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Engineering your future

Mike Jones

Jerry Gureghian

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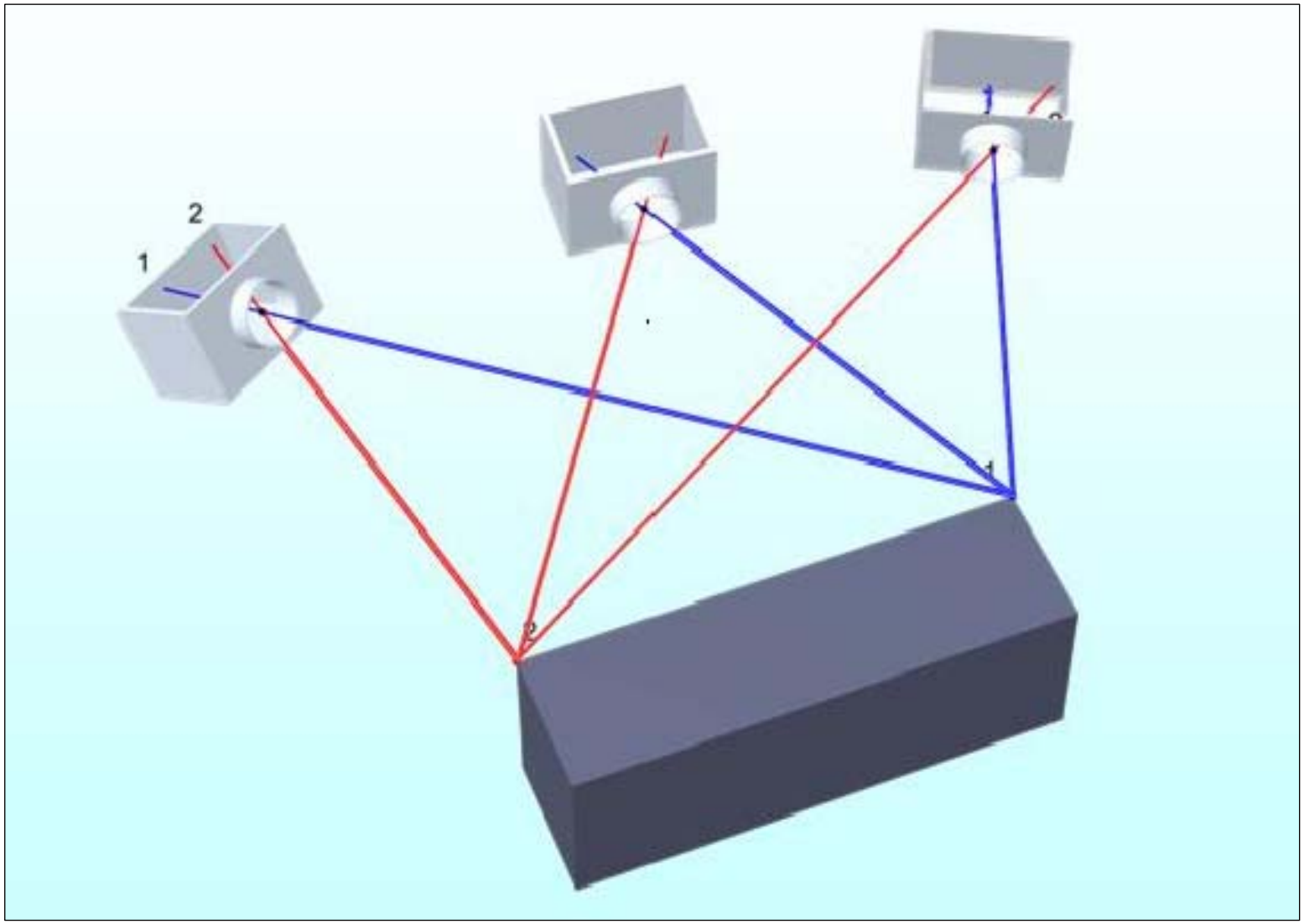
HydroSCAN Technology

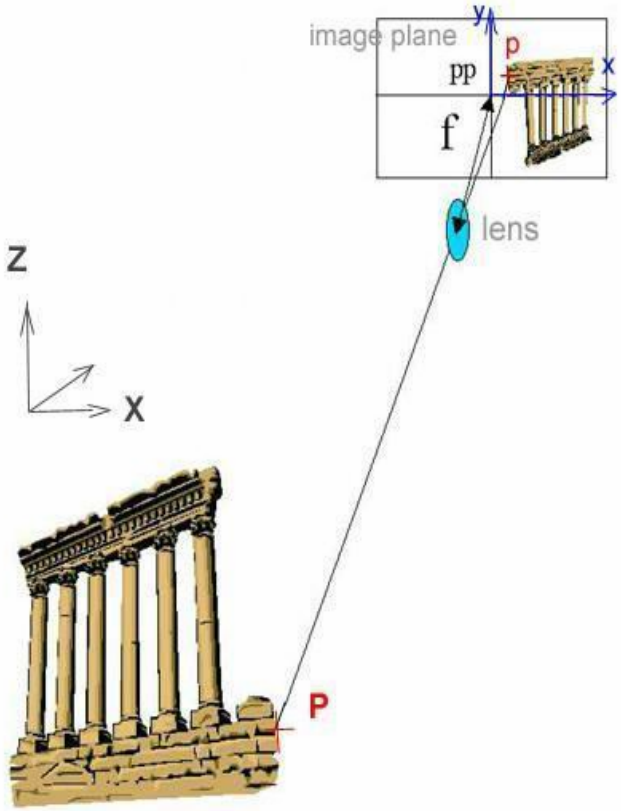
Laser accurate results from digital images

Digital Photographs from different view points provide ‘stereoscopic’ 3D discrete pixel information to the software



A point **P** on the object will project through the lens onto the image plane as p. The point coordinates in the image plane (x,y) are influenced by the point location in object space, the focal length f , the coordinates of the principal point pp, and the lens and other image distortions.

The object point **P**, the lens projection center in object space, and the image point p in image space lie on a straight line. This is the so-called collinearity condition and is given by two equations 4.1.



$$x_p - x_{pp} + \Delta x = -f \frac{(X_P - X_C)m_{11} + (Y_P - Y_C)m_{12} + (Z_P - Z_C)m_{13}}{(X_P - X_C)m_{31} + (Y_P - Y_C)m_{32} + (Z_P - Z_C)m_{33}}$$

$$y_p - y_{pp} + \Delta y = -f \frac{(X_P - X_C)m_{21} + (Y_P - Y_C)m_{22} + (Z_P - Z_C)m_{23}}{(X_P - X_C)m_{31} + (Y_P - Y_C)m_{32} + (Z_P - Z_C)m_{33}}$$

4.1

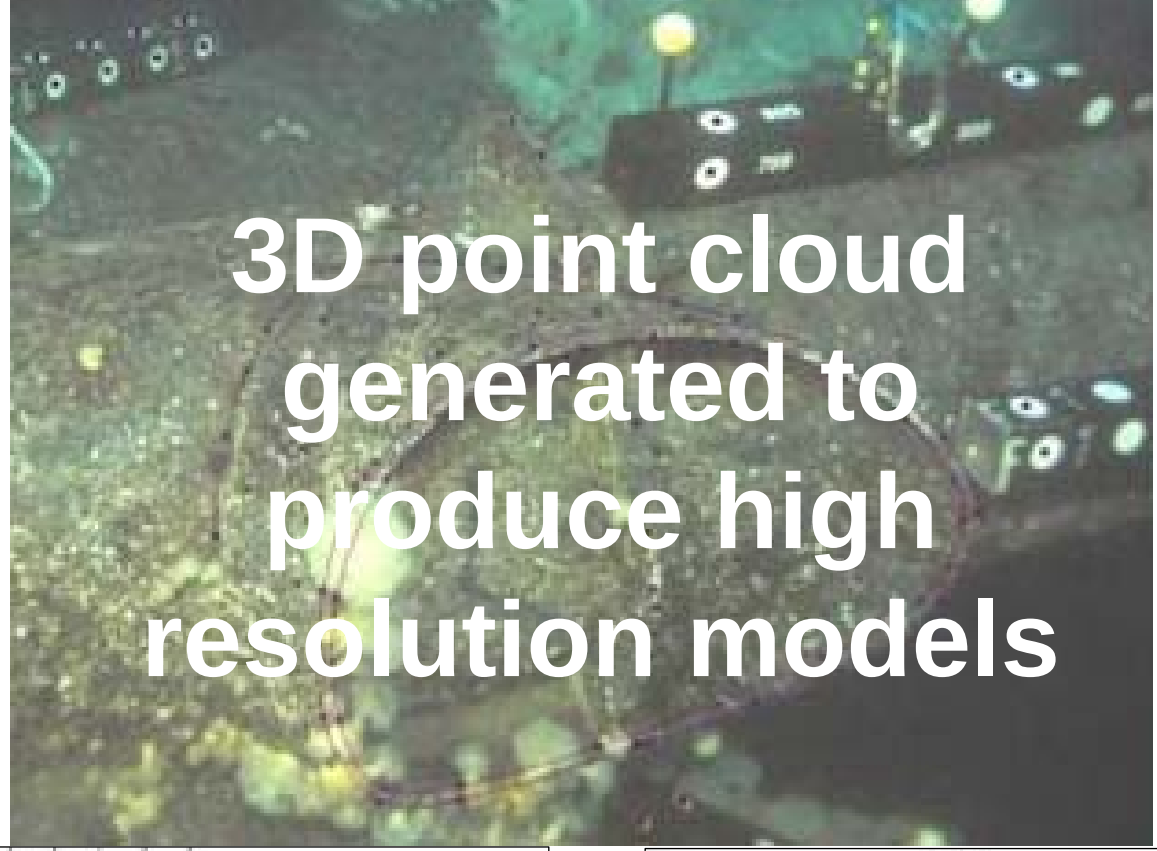
where Δx *and* Δy are corrections due to distortion parameters, X_C, Y_C, Z_C are the coordinates of the projection center in object space, and m_{ij} are the elements of the matrix R^{-1}, *where* R is the rotation matrix containing rotation angle around X (pitch), Y (roll), and Z (yaw).

