Goal and Constraints

❑ Orthographic overview image
from high resolution images
from multiple μUAVs (Micro Unmanned Aerial Vevicles).

❑ Exploit GPS and IMU data for initial placement.

❑ Low altitude UAVs and wide angle lenses to cover wide areas.

❑ Non-planar scenery induces significant perspective distortions.

❑ Restricted resources (processing, network, battery) constrict potential algorithm.

Structure Based Matching

1. Determine a pair of images with sufficient overlap and match extracted feature points within this overlapping area.

2. Use Bundle Adjustment to compute camera position and 3D structure for the matched feature points, iteratively.

3. Merge the resulting camera extrinsics with the raw extrinsics (from IMU and GPS) and orthorectify images.

4. Use plane fitting in the 3D structure to select feature points on the common ground plane and estimate the final image transformation.

Initial placement based on meta data
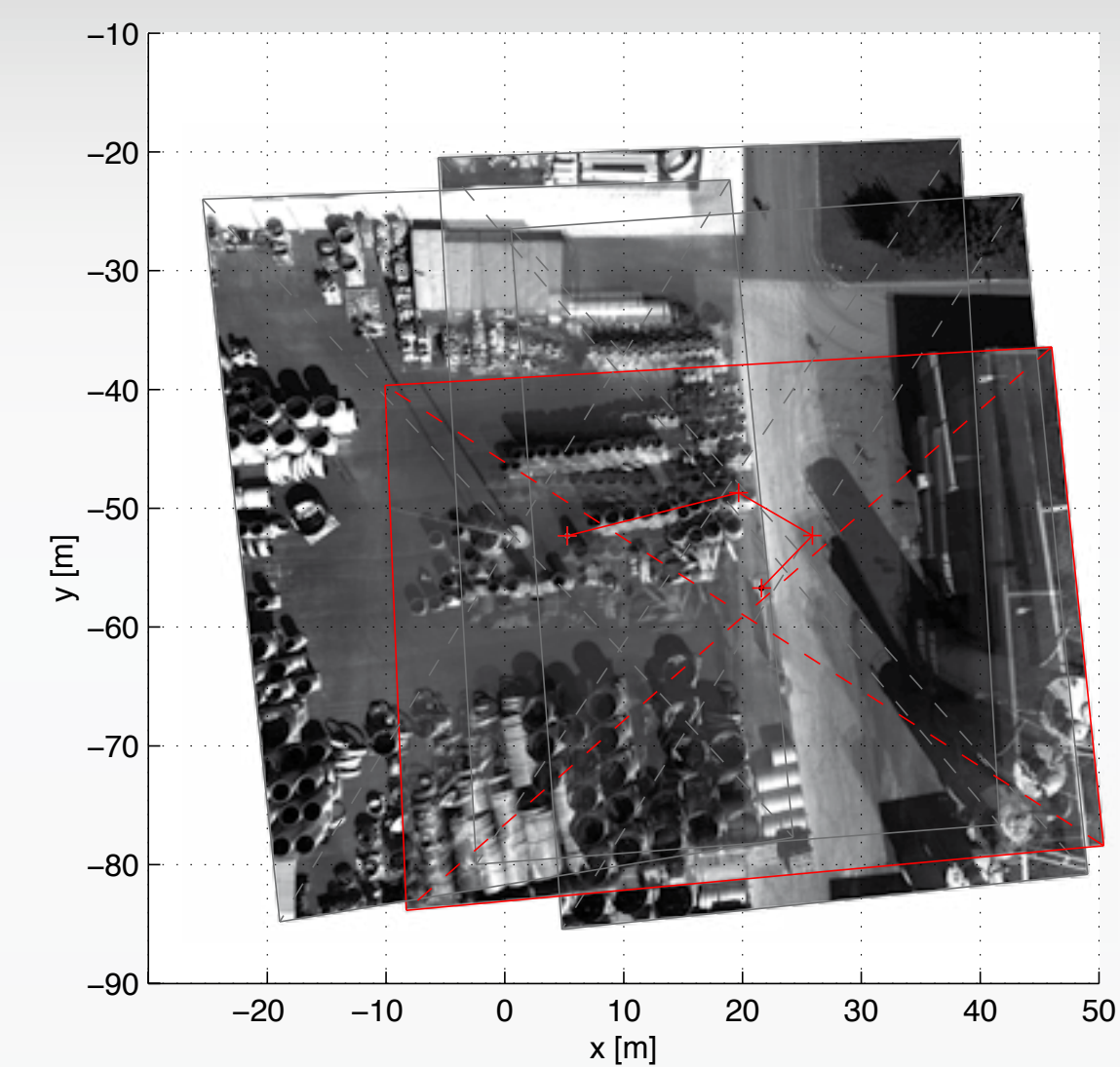
Example:
4 Images (4 camera positions), 3264 x 2448 px, RGB
GPS position and IMU attitude data from μUAV

