POWerNAV

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Introduction

Problems Tackled:

- Reading maps on smartphones is not a seamless experience
- Users must look at two different worlds and interpret them

Our Project:

- An application that overlays data on a map onto the real world
- Campus tour that shows a use case for our application

Tools:

- Moverio BT-200 with Android 4.0.4
- Android Smartphone
- Google Maps

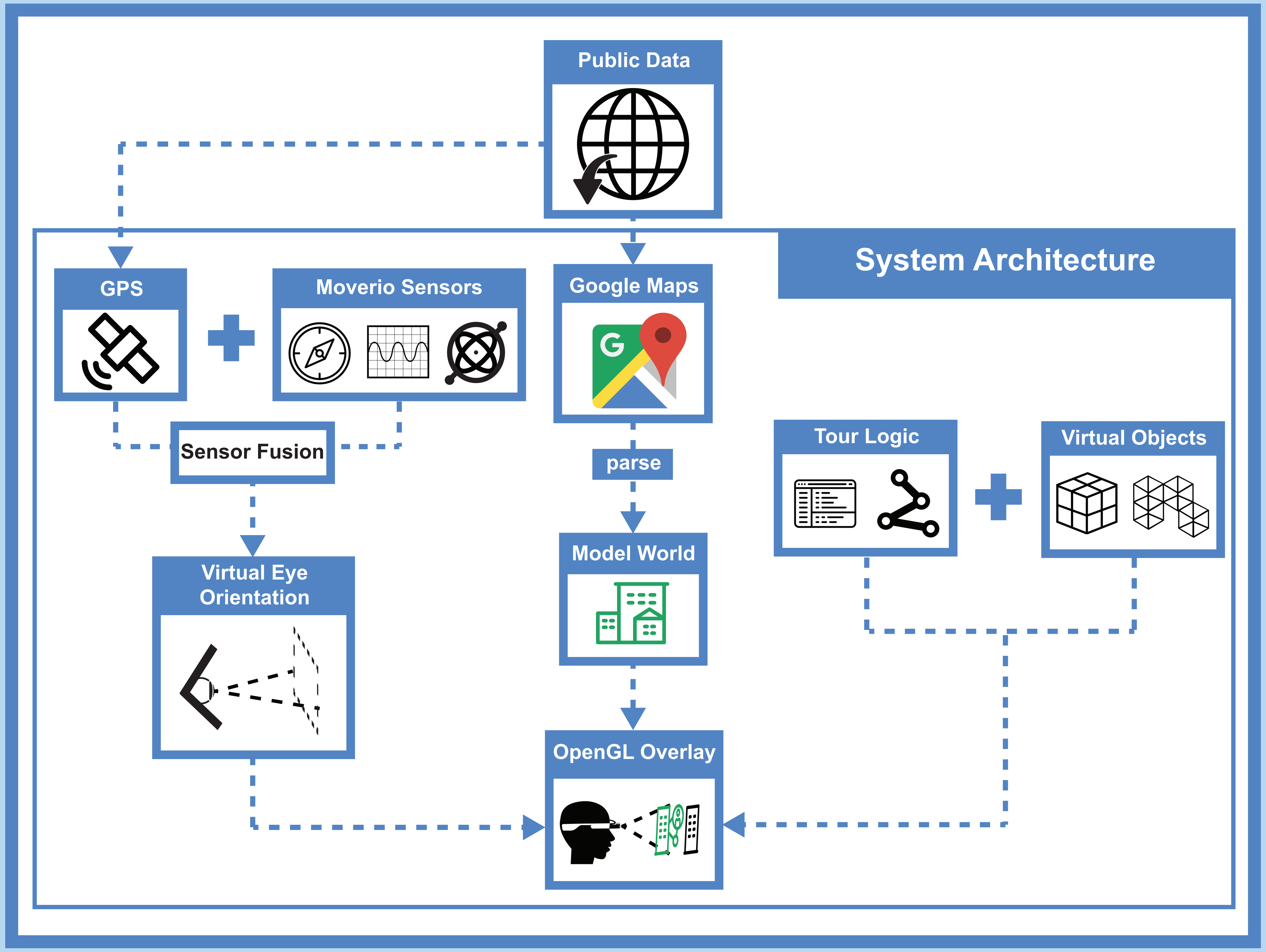
Challenges

GPS Inaccuracies

The OpenGL overlay is very sensitive even to minor position inaccuracies. Due to consistent but unpredictable GPS behavior, a filtering mechanism simply is not enough, so we also had to make some restrictive assumptions on user movement, similar to an automobile-grade GPS system.