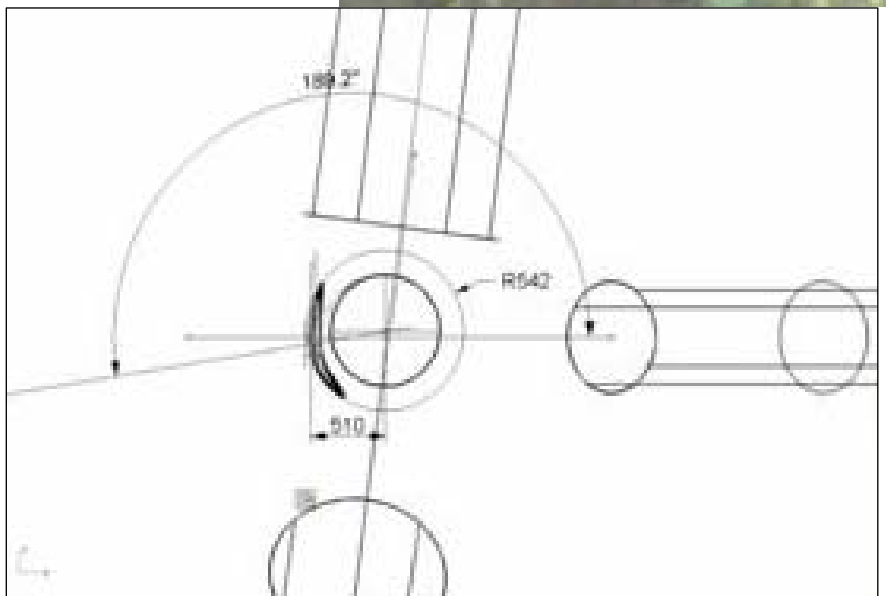
The corrections due to distortion is given by:

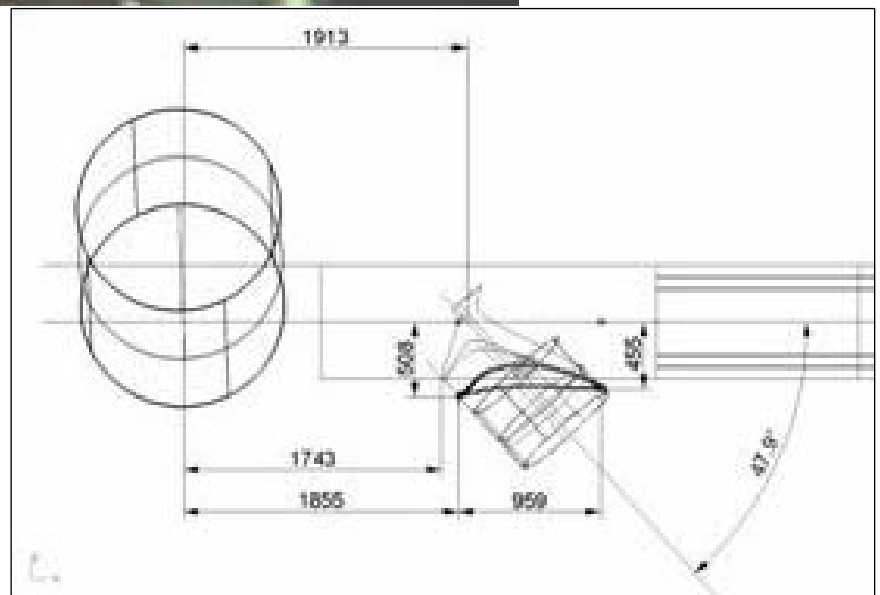
$$\Delta x = A(y_p - y_{pp}) + k_1 r^2 x + k_2 r^4 x + P_1(r^2 + 2(x_p - x_{pp})^2) + 2P_2(x_p - x_{pp})(y_p - y_{pp})$$

4.2

Advanced algorithms used to process the pixel data


3D point cloud
generated to
produce high
resolution models


R542
810


1913
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495
1743
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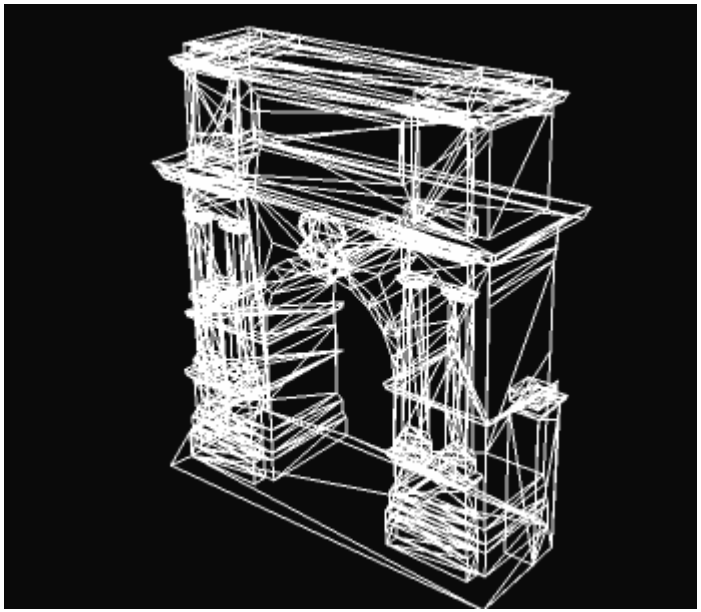
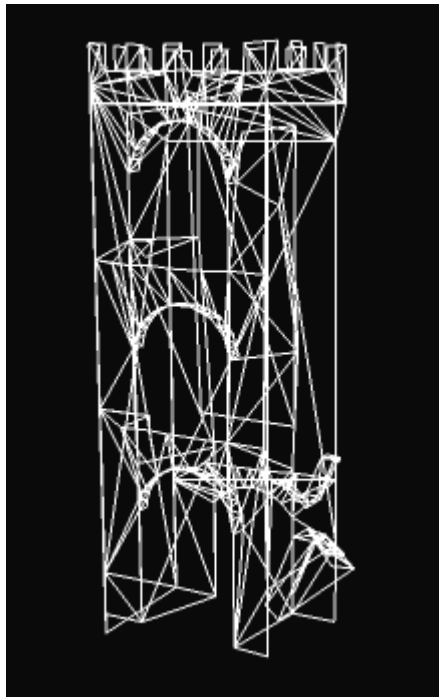
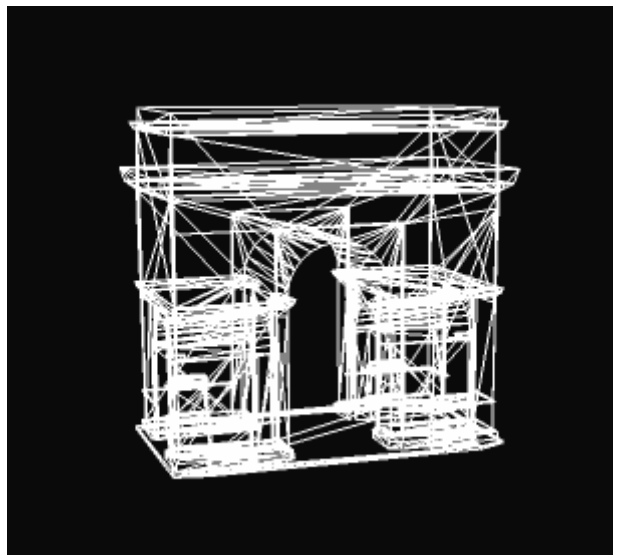
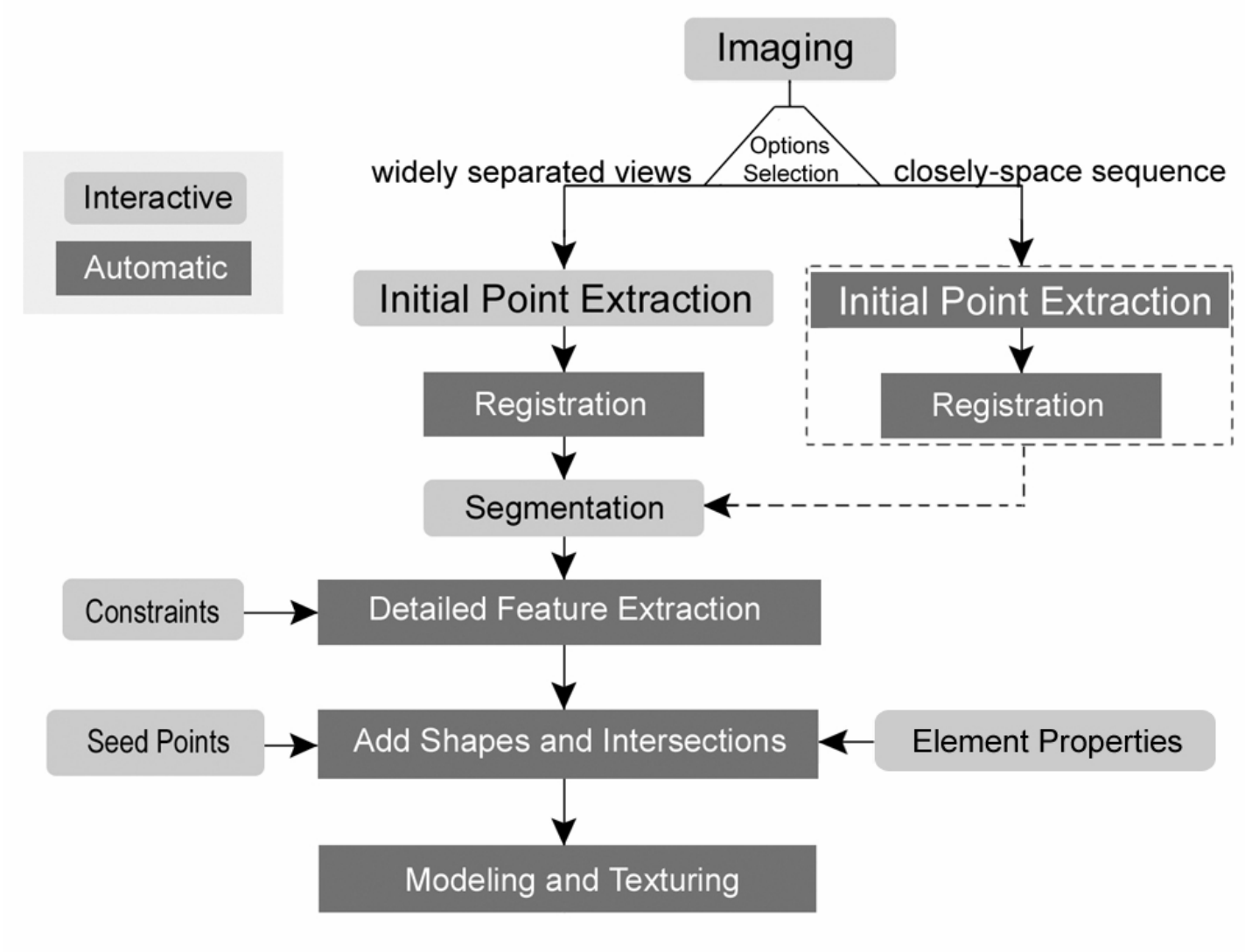
959
47.5°