Mosaicking function:

$$I = \biguplus_{i=1}^{n(t)} T_i I_i$$

Final transformation:

$$T_i = R_{C_i} \cdot T_{C_i} \cdot T_{\mathrm{match},i}$$

Camera projection:

Meta data: $\quad P_{\mathrm{IMU}_i} = [R_{\mathrm{IMU}_i}, T_{\mathrm{GPS}_i}]_{4\times 3} \Rightarrow \{\tilde{R}_i, T_{\mathrm{pos},i}\}$
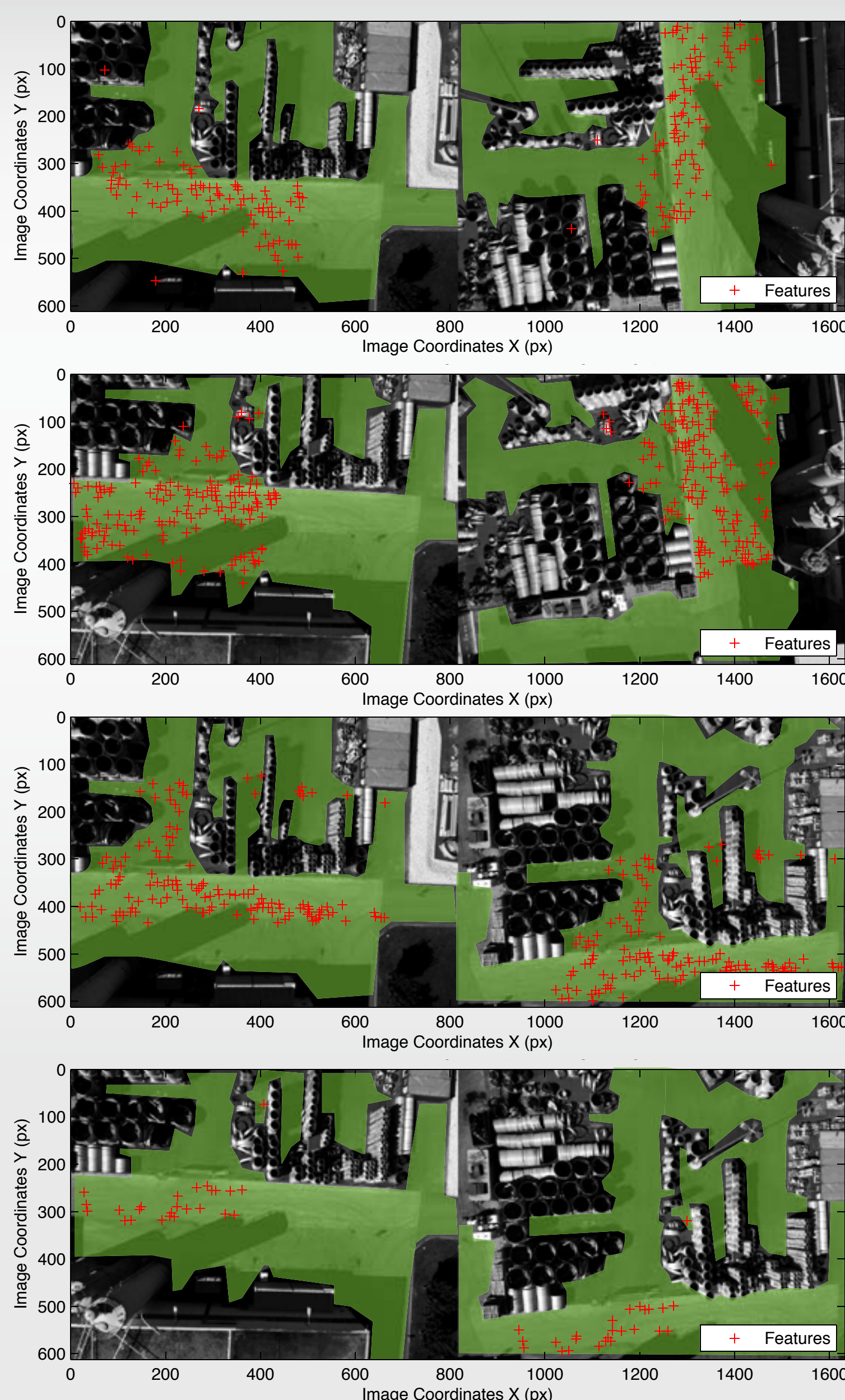
Image data: $\quad P_{\mathrm{SfM}_i} = [\hat{R}_i, \hat{t}_i]_{4\times 3}$

