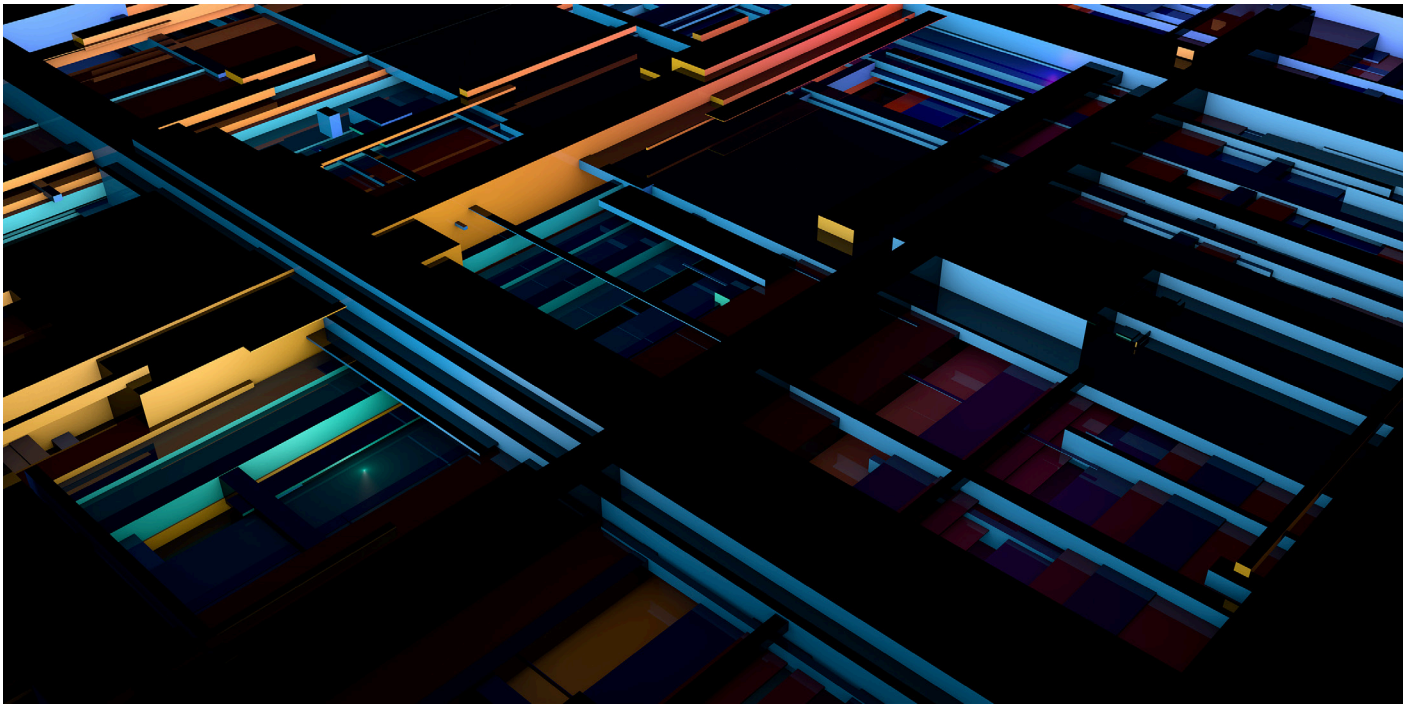
LANDING AI™

Deep Learning for Battery Inspection: The Landing AI and LandingLens Difference



Expanding mobile device, electric vehicle, drone, and untethered autonomous robot use is driving increased demand for a variety of battery technologies. While each battery is designed to meet the specific needs of an application, all must be lightweight and compact, deliver long life both during use and in storage, and output relatively consistent voltage in operation. While these goals can be achieved in numerous ways using a variety of materials and processes, many battery designs meet such demanding performance requirements using multilayer structures. Unfortunately, **small flaws or defects in a material that's either coiled or stacked into a multilayer structure tend to compound with each layer, potentially becoming larger or even catastrophic defects in the final assembly**. So inspection is key.

"Using cutting-edge deep learning tools like LandingLens enables our team to move faster and focus on developing and commercializing our next-generation batteries."

