High Accuracy Measurement with 360° and Giga-pixel Panorama Images

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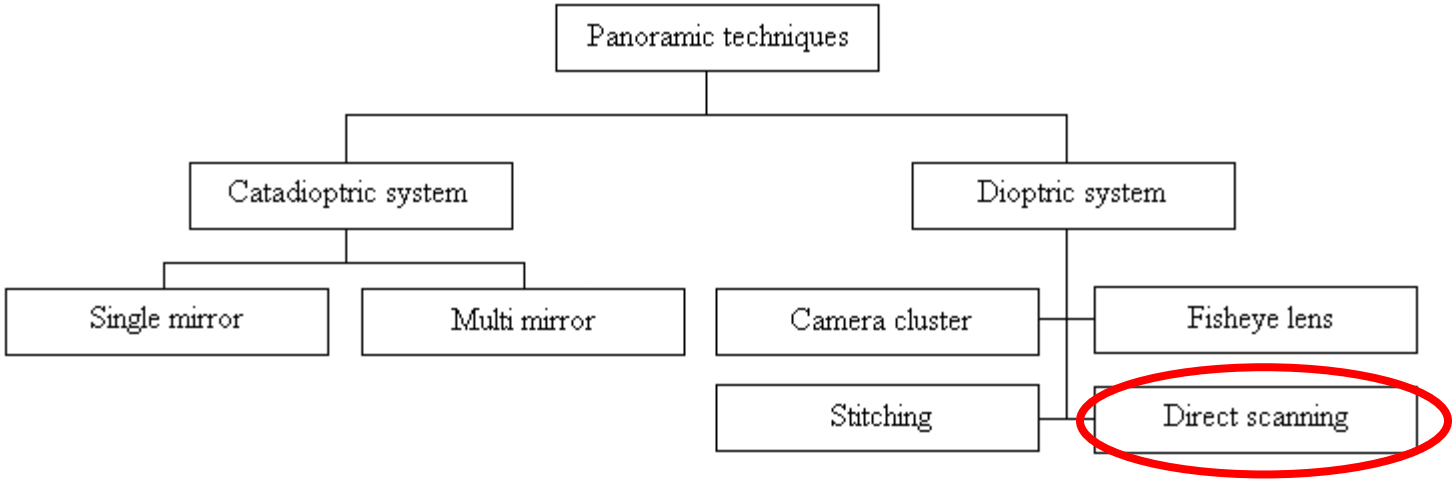
Panoramic techniques



Parts of FODIS panorama camera:

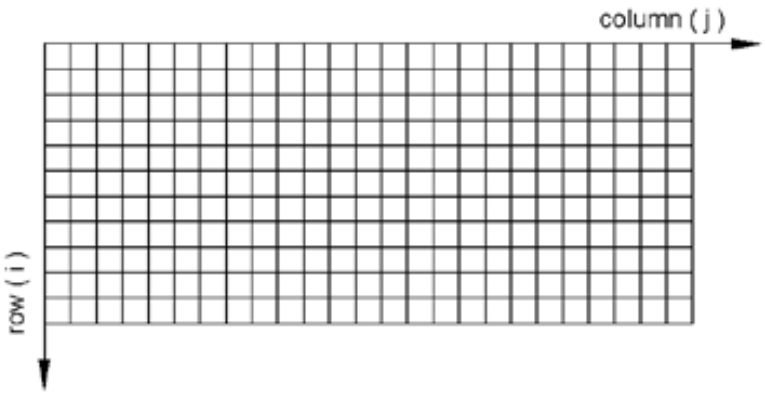
A: Linear array together with electronics
B: Optics with variable focal length
C: Motor for the rotation of A and B