PDT method - summary



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Single camera set up

Stereo camera set up

Basic Camera Equipment and Calibration Frame

Sony DSC-P120

Calibration Frame

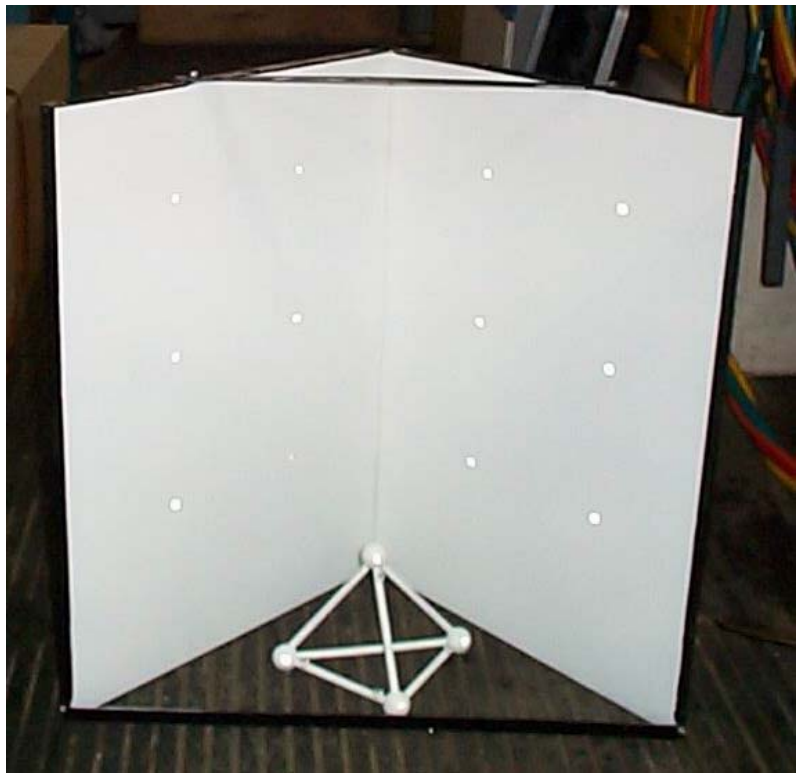


Image Capture Method

Image capture overlap for shared reference points increasing accuracy & data analysis

60% Overlap

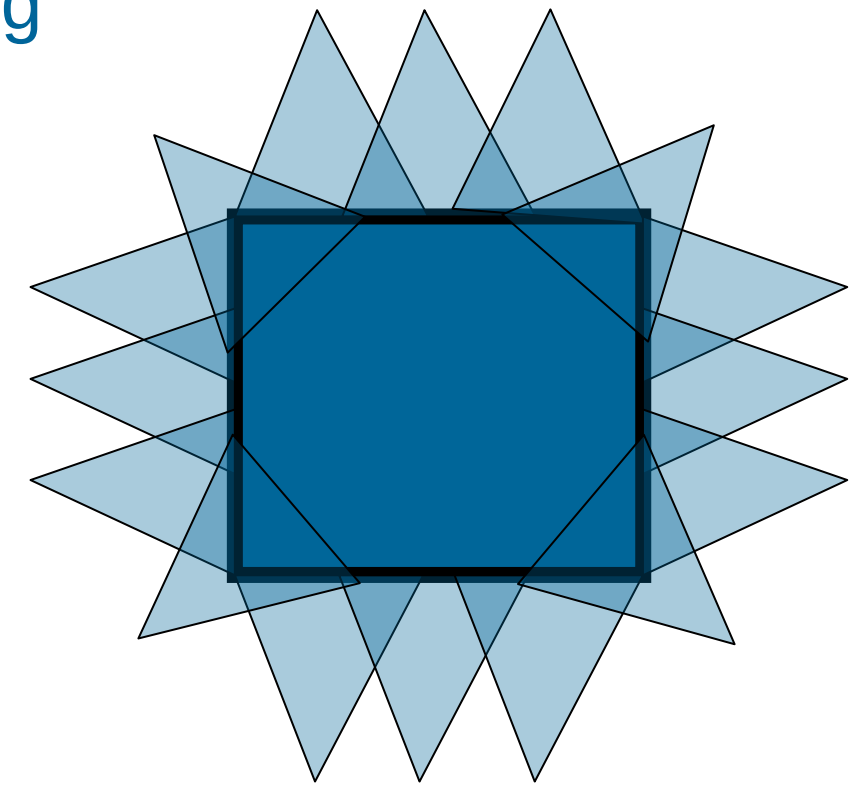
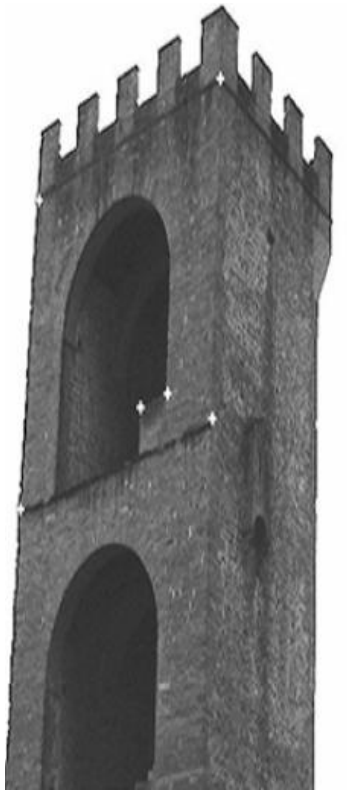
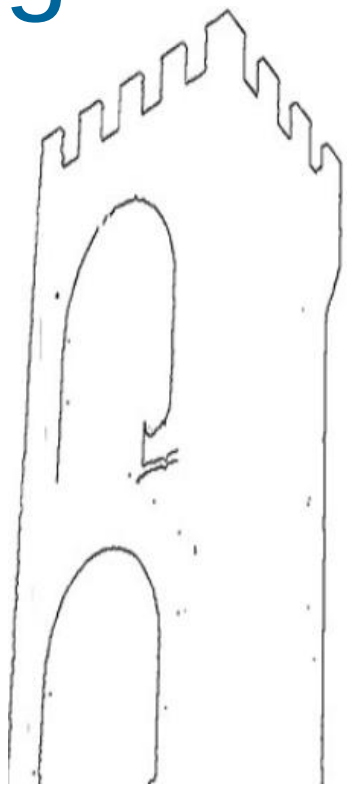
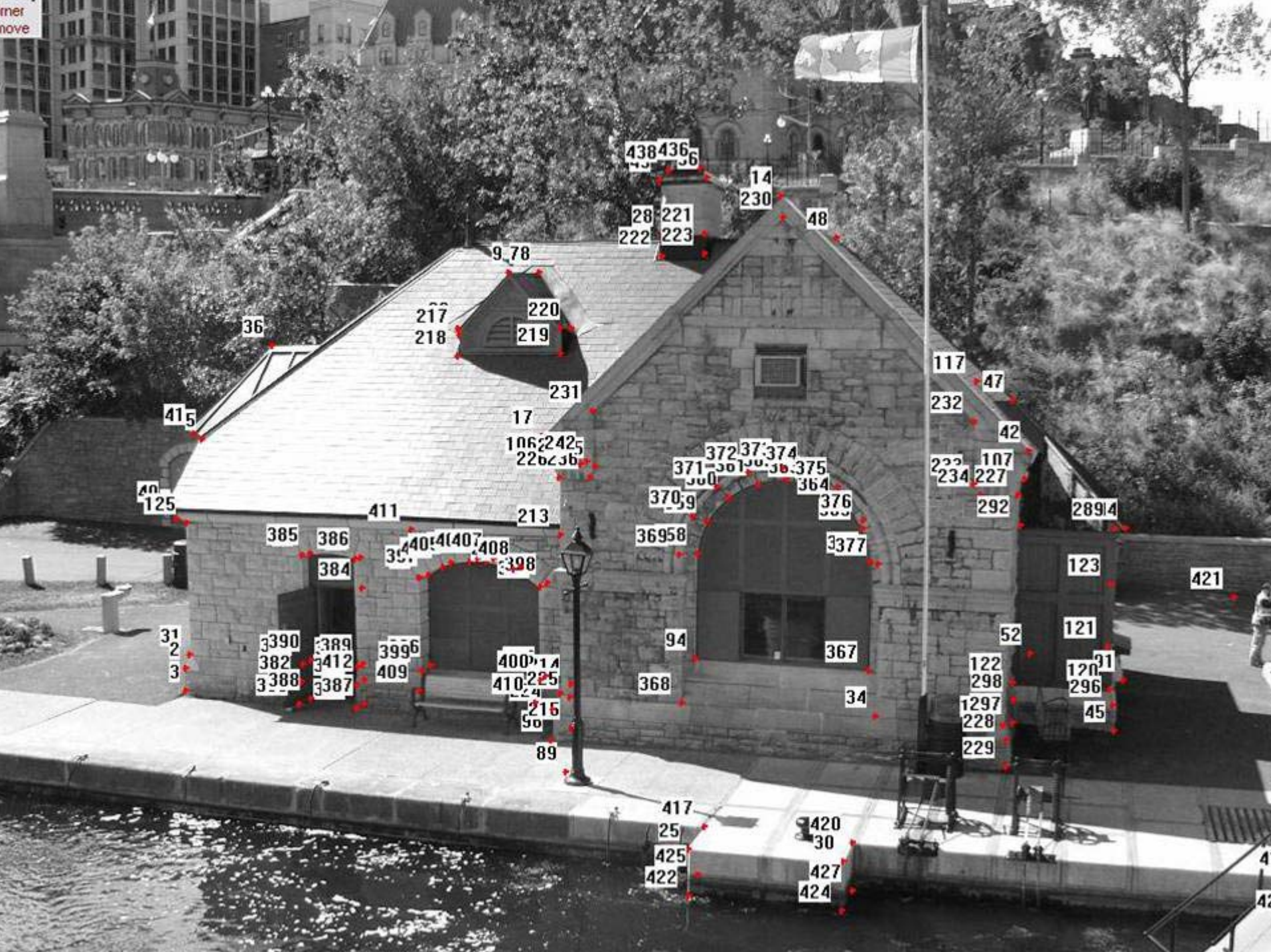