Tim Holme
Co-founder and Chief Technology Officer
Quantum Scape

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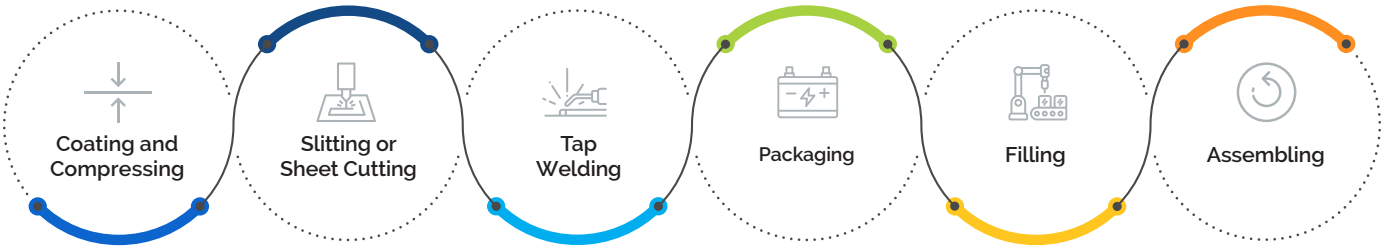
Battery Manufacturing Process



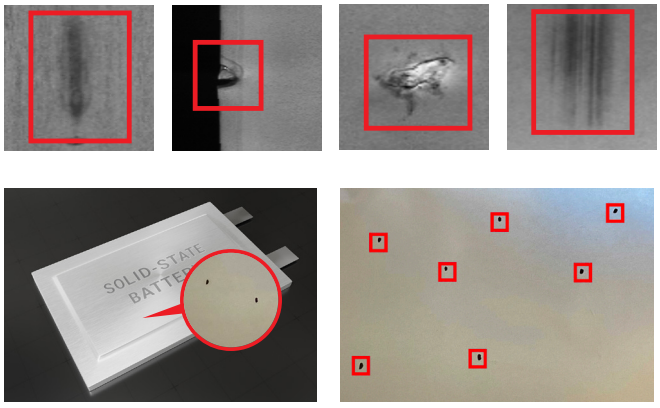
Nearly every part of a battery — whether it's the cathode or anode; a tab, pin, or solder joint; a weld seam; or a leak-proof container seal — can benefit from visual inspection. Manual inspection, however, has speed constraints, tends to be time-consuming and error-prone, and as a result may not actually improve quality. As battery manufacturers increasingly adopt automation to meet production goals, inspections must adapt to keep up with product performance and quality standards. Many battery manufacturers implement machine vision technologies in production processes to minimize defects, reduce scrap and rework, and increase quality and inspection speed. However, certain inspection tasks fall beyond the realm of traditional, rules-based machine vision systems. Here, deep learning can help.

Battery Inspection Challenges

Several issues can complicate inspection routines for rules-based machine vision systems. These include part and material variability. For instance, battery manufacturing requires a variety of different materials, including polymers, ceramics, various coatings, copper, aluminum, and other metals, as well as very thin plates, sheets, or films. Before stacking or coiling, the plates, sheets, or films must be inspected to ensure that they are free of defects.

Defects such as scratches, dings, dents, tears, holes, and other imperfections can be challenging to numerically quantify. For example, detecting powder coating defects on metal plates can be a real challenge for rules-based machine vision. The fact that coating appearance can vary significantly challenges a machine vision system attempting to determine if there is sufficient coating coverage on the surface of the metal. And while it's easy for a rules-based machine vision system to detect a tab or pin and measure its exact size, it's much more difficult to determine if the tab or pin is bent, twisted, or deformed in a way that could impede the alignment of the stack or the rolling of the coil.

After stacking and coiling, many batteries go through soldering or welding processes, in which tabs or pins are connected to complete the circuits of the multilayer battery structure. Traditional machine vision may not catch amorphous shapes — such as welds and solder joints — that beyond a certain tolerance and are considered defects. After welding and soldering, batteries must be sealed in leak-free containers. It can be quite challenging for traditional machine vision systems to understand the difference between a seal defect and a leak-free adhesive joint.



