

Crack detection on fasteners is crucial for ensuring safety and reliability in many applications. Various technologies exist for this purpose, each with its own strengths and limitations. The most widespread solution consists of using a NDT (Non-Destructive Testing) station with eddy currents. To date, this technology remains very valid and in fact, it is still widely used in sorting machines; however, new artificial intelligence tools combined with special cameras can recognize the presence of cracks in particular conditions, which the NDT system alone is not able to detect.

The better solution must be evaluated based on the production control needs (material and shape of the parts, control speed, etc.). **Below is a comprehensive comparison of different approaches to crack detection.**

- **NDT Eddy Current Control Station**
- **Top HD Camera + AI**
- **Linear Camera Station + AI**
- **Multi-Camera Control Station + AI**



NDT Eddy Current Control Station

How It Works

An eddy current probe generates an electromagnetic field that induces eddy currents in conductive materials. Any discontinuity (like a crack) produces an anomaly in the eddy currents, and is detectable as an electrical signal by a specific receiver probe.

Advantages

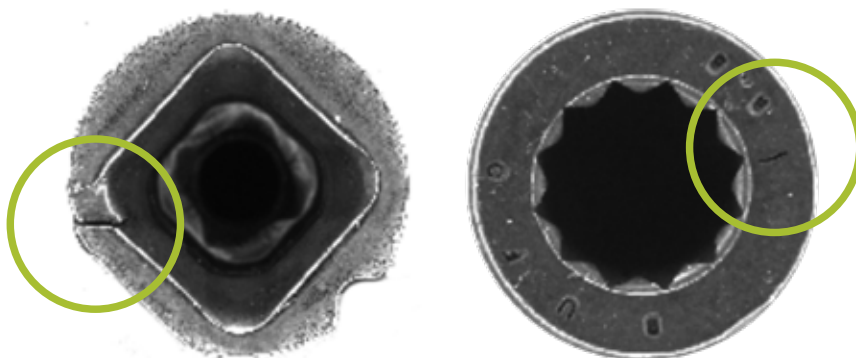
This control station can detect both open (surface) and closed (subsurface) cracks, as when they are under the material skin and so invisible to every optical method.

Limitations

- Material Dependency: Ineffective on non-magnetic metals (e.g., aluminum, copper, brass)
- Position Sensitivity: Effectiveness can vary based on crack location
- Speed Limitations: Requires rotation of parts, which can slow down the inspection
- Cost: The machinery can be expensive to implement and maintain

Top HD Camera + AI

How It Works

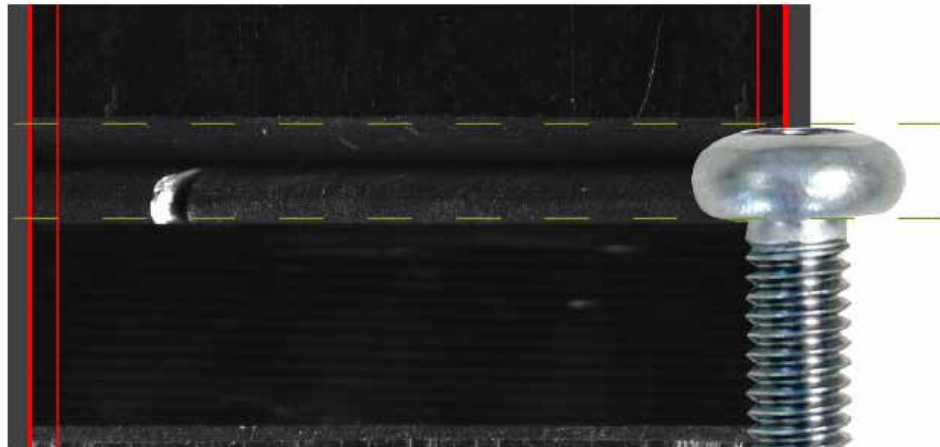


This control station is equipped with high-definition cameras to capture grayscale images of fasteners. AI algorithms analyze these images to identify defects, including cracks that might not be visible to the naked eye or detectable by eddy currents.