Image Processing





Automatic point extraction and detection of edges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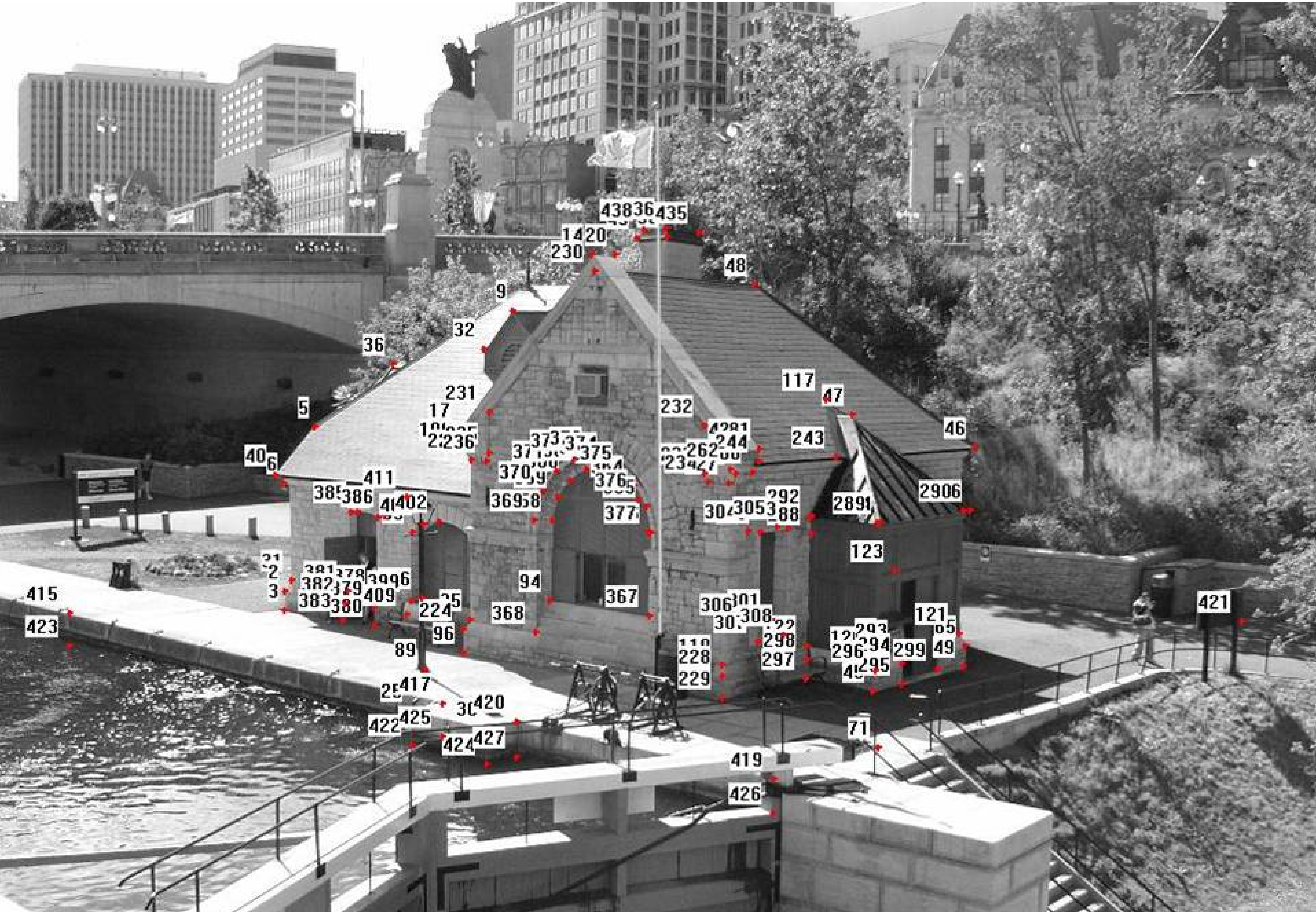