Defect examples

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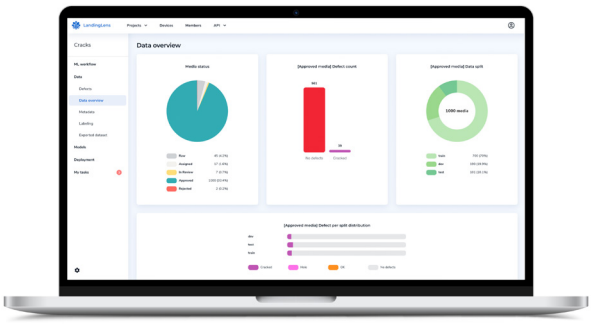
Turning to Deep Learning

Where manual or traditional machine vision inspection falls short, deep learning software can reliably handle product variability, deformations, and surface finish quality inspection tasks. Deep learning can also provide accurate inspection capabilities for difficult shapes, mixed parts, and mixed models, and it can adapt and learn as products, processes, and environmental conditions change. Furthermore, effective deep learning platforms allow end users to define defects up front so that the software can recognize defective parts.



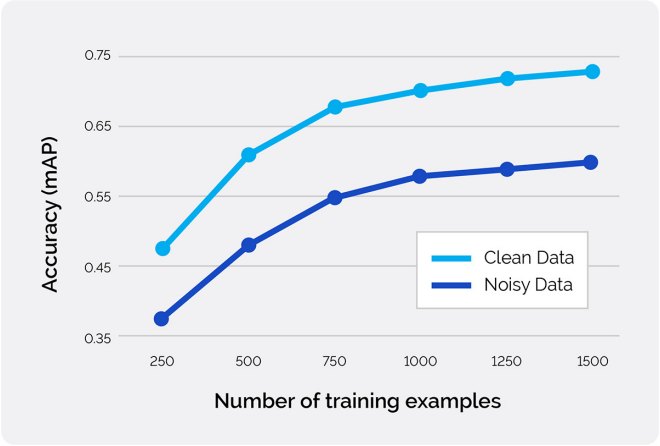
Teams develop consistent methods for collecting and labeling images and for training, optimizing, and updating the models

Deep learning software cannot replace traditional machine vision, but it offers a perfect complement. **Deep learning allows systems not only to locate parts and inspect for defects but also to classify and categorize defects**. Many manufacturers store images and data from past projects, and these can help train deep learning algorithms. Over time, neural networks can be iteratively improved upon and adjusted to continuously improve the inspection process.

The LandingLens Difference

Several deep learning software packages can help solve problems in battery manufacturing inspection, but **Landing AI's LandingLens end-to-end platform simplifies the process and offers an efficient, easy method for continually improving your models for long-term success.**

This all begins with our data-centric approach to AI, which involves feeding the model with clean, high-quality data (images).



LandingLens, an industry-first data-centric artificial intelligence (AI) visual inspection platform, helps improve inspection accuracy and reduce false positives.

LandingLens' digital Defect Book makes it easy to efficiently define defects, while the agreement-based labeling tool delivers the ability to improve the Defect Book over time by reaching an internal consensus on defects. The software's smart tagging tool allows cross-functional collaboration for accurate labeling, no matter the location. Other tools simplify model development and management, while training tools allow users to test and evaluate models and to execute many training environments simultaneously, using a variety of model architectures to fit any machine vision application. Additionally, the software offers an error analysis report for evaluating existing models, removing the need to start each model anew.

Machine vision has long played a significant role for major battery manufacturers. By implementing machine vision and deep learning technologies into production processes, battery manufacturers can maintain high quality standards and keep up with customer demands.

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About LandingLens

LandingLens is an industry-first data-centric artificial intelligence (AI) visual inspection platform. It helps improve inspection accuracy and reduce false positives. The end-to-end platform standardizes deep learning solutions that reduce development time and scale projects easily to multiple facilities across the globe. Our focus remains on our customers and continual product innovation to solve the real-world problems of the manufacturing audience. To learn more, visit: www.landing.ai and follow Landing AI on Twitter and LinkedIn.

About Landing AI

Landing AI™ is pioneering the next era of AI in which companies with even limited data sets can realize the business and operational value of AI and move AI projects from proof-of-concept to full scale production. Guided by a data-centric AI approach, Landing AI's flagship product is LandingLens™, an enterprise MLOps platform that offers to build, iterate, and operationalize AI powered visual inspection solutions for manufacturers. With data quality being key to the success of production AI systems, LandingLens™ enables users to achieve optimal data accuracy and consistency. Founded by Dr. Andrew Ng, co-founder of Coursera, former chief scientist of Baidu, and founding lead of Google Brain, Landing AI is uniquely positioned to lead the development of AI from a technology that benefits a few to a technology that benefits all.

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