Design Project - SIE 2024

Accuracy assessment of precise mapping with mobile phone

Fanny Bitoun & Germana Sergi — EPFL supervisor: Jan Skaloud — Pix4D advisor: Martin Rehak

Introduction and objectives

Precise **Global Navigation Satellite System (GNSS) positioning** and **3D modelling** are fundamental elements in the fields of surveying and mapping. Traditional techniques involve accurate instruments for single point measurements and terrestrial mapping, as well as professional software for data processing. However, these techniques are complex and the instrumentation is usually difficult to carry and to use. Pix4D is on a mission to **democratize photogrammetry**, a technology that aims to reconstruct 3D scenes from photographs. Coupled with a real-time positioning device (viDoc RTK), a mobile device can be used for mapping and 3D modelling in different domains, e.g. in construction sites, for which precise distances and volumes need to be determined.

The objective of the project is to assess the **accuracy** of Pix4D's technologies with respect to traditional techniques. Two scenarios are tested:

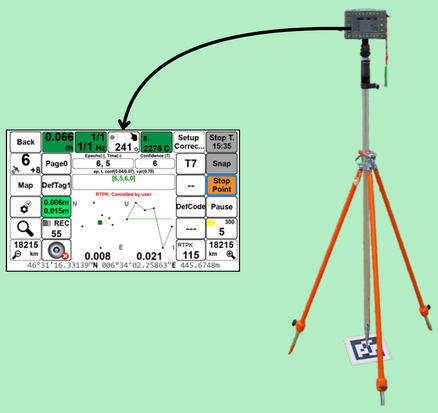
- **Single point measurements**: compare the coordinates' accuracy of an iPhone 13 Pro coupled with the viDoc RTK from Pix4D against the TRIUMPH-LS GNSS receiver from Javad
- **Volumetric meaurements**: compare the volumes' accuracy of an iPhone 13 Pro coupled with the viDoc from Pix4D against the Leica ScanStation C10 laser scanner

iPhone with viDoc RTK: how accurate is it? And what are the advantages of using it?

METHODS

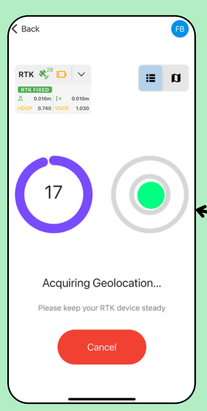
1. Single Point Measurements

Javad GNSS Receiver



VS

iPhone with viDoc RTK



Pix4Dcatch interface for Point Measurement

Data Acquisition: 3 min measurement on a pole fixed with a tripod

Single points:

- Several points selected according to their level of **obstruction**
- Points with known coordinates: cadastral points or points previously measured by the lab (reference)
- Accuracy assessment made on position error

Volumetric measurements:

- Case study: **stockpiles** found in construction sites, knowing their volume is necessary for their proper management
- Three stockpiles of various sizes and textures tested
- Accuracy assessment made on volume percentage error

Differences in workflows

No differences between *Javad GNSS receiver* and *iPhone + viDoc*

Leica laser scanner

- Acquisition time: 4h
- GCPs coordinates required
- Assisted alignment for point cloud generation

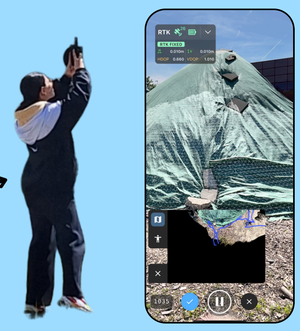
iPhone + viDoc

- Acquisition time: 30 min
- Automatic georeferencing
- Automatic point cloud generation

2. Volumetric Measurements

2.1 Data Acquisition

iPhone with viDoc RTK



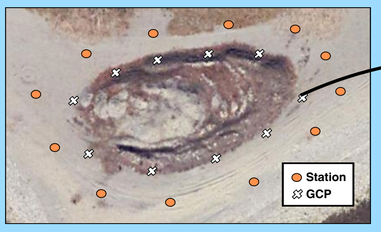
Pix4Dcatch interface for Volumetric Measurement

VS

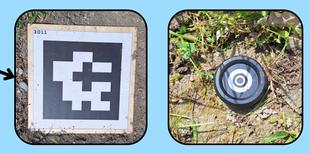
Leica Laser Scanner

Example of stockpile

2.2 Georeferencing (only for Leica scanner)



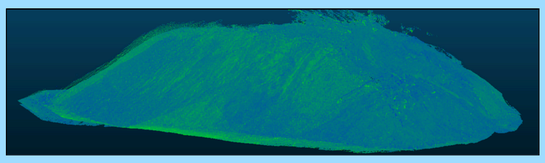
Satelllite view of the stockpile with positions of stations and GCPs



Georeferencing: targets and nails used as Ground Control Points (GCPs)

