Optical Validation of Precast and Reinforced Concrete

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Approach

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Building Information Modeling (BIM):
► Building design, project planning and construction on one common dataset
► Detailed 3D construction plans down to reinforcement bars
► Usage is spreading rapidly

Idea:
► Automatic validation of construction to BIM
► Enrichment of plans by tolerance values and building regulations
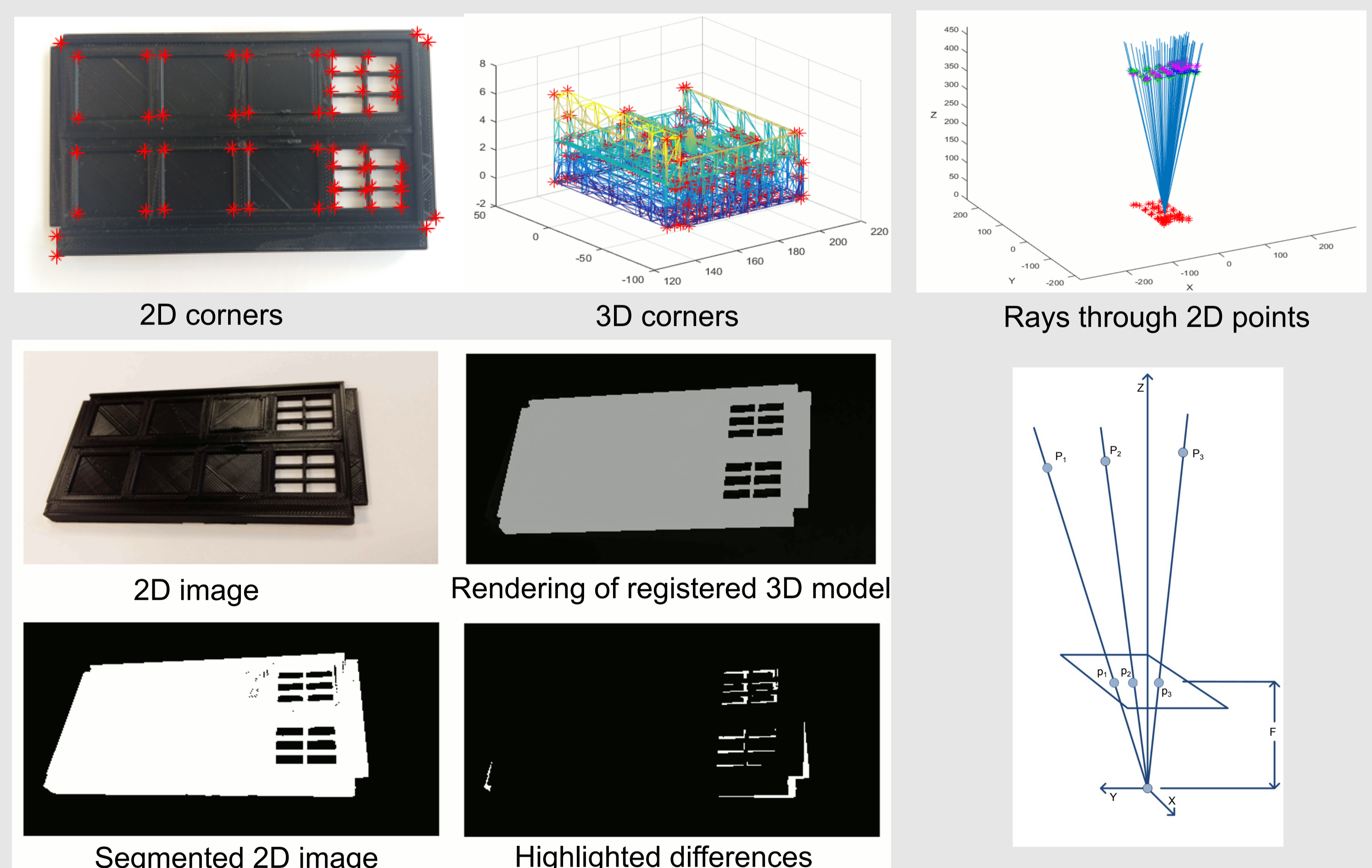► Usage of optical sensors and computer vision to validate construction
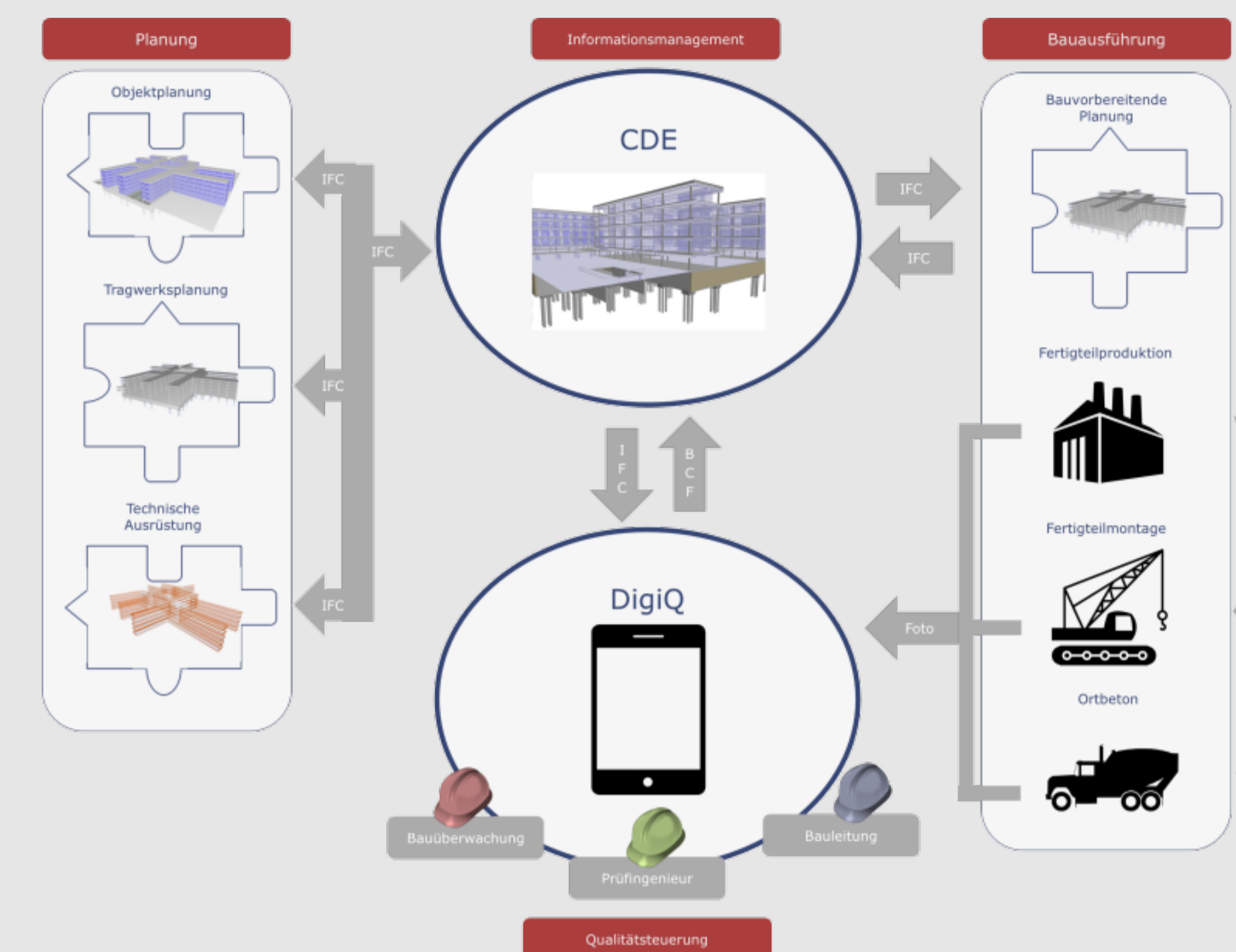
Automatic Optical Validation of Reinforcement Bars