435
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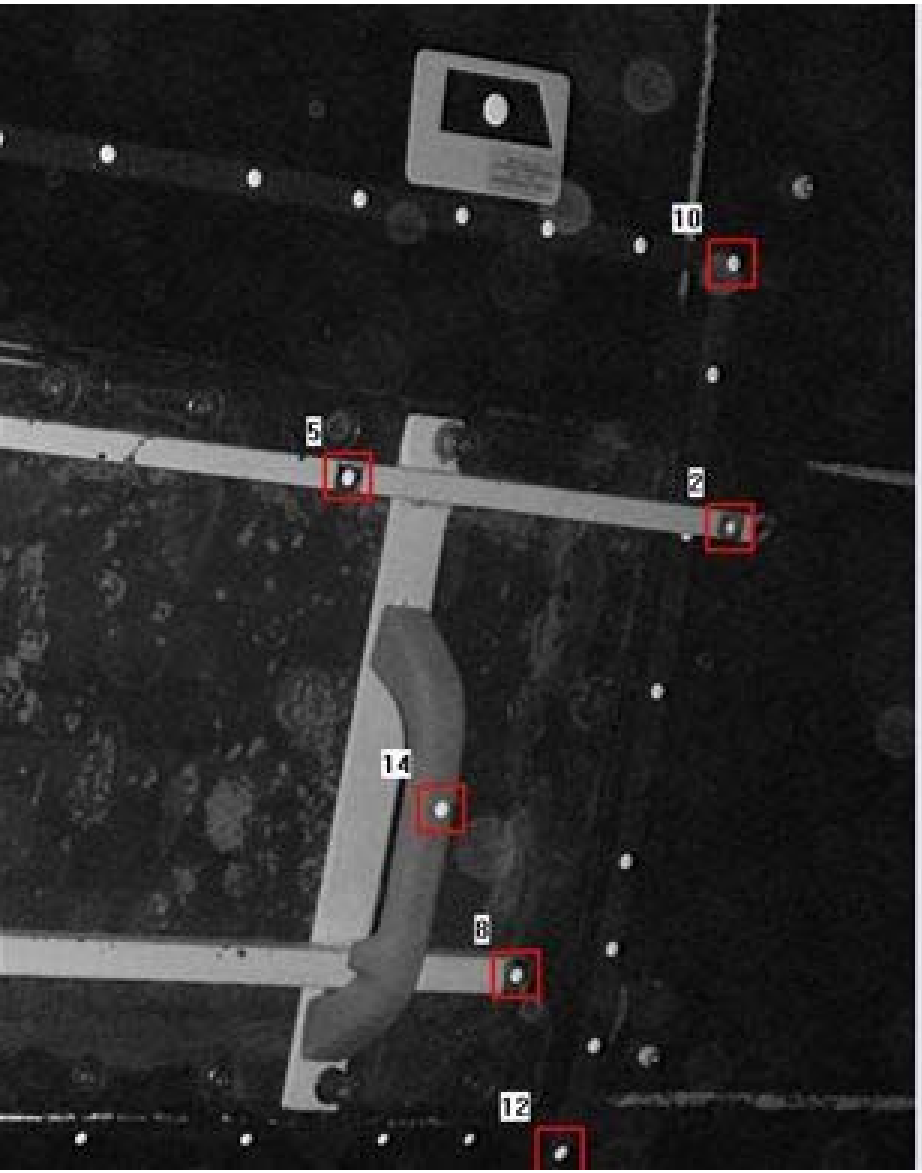
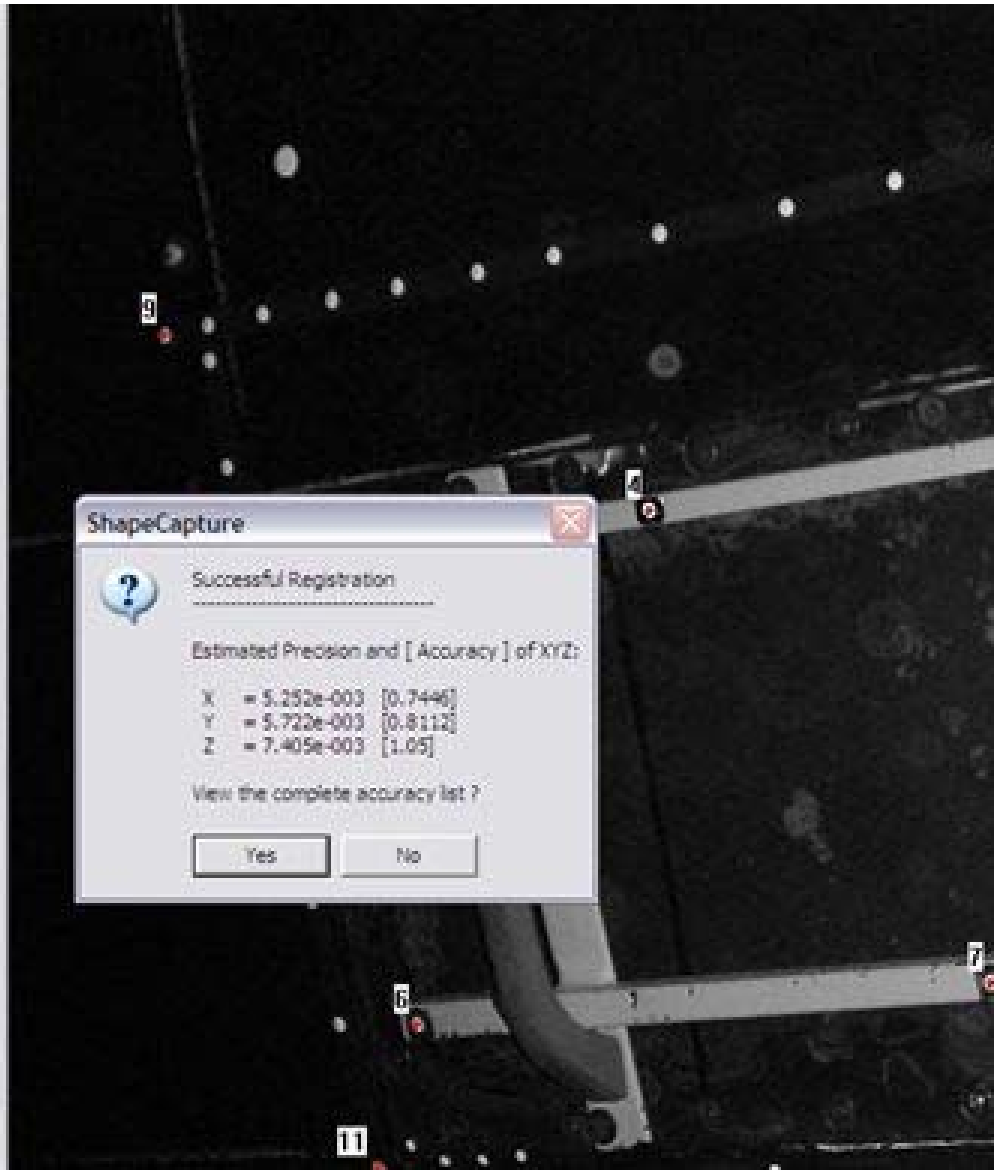
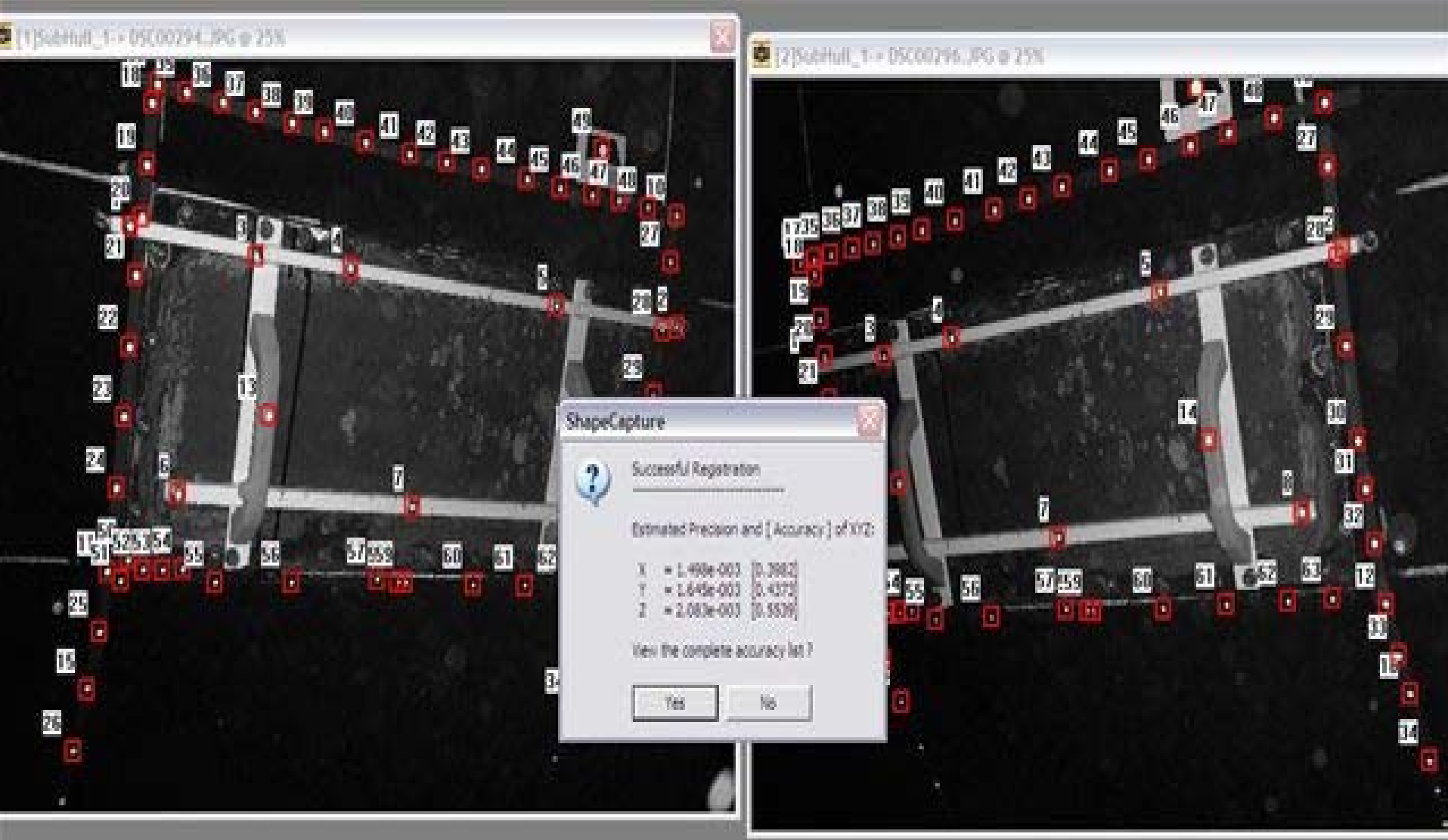
Manual point selection & registration

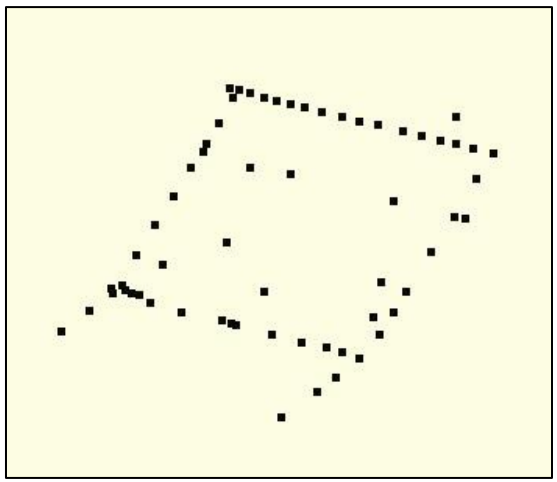




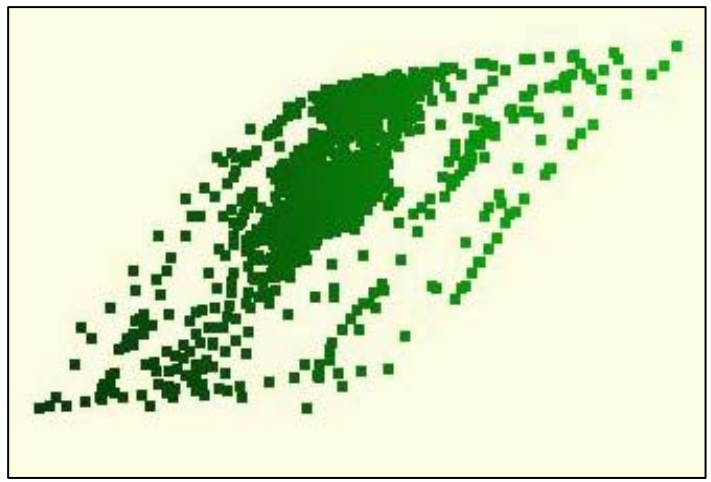


Automated point selection & registeration

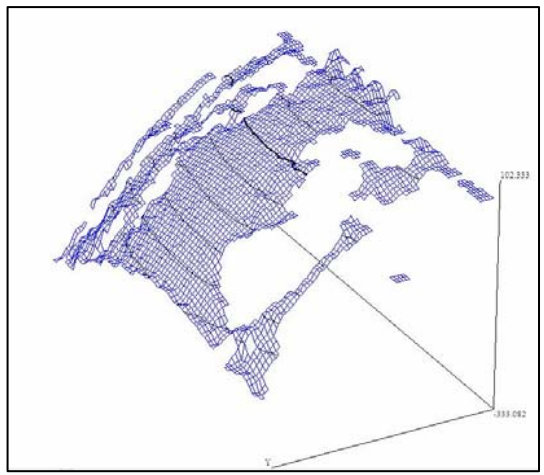
Data processing: Automatic generation of 3D point clusters & contour mapping



3D Small Point cluster



Point clusters extracted from individual pixel data in the images



Early Stages of Contour Maps

Image texture overlay

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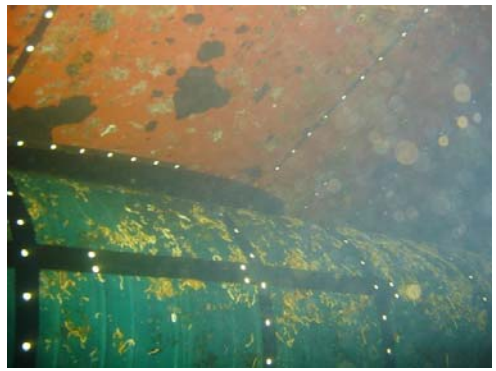
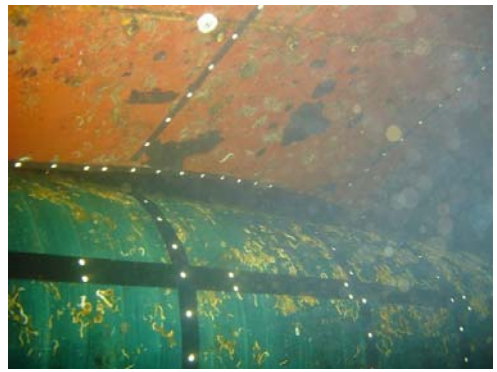
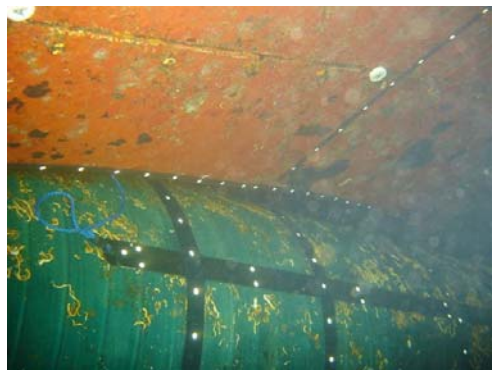
Underwater Application

