Automatic alignment and completion of point cloud environments using XR data

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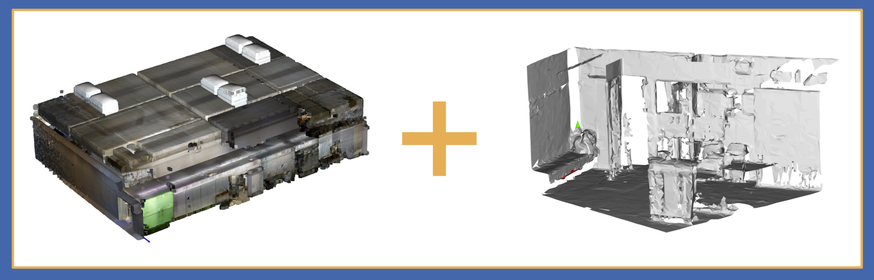
PROBLEM

The AECO industry needs up-to-date and detailed 3D building data.

- The captured data is often incomplete
- Captured data quickly becomes outdated
- The data coming from lower-end, cheaper capture devices is rarely used.

OUR APPROACH

Combining high-end (TLS or photogrammetry) datasets with lower-end XR datasets, by updating small parts of the full point cloud, could extend their relevance and decrease the total recording investment. Creating an automatic alignment method will enable a faster feedback loop to the device.



RELATED WORK

Existing works rely on using multiple sensors to capture data at different scales and levels of detail, ranging from adding highly detailed scans of small selected objects [2], to filling in large occluded areas using drone footage [1]. These methods, however, rely on a (semi-)manual alignment step, making the quick feedback loop from an XR device not feasible.

Merging different datasets in the current state of the art is mostly focused on improving the coverage of the initial scan [3].

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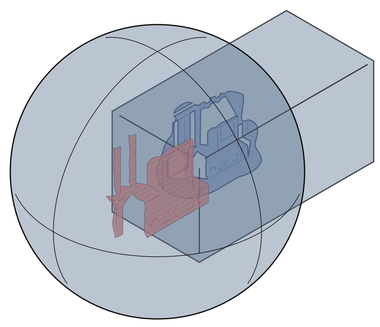
METHODS

We aim to achieve our goal in two steps. By setting up a automatic alignment pipeline, we improve upon the current state of the art. This is achieved with a python based web server. The completion takes into account the accuracy of the existing scans and aims to only update areas in the point cloud that are properly captured with the XR device.

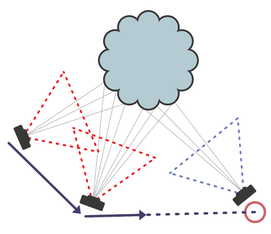
ALIGNMENT

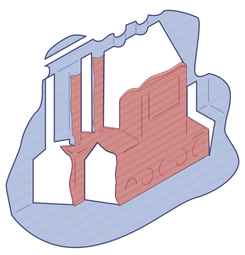
Global Sub-selection



Using a rough global pose, only the relevant reference data is selected.

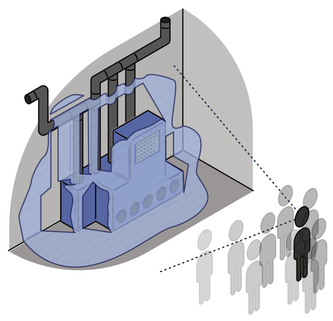
2D & 3D Session alignment





Using ORB (2D) and FPFH (3D) features, a number of estimations is made for all the different resources.

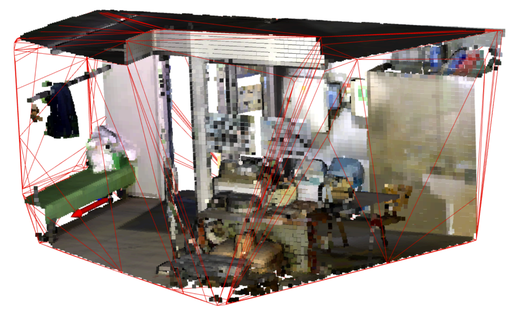
Pose Weighting



Each estimation has a number of matching parameters. These are used to calculate the confidence and pose.

COMPLETION

Relevant Sub-selection

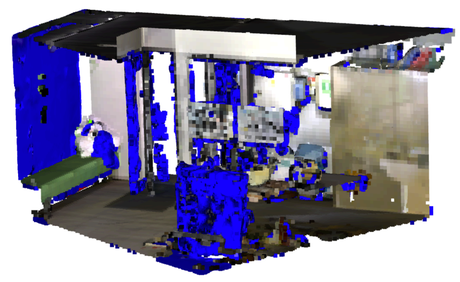


The convex hull of the XR dataset is used to query only relevant points.

Out-of-date Point Removal

Remove all the points that both fail the coverage test (distance query) & the visibility check (normal comparison)

New Point Addition



Adding new points from the sampled XR mesh where there are no existing points.

RESULTS

Our approach can confidently align two different datasets by weighting multiple estimations from both 2D and 3D methods with an accuracy of +- 5cm and 0.3°

The completion removes out-of-date points and adds new points to the original dataset. Resulting in an up-to-date dataset.