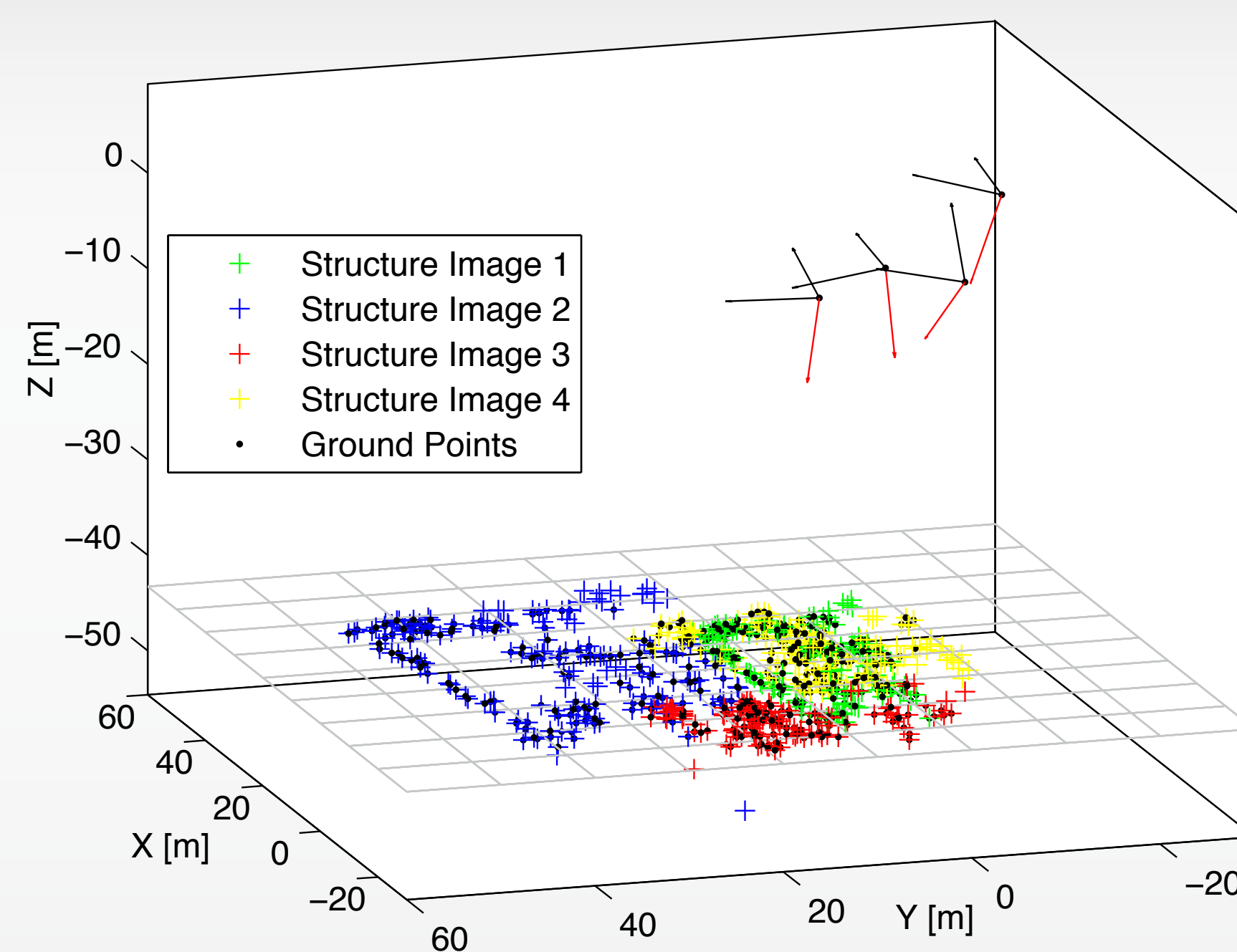Merged to: $\quad P_{C_i} = [R_{C_i}, T_{C_i}]_{4\times 3}$