Sensor Inaccuracies

The accelerometer, magnetometer, and gyroscope all play an important role in correctly updating the eye orientation. We tried many different sensor fusion algorithms, and also researched and tried to incorporate OpenCV to correct orientation errors that inevitably build up over time. The result is still not as accurate as we would like. We believe there is still room for hardware sensors to get better and cheaper.



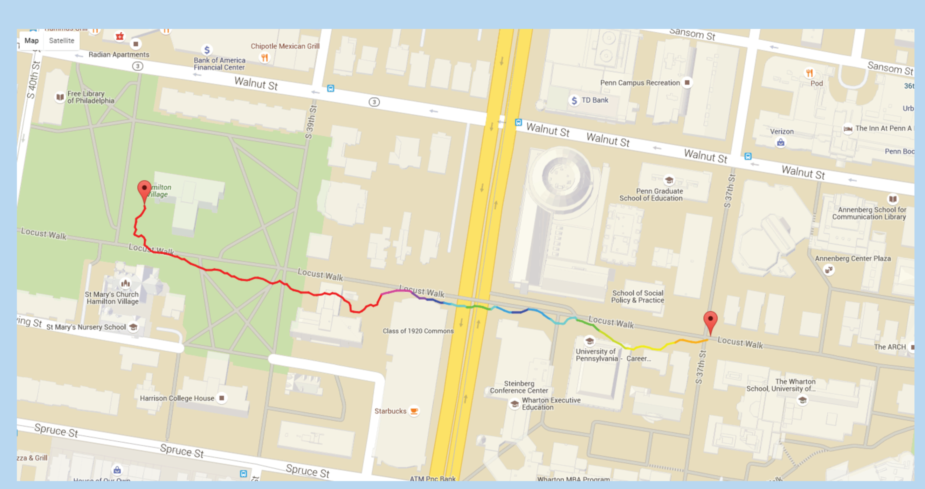


Figure 1: Visualization of collected GPS data, location can be off by up to 20 meters in image.

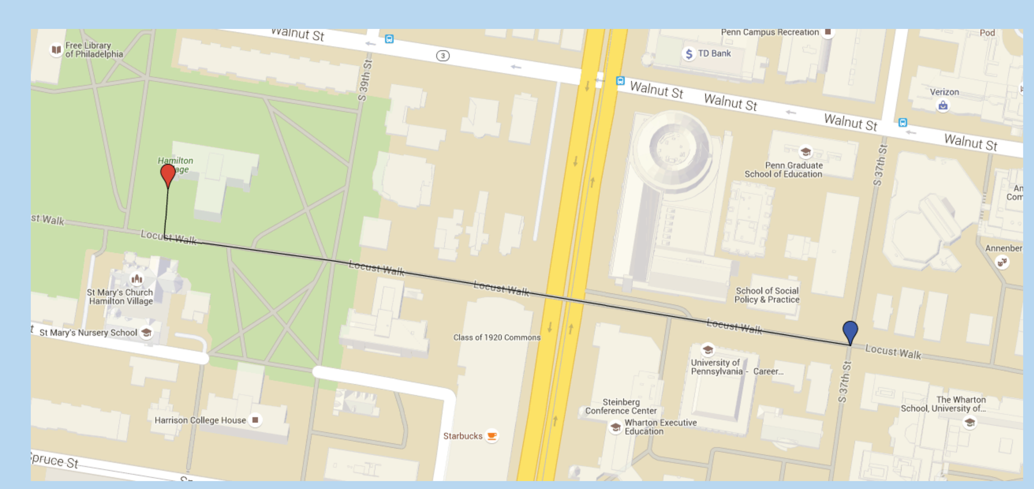


Figure 2: Actual path taken as shown in Figure 1. Red marker indicates start and blue marker indicates end.

