Monocular Cable Layer Segmentation and Dimension Measurement

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INTRODUCTION

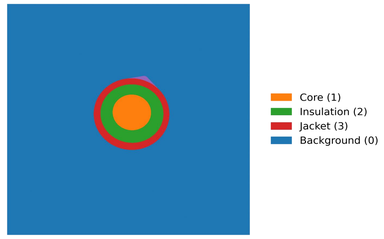
In multi-layered cable installation, technicians must verify that each layer meets dimensional specifications. Manual caliper measurement is slow, subjective, and impractical at scale.

Our app automates this process using only a smartphone to converts pixel measurements into physical dimensions in millimeters with no manual calibration required.

OBJECTIVES

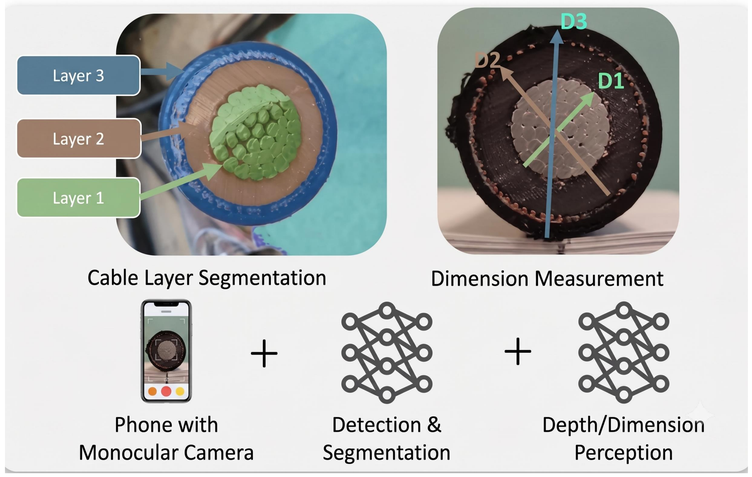
- **Segment** cable cross-section layers from a single phone image with high pixel-level accuracy using on-device deep learning.
- **Measure** layer diameters and wall thicknesses in millimeters with precision comparable to manual calipers.
- **Ensure compatibility** across all Phone models — with or without LiDAR — requiring no additional hardware.
- **Validate** measurement accuracy against cable accessory dimensional specifications.

DATASET



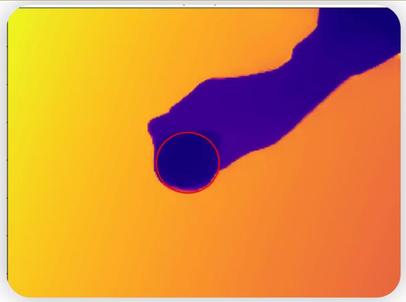
- **Synthetic rendering pipeline** — photorealistic 3D cable models with HDRI lighting and diverse industrial/laboratory backgrounds.
- **Automated augmentation** — randomized spatial transformations and compositing to maximize dataset variance and model robustness.
- **Auto-generated ground truth** — pixel-perfect segmentation masks produced alongside RGB images, eliminating manual annotation.

MODEL & APPROACH

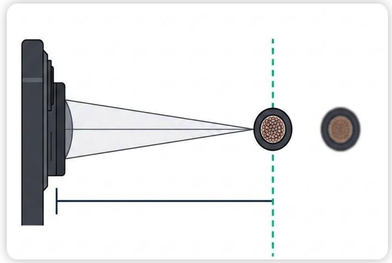


Physical Size = (Pixel Size × Depth) / Focal Length

DEPTH MEASUREMENT



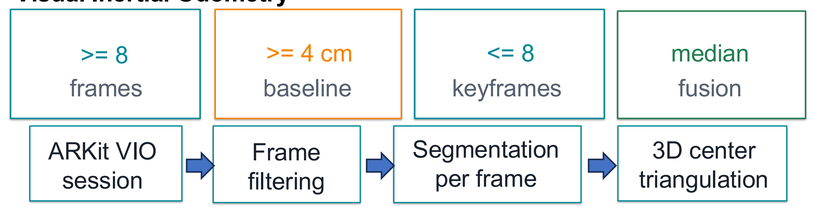
LiDAR Depth: Sample median depth from the segmentation mask region on the ARKit depth map.



Fixed-Focus : Lock lens to macro limit focal plane = known distance. 3-second sweep auto-selects the sharpest frame.

VIO: NO-LIDAR METRIC MEASUREMENT

Visual Inertial Odometry



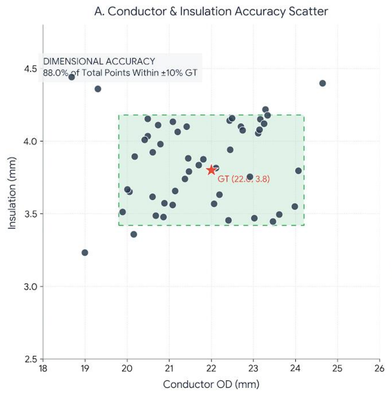
Scale estimation

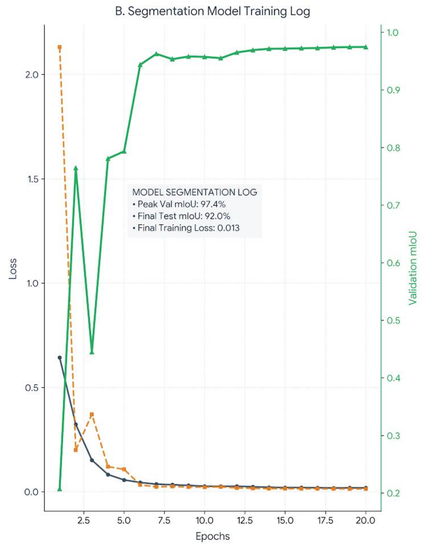
- Back-project mask centers using intrinsics and ARKit pose.
- Triangulate the cable center from multi-view world rays.
- Convert layer pixel widths to millimeters and fuse by median.

Quality signal

- Baseline score: stronger side motion improves geometry.
- Frame score: more valid masks increase stability.
- Reprojection score: lower pixel error means views agree.

RESULT





	Conductor OD	Insulation
Mean Value (mm)	21.682	3.854
Mean Absolute Error (mm)	1.221	0.259
Root Mean Squared Error (mm)	1.427	0.299
Relative Error (%)	5.55% ± 3.35%	6.81% ± 3.93%
Coef. of Variation (CV)	6.41%	7.62%

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