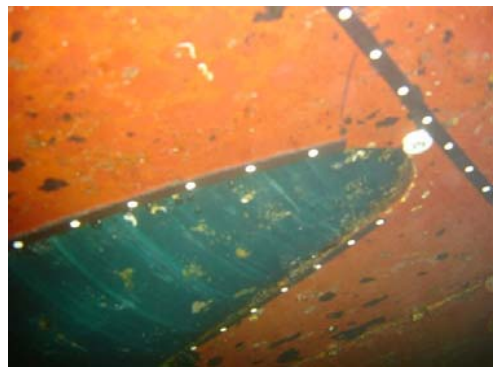
Survey of the Defence Diving School Training Aids

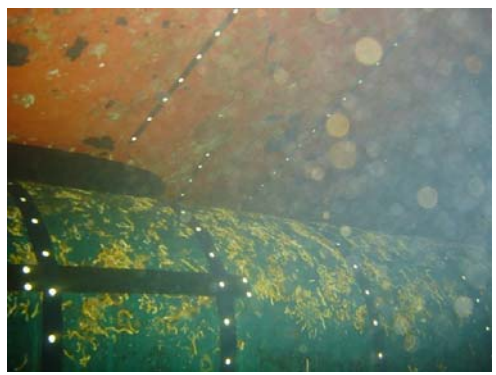
Underwater Application:
Defence Diving School Training Aids