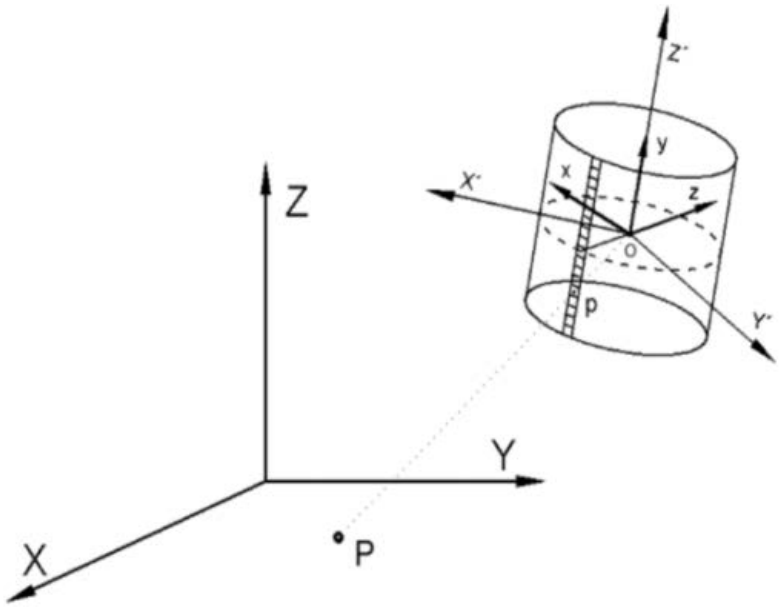
Image format: 36,000 x 7500 pixels (45mm lens)

Measurement and documentation

- Mathematical sensor model
- Calibration & accuracy evaluation of the system
- 3D measurements and applications

Mathematical sensor model





$$y = (i - \frac{N}{2}) \cdot p_y \qquad \theta = j \cdot p_x$$

$$\begin{pmatrix} X' \\ Y' \\ Z' \end{pmatrix} = M_{\omega,\varphi,k} \cdot \begin{pmatrix} X - X_0 \\ Y - Y_0 \\ Z - Z_0 \end{pmatrix}$$

$$\theta = -\tan^{-1}(\frac{Y'}{X'}) \qquad y = \frac{c \cdot Z'}{\sqrt{X'^2 + Y'^2}}$$

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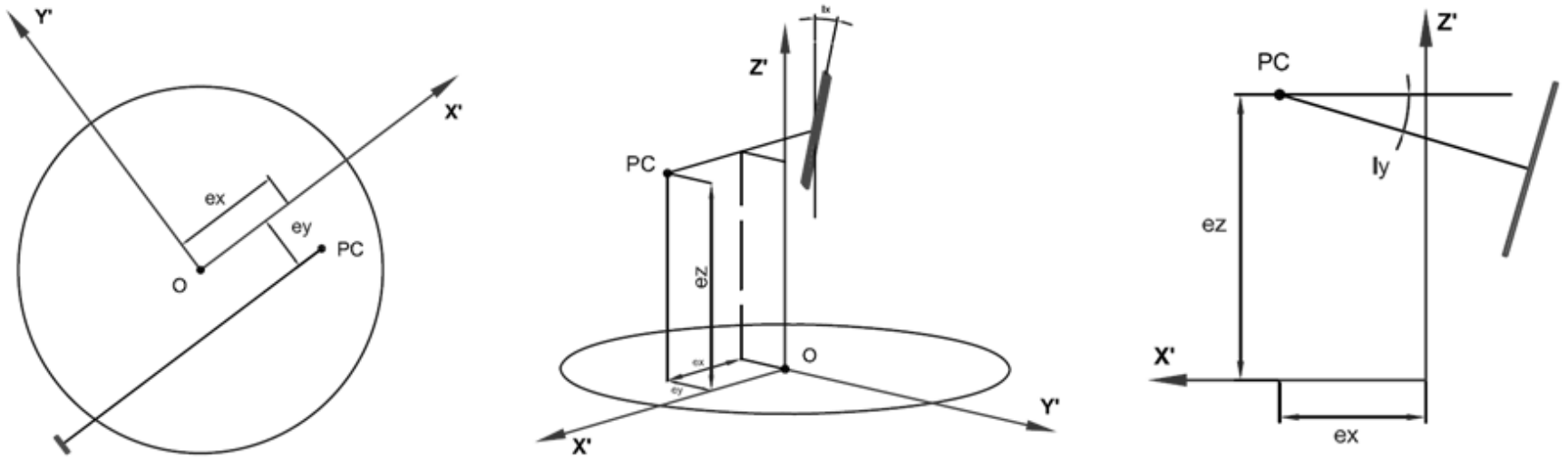
Mathematical sensor model – Systematic errors



(a) (b) (c)

(a) Eccentricities, (b) inclination of the Linear Array, (c) tilt of the Linear Array with respect to the rotation axis.