Advantages

- Able to detect small cracks on the upper or internal surfaces of the piece (impossible positions for eddy current)
- Not affected by variations in lighting and surface refraction, ensuring better performance than traditional optical control
- Capable of distinguishing between cracks and other markings

Linear Camera Station + AI**How It Works**

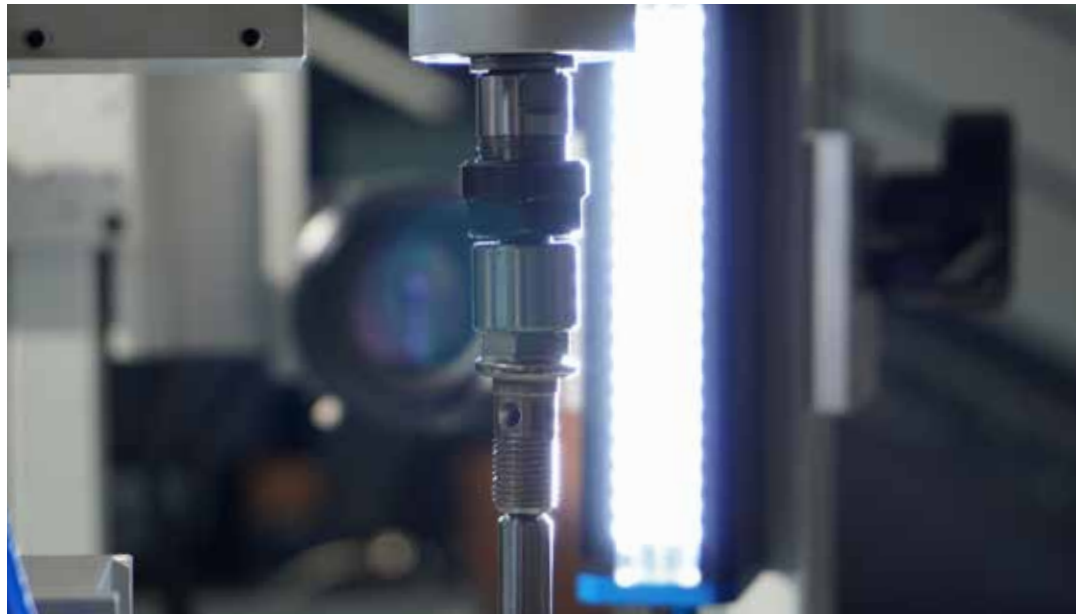
A linear camera captures the images of fasteners on 360° rotation. The AI tool processes the images to identify defects along the side surfaces.

Advantages

- 360° view of cylindrical pieces allows detection of cracks in otherwise inaccessible areas
- Can be used for various shapes, not limited to circular heads
- Capable of detecting a wide range of surface defects, beyond just cracks

Limitations

- Reduced inspection speed compared to other methods, as the system relies on rotational movement.



Multi-Camera Control Station + AI

How It Works

This control station combines images from multiple cameras to provide a complete view of the fastener surface without needing rotation.

Advantages

- High-speed inspection (up to 700 pieces per minute) due to continuous operation
- Effective in identifying cracks in various positions and shapes
- Capable of detecting a wide range of surface defects, beyond just cracks



Dimac and AI Training

The AI training process requires a robust computing station, the necessary software licenses, and specific skills.

The sorting machine software includes an easy procedure to assist operators in acquiring sets of images of compliant and defective samples. From these sets, Dimac's technicians build an effective and computationally efficient neural network. This process requires considerable computation time for the AI training and validation phases.

The trained neural network (in practice a file) is upload by remote on the sorting machine, in order to be used for sorting.

Conclusion

The landscape of crack detection in fasteners is evolving, driven by advancements in AI and imaging technologies. While traditional methods like eddy current remain effective, newer approaches AI-based and optical systems offer significant advantages in speed, flexibility, and defect detection capabilities.

AI enhances the efficiency and precision of inspections, enabling the identification of patterns and defects beyond human capabilities.

Continuous refinement of AI models and datasets is essential for maintaining effectiveness and accuracy, and human expertise is once again crucial for interpreting results and making informed decisions.