Matching with similarity transformation:

$$\boldsymbol{x}' = T_{\mathrm{match}}\, \boldsymbol{x} = [sR, t]_{3\times 3}\, \boldsymbol{x}$$
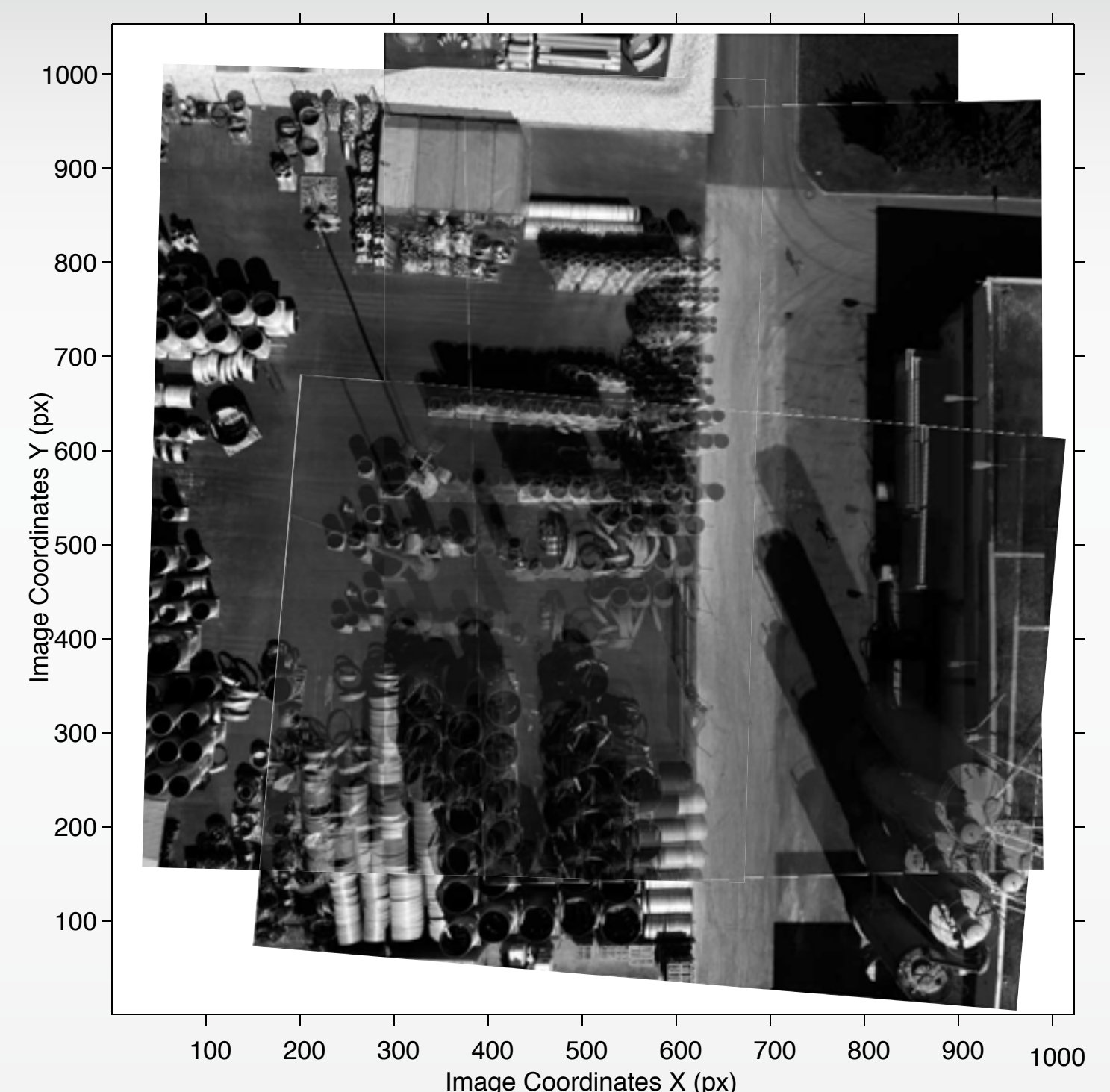
Matching on the ground plane

Structure reconstruction to fit ground plane

Mosaicked result

Conclusion and Further Work

❑ SfM/BA results are used to find corresponding points on the ground plane and enhance the camera extrinsic parameters from initial meta data (IMU, GPS).

❑ Images from wide angle lenses and from low-altitude can still be used to build an orthographic overview image.

❑ Improvement of the 3D reconstruction by combination of multiple bundles and of the matching function by enhanced plane fitting algorithms.

STRUCTURE BASED MOSAICKING OF AERIAL IMAGES FROM LOW ALTITUDE OF NON-PLANAR SCENES

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