$$\theta = -\tan^{-1}\left(\frac{\tilde{Y}}{\tilde{X}}\right) + d\theta$$

$$y = \frac{c \cdot \tilde{Z}}{\sqrt{\tilde{X}^2 + \tilde{Y}^2}} + dy$$

$$d\theta = d\theta_{dc} + d\theta_{dy_0} + d\theta_{dp_x} + d\theta_{lx} + d\theta_{ly} + d\theta_{lens} + d\theta_{ex} + d\theta_{ey}$$

$$dy = dy_{dc} + dy_{dy_0} + dy_{dp_x} + dy_{lx} + dy_{ly} + dy_{lens} + dy_{ex} + dy_{ey}$$

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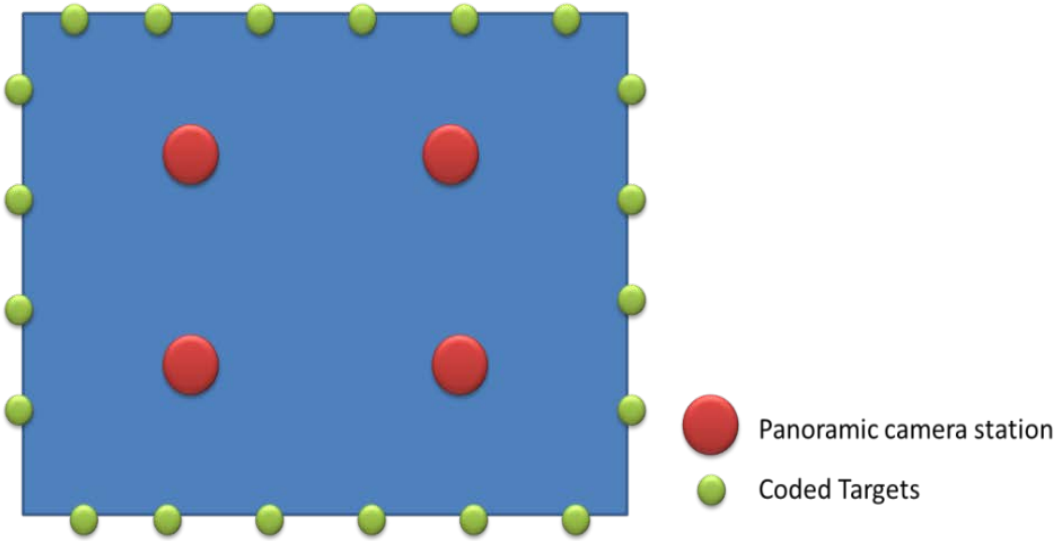
Calibration & accuracy evaluation of the system



Root Mean Square (RMS) of image point residuals:

(0.25, 0.19) pixel (1 pixel is equivalent to 0.008 mm)

Comparison with an independent measurement:

Positioning accuracy in average is **1mm in 10m**

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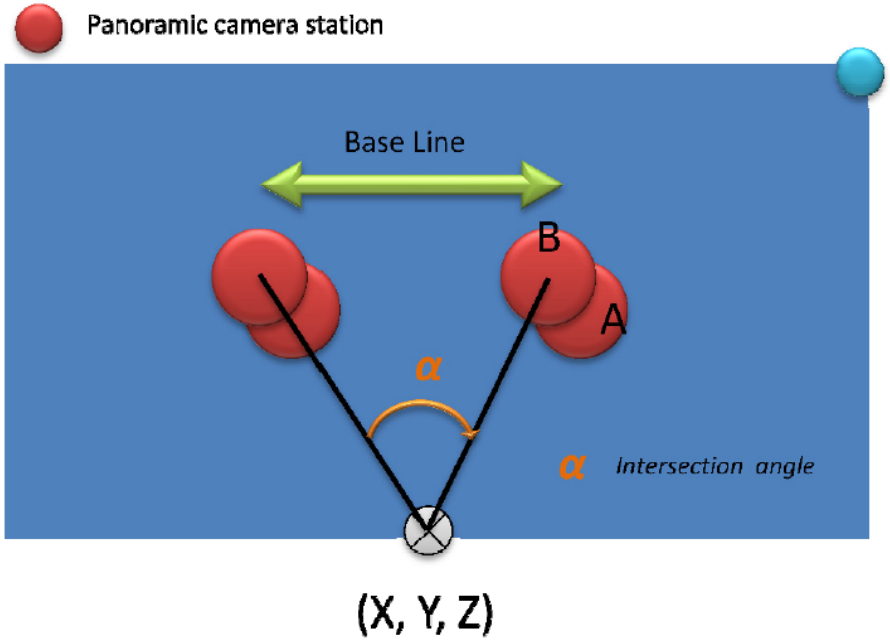
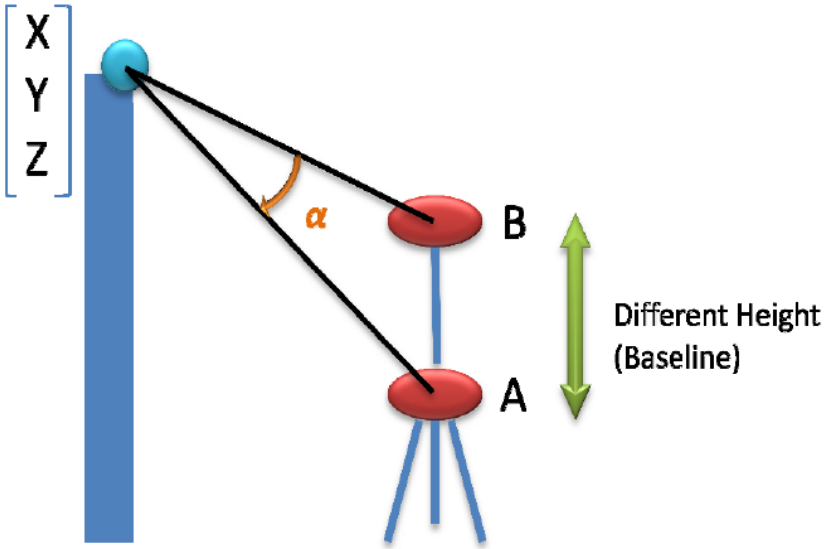
3D measurements and applications

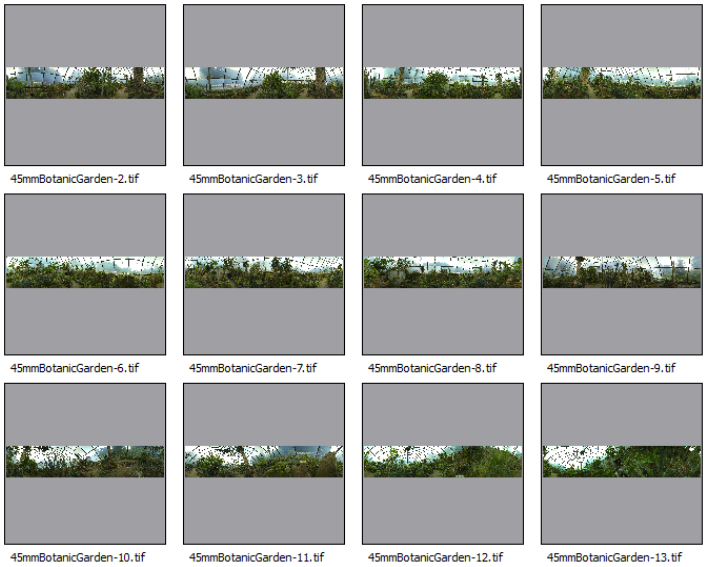
Basic rules:





3D measurements and applications – Botanical garden

Dimension: 25m
Panoramic images: 12



Distance: 5m

Botanical garden – Zürich, Switzerland

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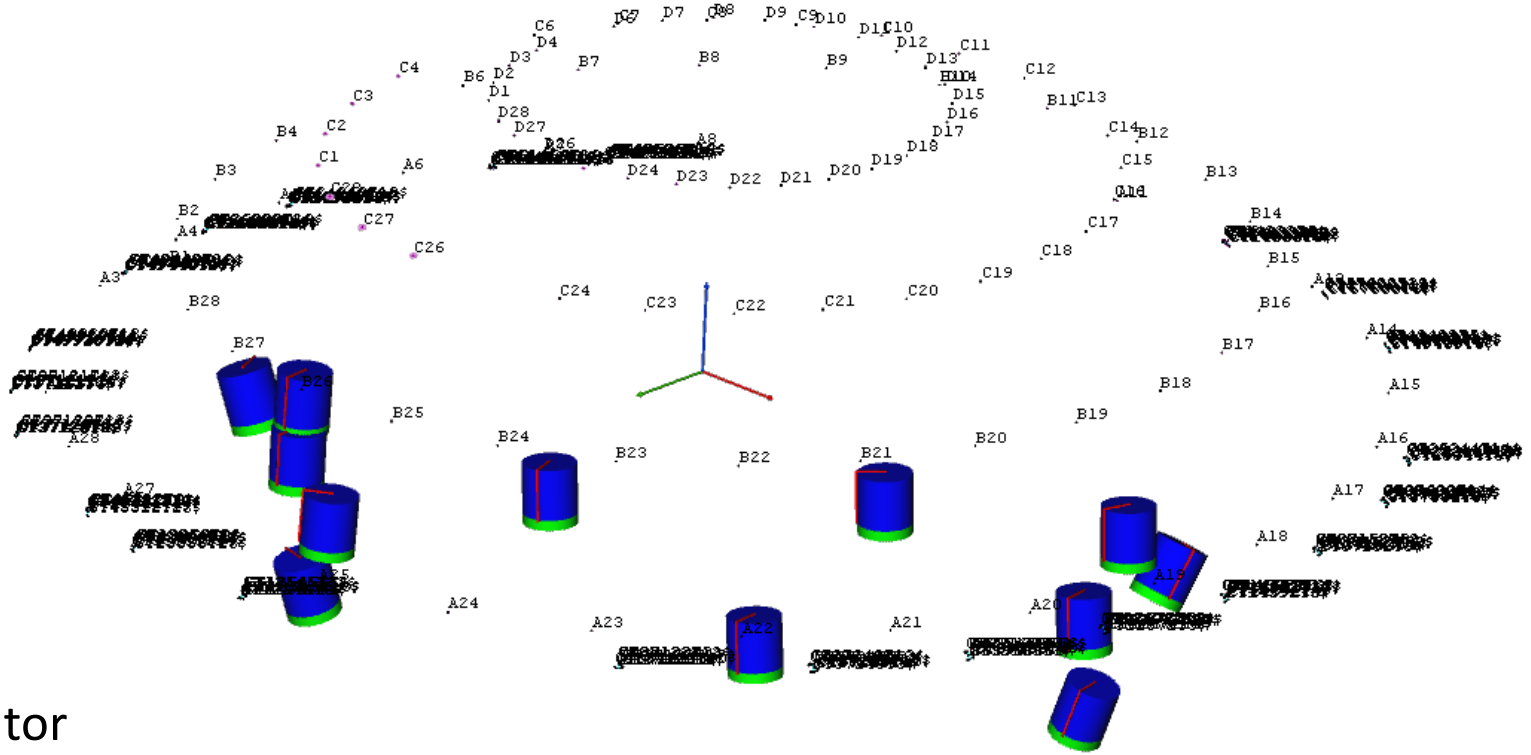
3D measurements and applications – Botanical garden