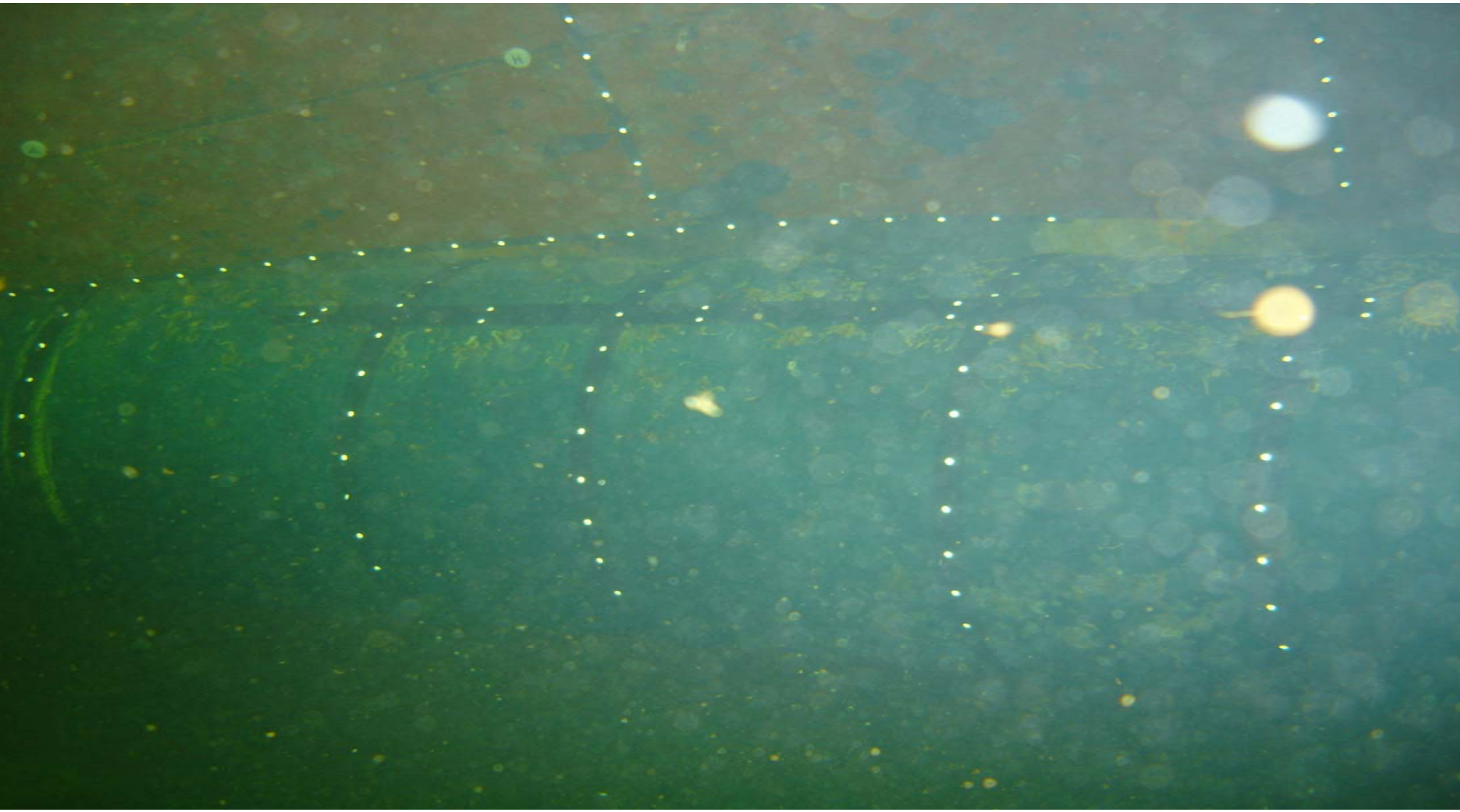




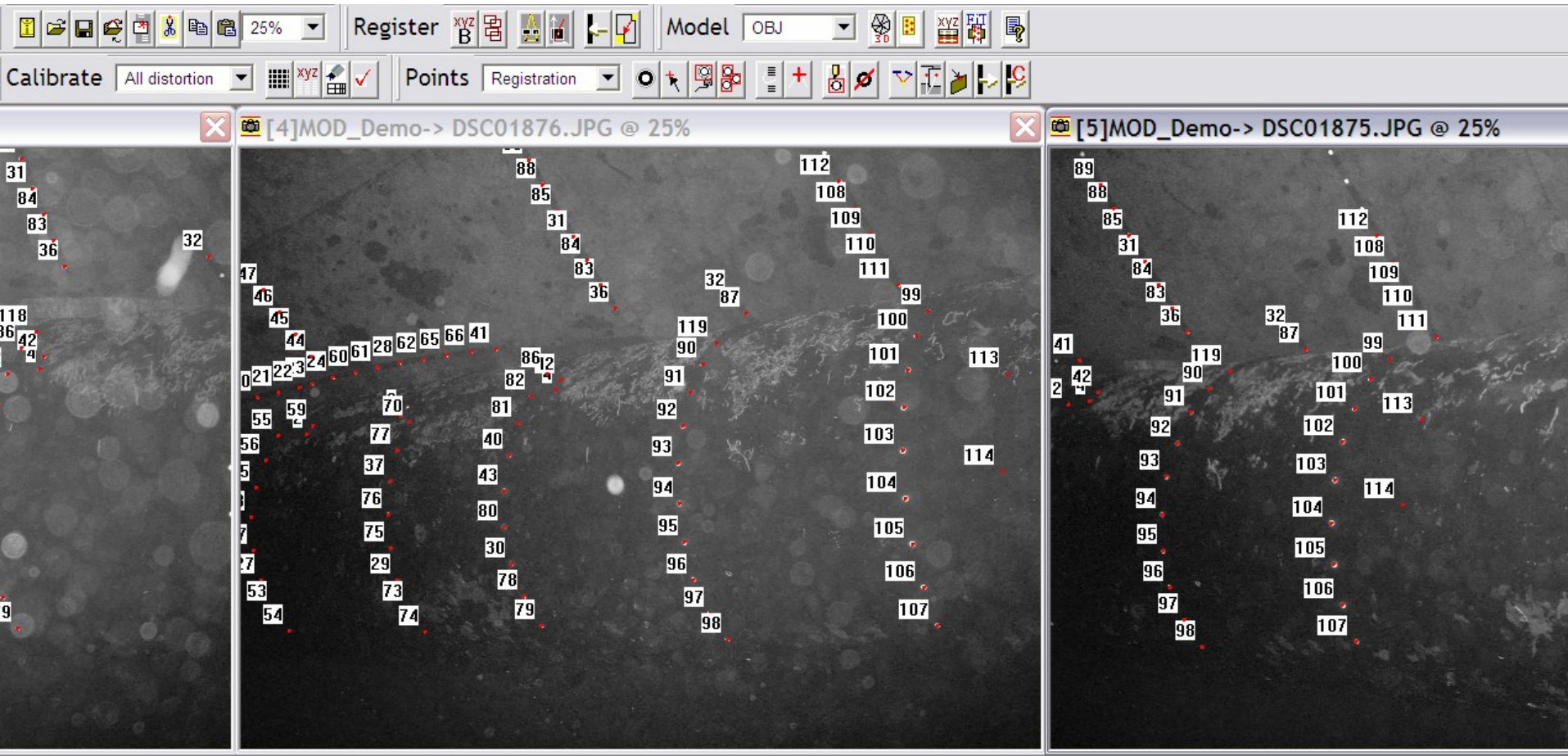




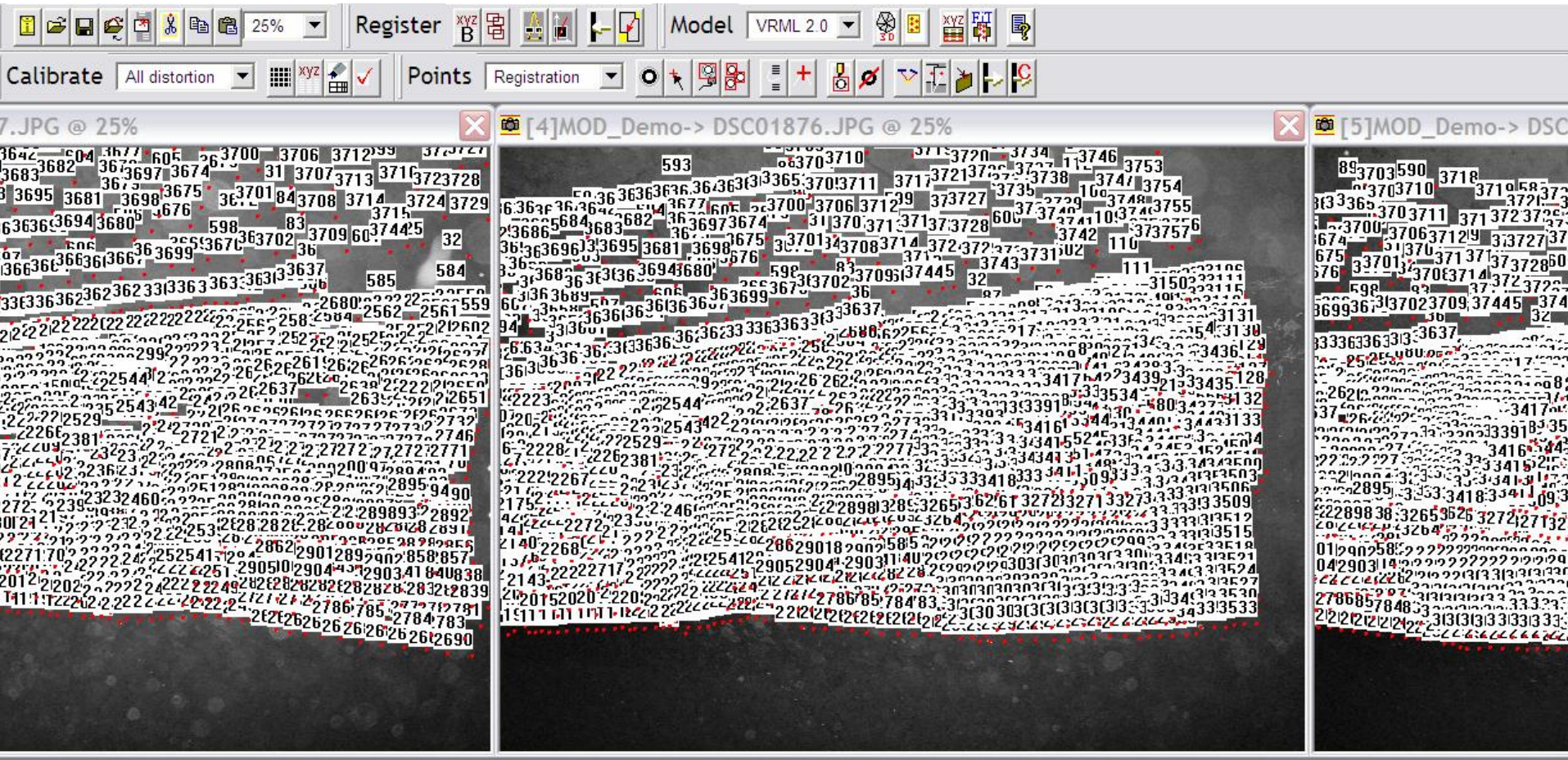
Composite of 5 Photographs



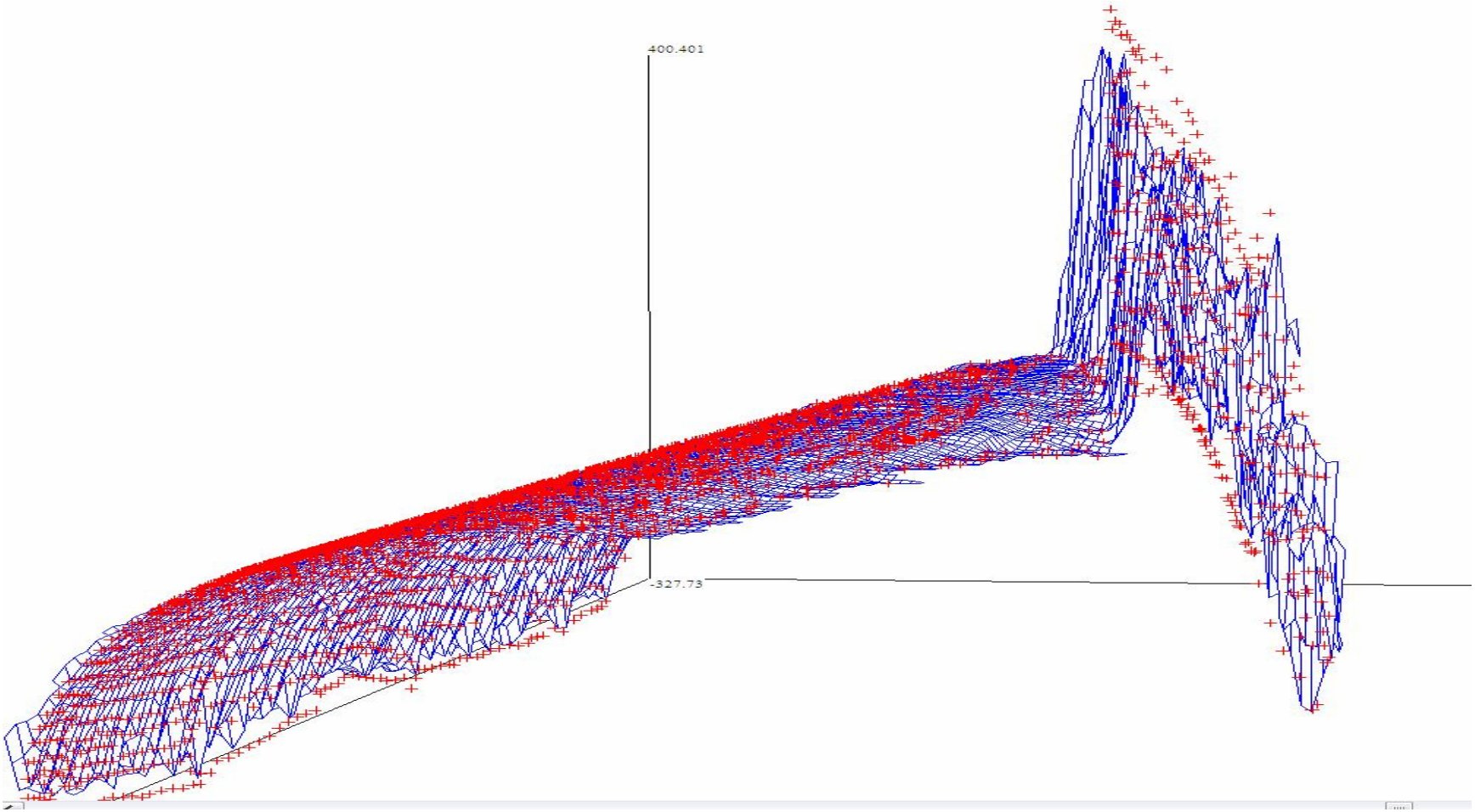
Shaft Indicated Points



Computer Generated Points

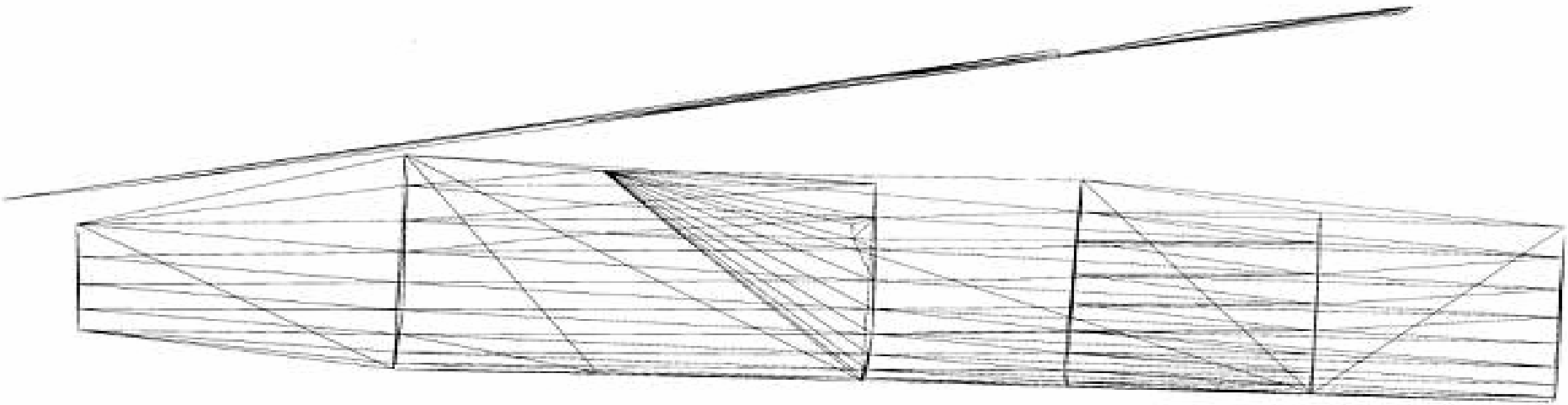


Shaft and Hull Point Cloud Data



Pixel data used to generate 3D point cloud

Point cloud data exported into formats such as AutoCAD



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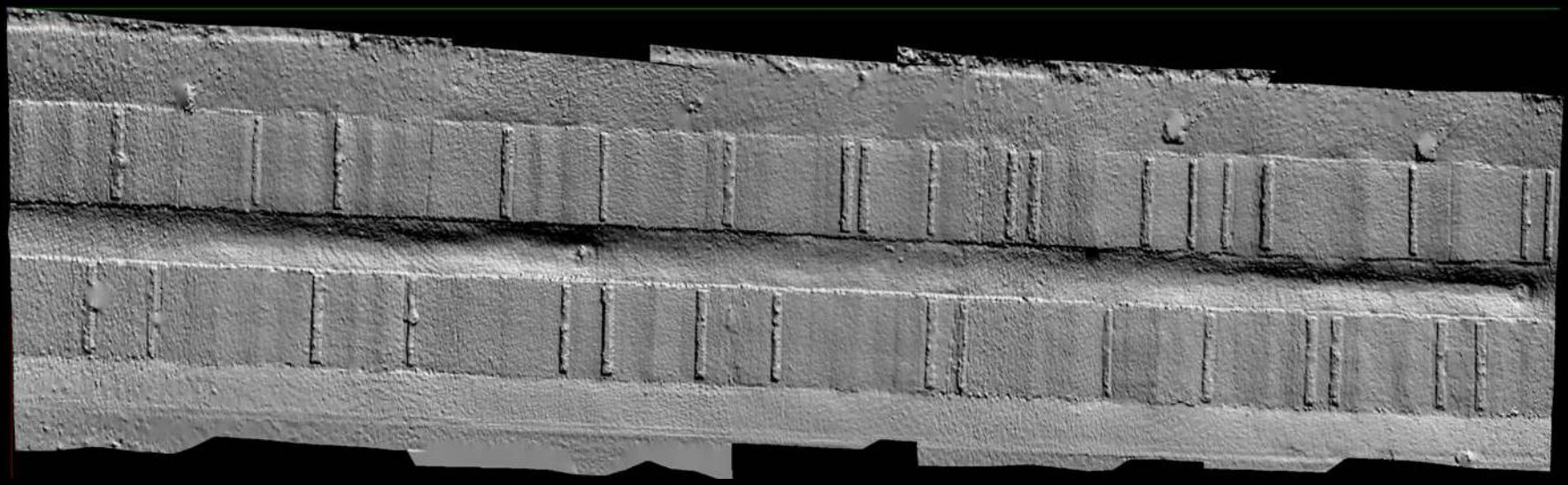
Surface application using the stereo camera set up


AUTOMATED ROAD SURFACE
PROFILE MEASUREMENT

Image capture: Stereo camera mounted on cherry picker moving at 15 mph capturing up to 30 frames per second