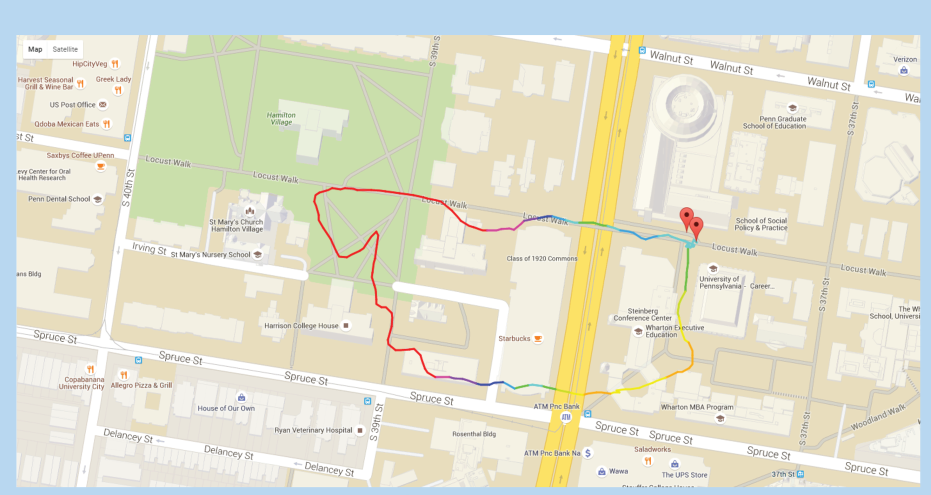


Figure 3: Visualization of collected GPS data, location can be off by > 20 meters in image.

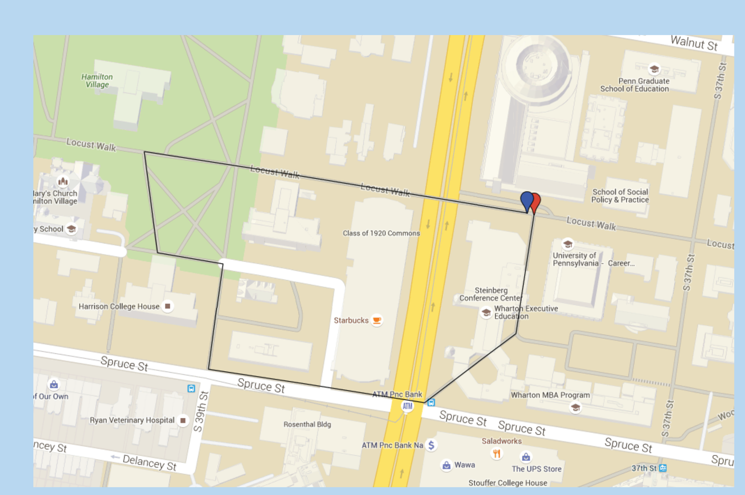


Figure 4: Actual path taken as shown in Figure 3. Red marker indicates start and blue marker indicates end.

Implementation

Public Data

- accessed by locating the user with GPS
- raw map data of Penn campus from Google Maps

GPS & Moverio Sensors

- Latitude and longitude are obtained by a separate smartphone and communicated to the Moverio via bluetooth.
- Sensors that are integrated into the Moverio include an accelerometer, magnetometer, and gyroscope.

Virtual Eye Orientation

- Through filtering and sensor fusion of sensor values, the Moverio can continiously update position and orientation variables, which are necessary for proper overlay rendering.
- The Moverio must constantly track the user's location and head movement for accurate performance.

Google Maps

- Points of interest, streets, and building footprints are stored as points, lines, and polygons.
- Map data is stored in kml format and parsed into a usable local coordinate system

Model World

- The world data is stored in a local 3D coordinate system that is accessed each time a frame is drawn for the overlay.
- Building polygons are extruded to provide volume.

Tour Logic & Virtual Objects

- The application can also display objects that do not exist in the real world, to deliver an "augmented" experience.
- The application includes a tour engine which directs the user along a predetermined list of POIs, using augmented beacons and arrows.

OpenGL Overlay

- The eye position and orientation and enhanced model world are unified into an experience delivered by the Moverio's screen.
- The displayed information enhances the user's experience of navigating within the real world

Conclusions

- There is potential to the idea of overlaying map data with AR.
- Learned how to overcome inaccurate sensor data with complex sensor fusion algorithms.
- As AR technology improves, so will the experience of the user.