without adding new 3D objects like floating arrows but making the *city alive and showing the way*

-> Texture synthesis, Directional mesh morphing

Improving time travel

- Integrate video in the projection on wall
- Dynamic relighting of old photographs, recoloring from BW
- Refine the blending between real and virtual using segmentation

Thank you!

Questions?

Contact: alexandre.devaux@ign.fr

twitter.com/alexandredevaux

IGN-France LASTIG, GEOVIS Team

https://umrlastig.github.io/geovis