Stereo images combined to create 3D point cloud

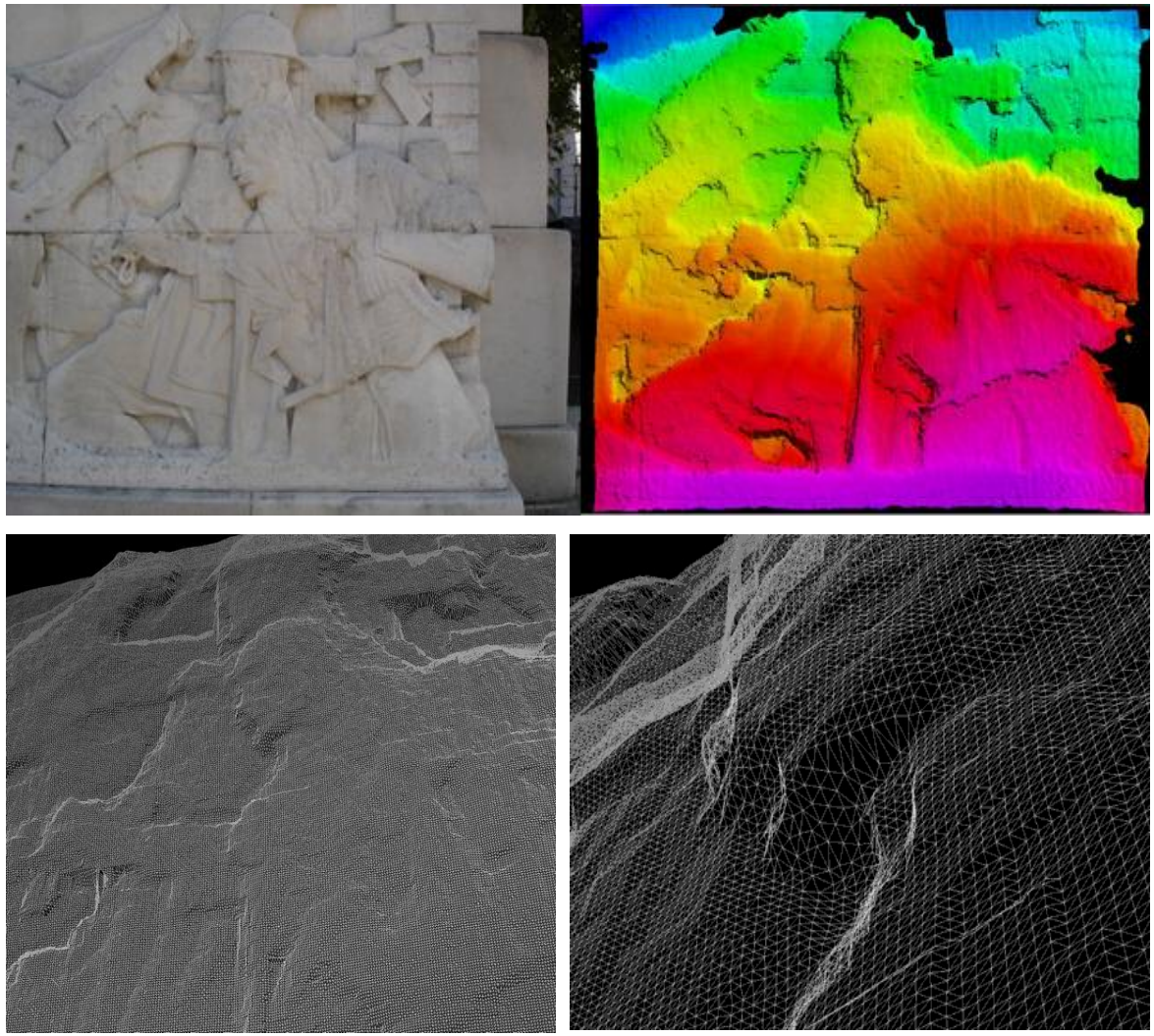


This 3 km road section contains over 140 million points with an accuracy of 1 mm in surface elevation.

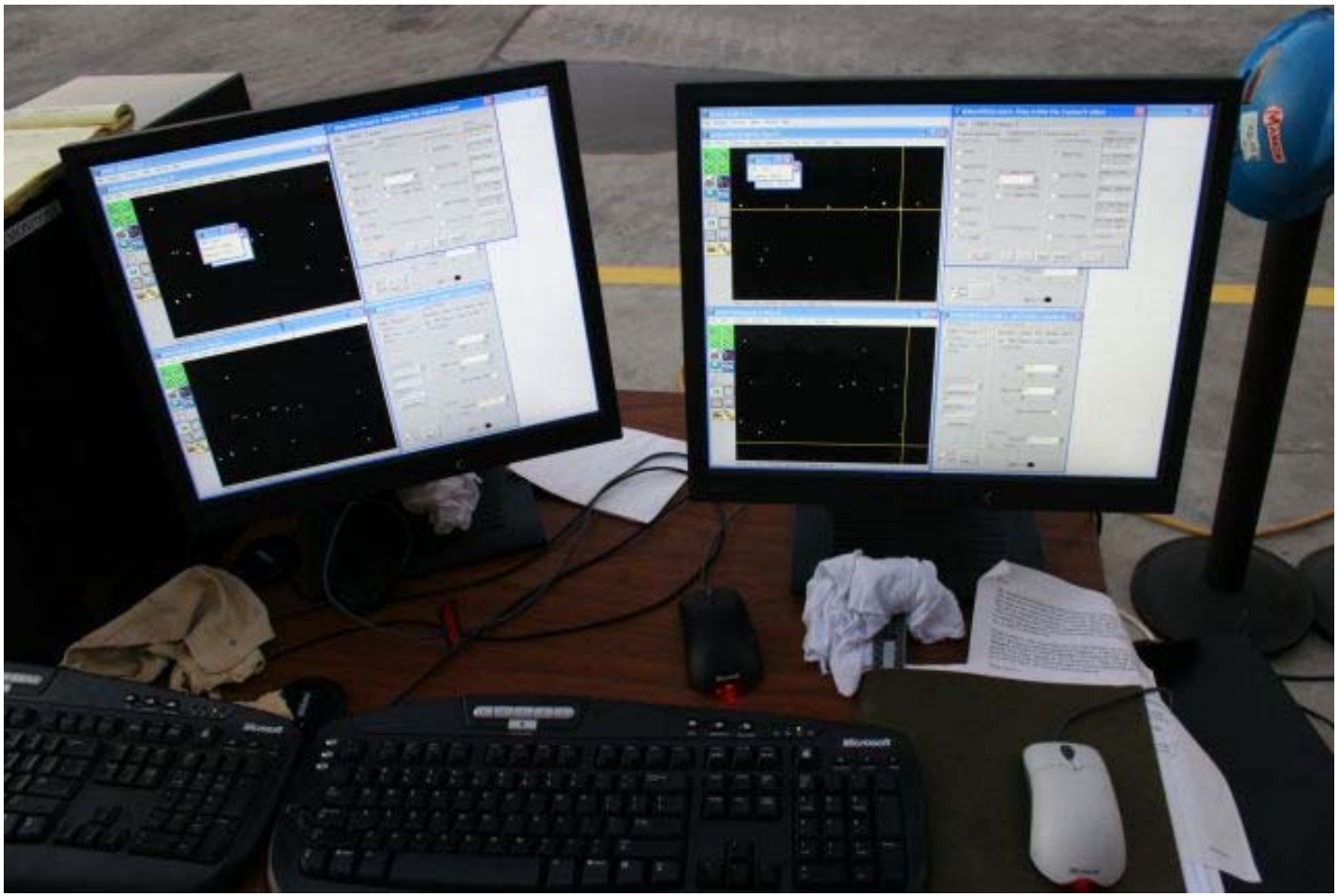
Image matching with high resolution cameras exceed the accuracy of conventional laser scanning with lower cost and faster data throughput.

Accurate high resolution textures can be applied to wireframes for measurement and interpretation.

Any digital camera properly calibrated can be used



Adaptive targeting approaches for dynamic measurement of large structures



Deployment capabilities

Surface

Underwater

Questions?