

Intelligent Inspection Equipment for Pre-Embedded Parts

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Applicant company: CNNC

Project's holder representative: Dr. Jiaqi Xu

1. Project Overview

Our project presents a next-generation Intelligent Inspection Equipment for Pre-Embedded Parts, specifically designed for the stringent needs of nuclear power construction quality control. It leverages advanced machine vision, deep learning, and proprietary AI hardware to deliver millimeter-precision inspection at unprecedented speed, while seamlessly integrating with established nuclear QC workflows.

2. Background

- Pre-embedded parts in nuclear power projects vary widely in type and specification. Traditional inspection methods exhibit significant drawbacks:
- Time Consumption: ~10 minutes per part; for 20 parts in one wall section, up to 3 hours.
- Labor Intensive: Requires two-person QC teams.
- Redundancy: Inspections repeated independently at all three QC levels.
- Manual Processes: Dependence on total stations, levels, and tape measures for checks.
- Low Automation & Accuracy Control: Susceptible to human error and inefficiency.
- Safety Risks: Frequent work at height increases hazard exposure.

3. Core Technology

Our solution combines:

- Deep Learning Analysis Engine: Millimeter-level dimensional inspection and 3D spatial pose determination.
- Integrated Workflow: Embedded in nuclear engineering's three-level QC and management systems.
- Proprietary AI Board: Optimized for computing power, energy efficiency, and reliability.
- Advanced Sensor Fusion: Pixel-level registration of high-fidelity 2D visual data with high-precision 3D point clouds.
- Performance: 1–2 mm accuracy and ~1 s inspection cycle per part.

4. Technology Readiness Level

TRL 7 (per T/CASTEM1016-2025): Demonstrated in operational environment.

Successful on-site functional testing at Ningde Nuclear Power Project under real construction conditions.

5. Intellectual Property & Awards

- Winner Prize: Startup in Shanghai International Innovation & Entrepreneurship Competition.
- Two invention patents filed.
- Selected as a CNEC–EDF Joint Laboratory collaborative project.

6. Applications & Future Plan

Primary use in nuclear power construction for:

- Rebar cages
- Pre-embedded parts
- Penetration sleeves
- Boxes & openings
- Planned industrialization for wider infrastructure sectors requiring high-precision QC.