► Image segmentation using canny edge detection
► Segmentation of object by contour detection (largest)
► Iterative optimization of external camera parameters
  ► Initialization by bounding box
  ► Analyses by syntheses approach
  ► Rendering of 3D model using estimated camera
  ► Minimize distance of every object pixel to image pixel using 2D Hausdorff metric
► Visualization of final result as augmented reality

| Edge detection | Contour extraction | 3D bounding box |
| Convex hull | 2D bounding box | Augmented result |
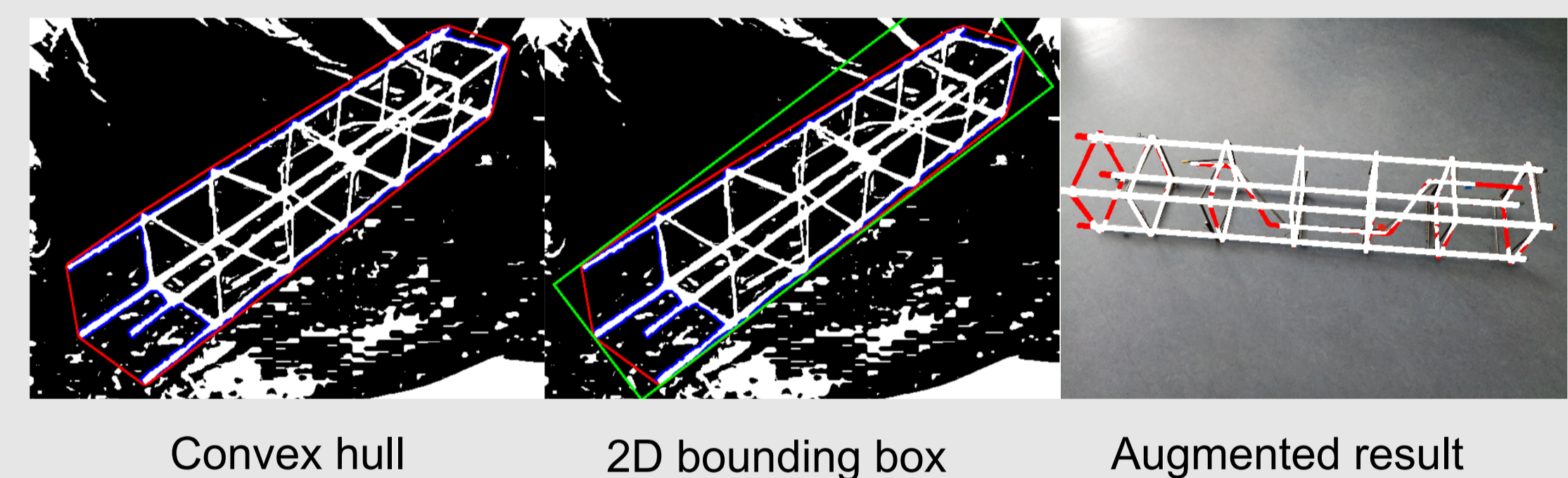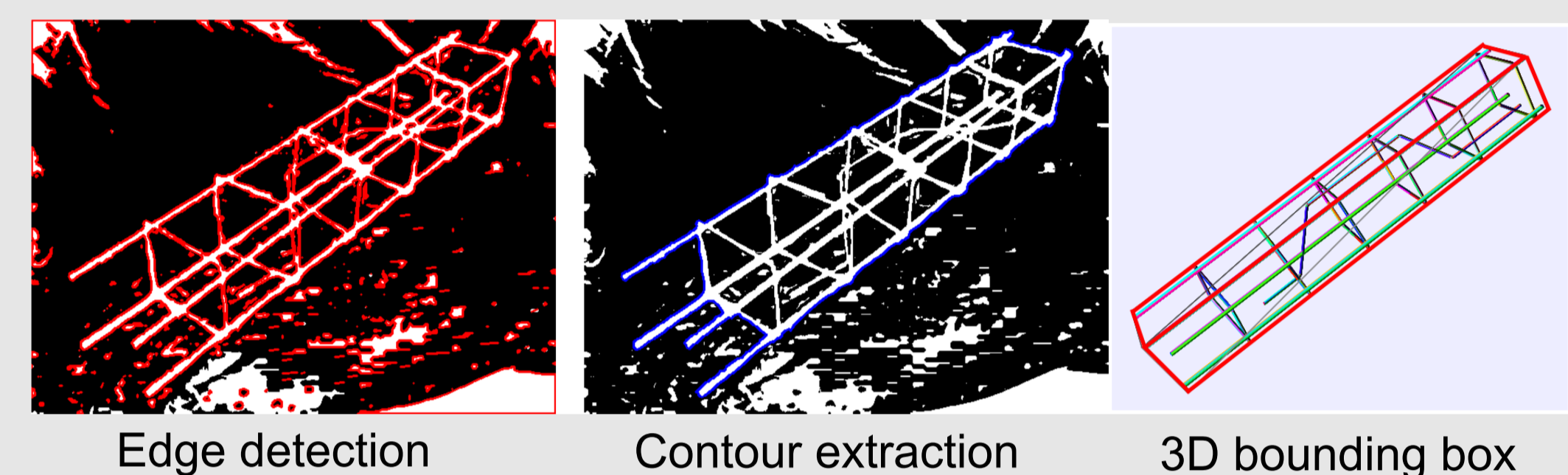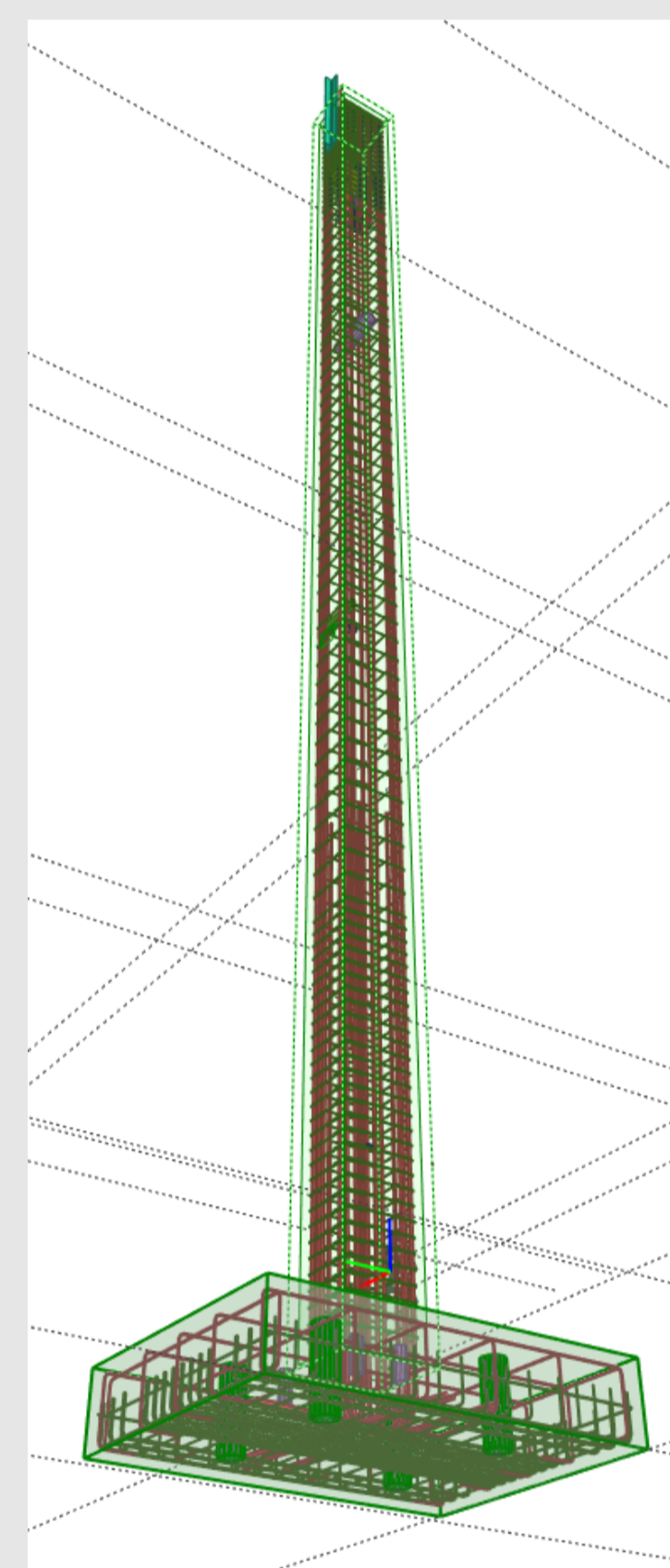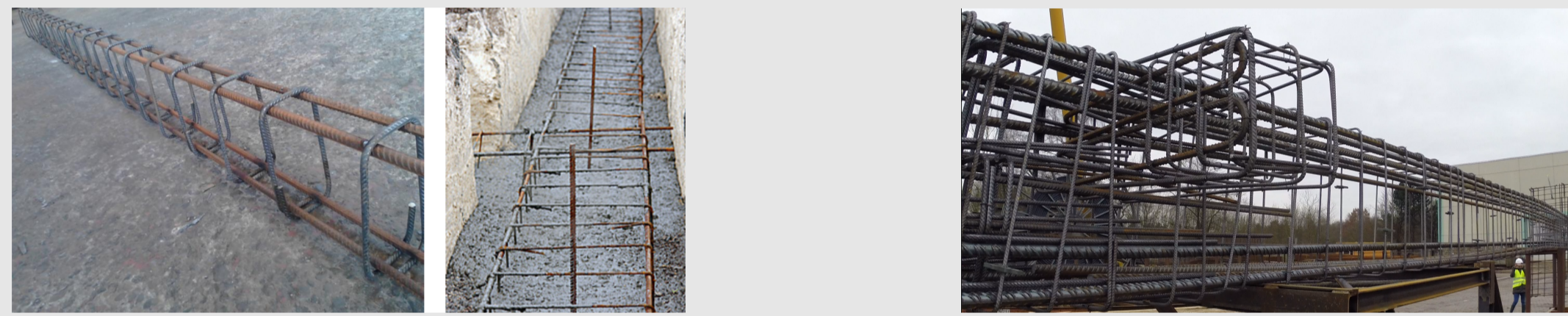
Automatic Optical Validation of Precast Concrete Structures

► Extraction of 2D corners from image
► Extraction of 3D corners from 3D model (3 faces w/ ~90°∡)
► Projection of 2D point cloud to 3D camera space
► Initial point cloud matching using procrustes / ICP
► Minimization of distances between 3D model points and rays from estimated camera center through 2D points
► Minimize distance of every object pixel to image pixel using 2D Hausdorff metric

2D corners	3D corners	Rays through 2D points
2D image	Rendering of registered 3D model	
Segmented 2D image	Highlighted differences	

Results

► 2D-3D registration of reinforcement bars via bounding box
► 2D-3D registration of precast concrete elements via 2D/3D corners
► Validation and difference detection using 2D Hausdorff distances
► Visualization via augmented reality and highlighting of errors

Future Work

► Test algorithms on construction site in rough environment
► Integrate algorithms into mobile demonstrator (toughbook)
► Integrate Comon Data Enviroment (CDE) interface for data and tolerance storage

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