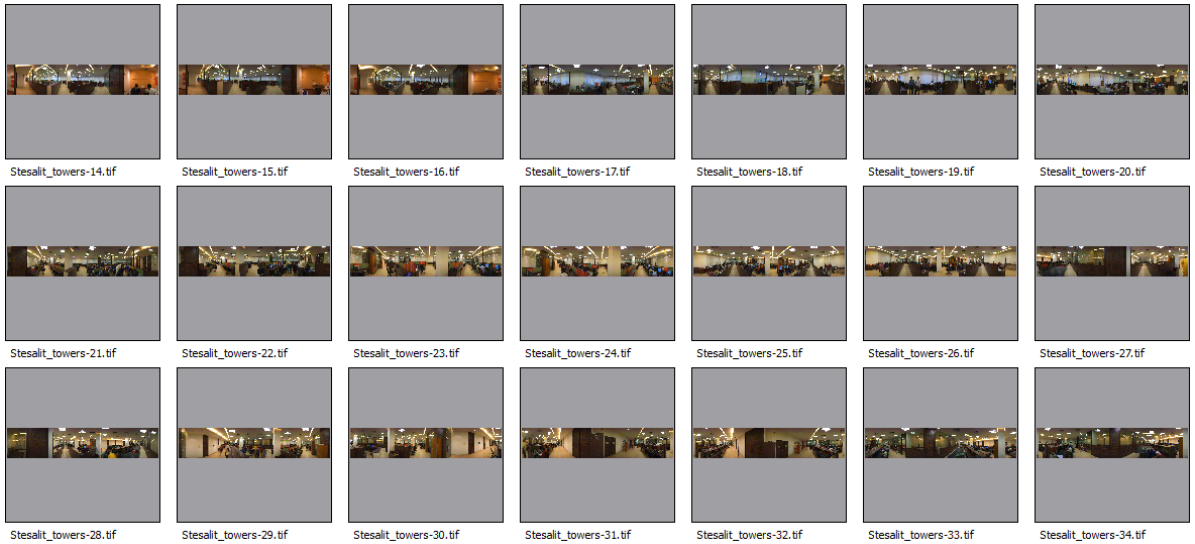
Dimension: 25m



1 operator
1 hour field work
7 hours office work

3D measurements and applications

Dimension: 46m x 12m
Panoramic images: 21



Distance: 35m

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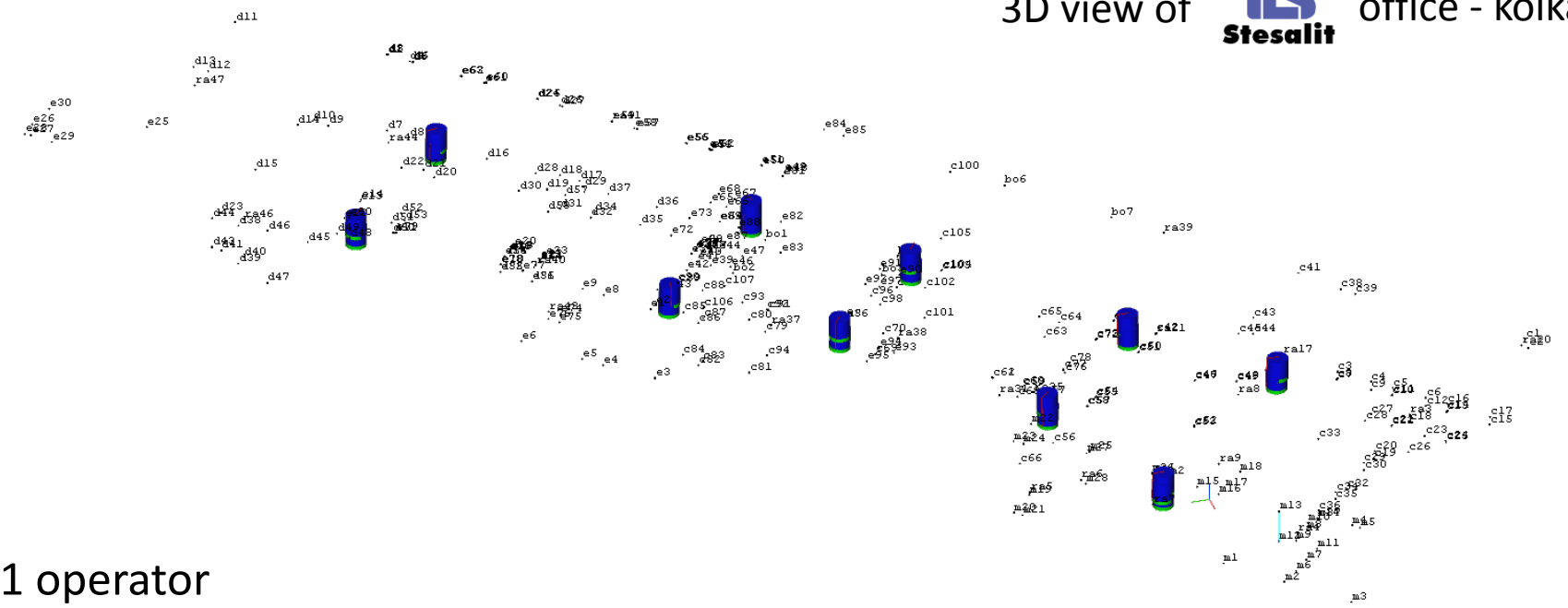
Stesalit office - kolkata

3D measurements and applications

Dimension: 46m x 12m
Panoramic images: 21

3D view of Stesalit office - kolkata



1 operator
3 hours field work
1 day office work

Virtual tour with embed measurements

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Conclusions

Accurate: **1m in 10m**
Reliable: works under rush condition
Time-efficient: **1 operator**, **rapid field and office works**
Rich results: **3D** and **image-based modeling with embed 3D measurement**

Acknowledgement

Part of data for this presentation was prepared with close collaboration of Stesalit Limited – FODIS partner in India.

Thank you for your attention.

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