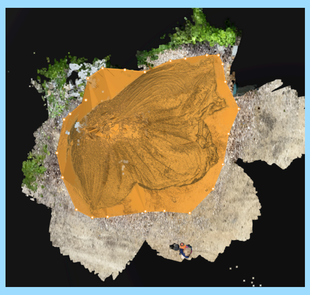
2.3 Point cloud generation

Using Pix4Dmatic



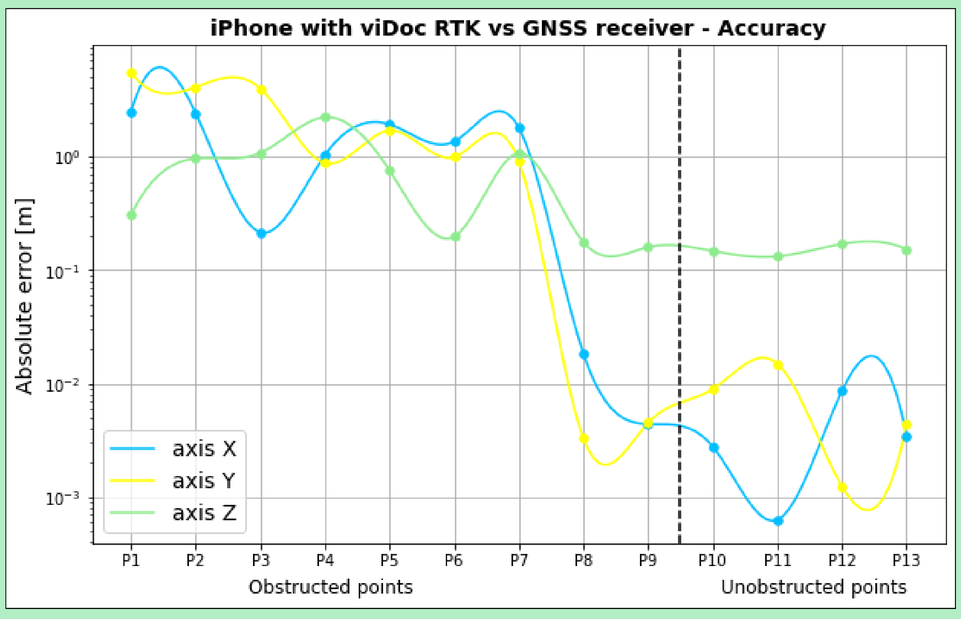
Using Cyclone Core + Cyclone Register 360

2.4 Volume measurement



Pix4Dsurvey

RESULTS



Absolute position error, computed as coordinate difference, of the iPhone relative to the Javad GNSS receiver on each axis

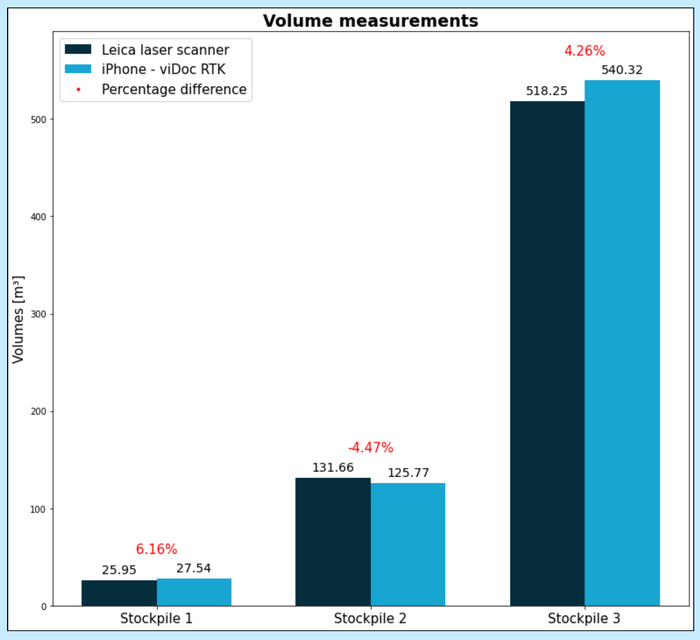
Overall accuracy

Single point measurements

- *X, Y axes:* **dm-to-m level** accuracy for obstructed points, **mm-to-cm level** for unobstructed points
- *Z axis*: constant accuracy to **dm-level**

Volumetric measurements

- **~5%** difference



Volumes of the three stockpiles measured on Pix4Dsurvey

Conclusion

How accurate is the mobile phone?

- *For point measurements*: **satisfying** results in areas with no obstruction
- It **can not yet replace a traditional GNSS receiver** for very precise positioning, especially for obstructed points (dm-to-m precision)
- Quite **good accuracy** for *volume measurements* (~5% difference)

What are the advantages of using it?

- Two types of measurements performed by a device well-known and **easy to use**
- Clear advantages for 3D mapping:
  - **reduced weight** of instrumentation
  - **tremendous gain of time** for acquisition (5-10 times faster)
  - **automatic** georeferencing and data processing