Technical Report 25-01
Technology Assistance Grant Program - August 2025

Battery Inspection Project

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Background

A leading engineering technology manufacturing and development company located in Auburn, Alabama reached out to ICAMS to pursue process improvement utilizing Industry 4.0 technologies. The company has requested to have their name withheld from this report in order to protect their intellectual property and methods. They were founded to commercialize microfibrous materials technology. Currently, this small- and medium manufacturer (SMM) is performing work to support the development of high-power battery modules.

Figure 1 presents a standard battery configuration manufactured by this SMM. The thermal management approach is used in pulse power systems and enables the operation of high-performance power system components (lithium-ion batteries, super capacitors, etc.) in extreme environments by synergistically combining active and passive cooling capability with structured materials that promote heat transfer and thermal interfacing. These high-power battery modules demand precise manufacturing and quality control to ensure performance, safety, and reliability in naval applications.

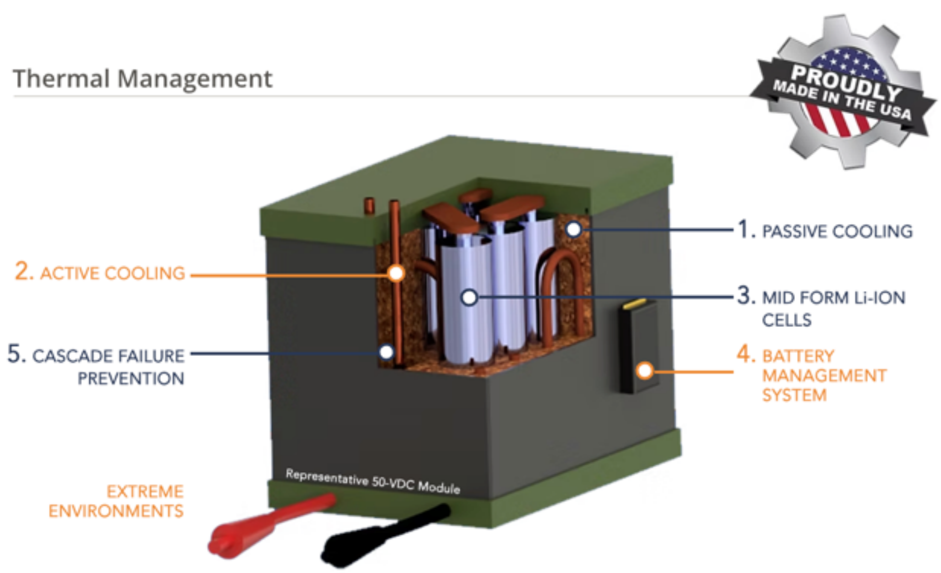

Figure 1. Typical Battery Cell Produced

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The Problem Addressed

To ensure the performance, safety, and reliability of this product, it is necessary to have precise processes and quality control. This Technology Assistance Grant (TAG) project is designed to ensure process control. During the assembly of six-cell battery modules, the SMM has identified a recurring alignment issue. Each battery cell is required to be 0.070 inches from the side of the battery and aligned with the other cans within ±0.030 inches. Previously, these measurements were taken using manual calipers, introducing three distinct problems:

1. Variability from operator to operator.
2. Time-consuming inspections.
3. Lacked a consistent digital record of measurements obtained from each battery.

The primary objective of this project was to assist the SMM in implementing a semi-automated, non-contact measurement process that inspects the cell can alignment and provides the operators and management with documented quality feedback in real-time. The SMM was also interested in documenting the subassemblies' width in addition to the cell alignment. The measurements attained need to be stored digitally to meet the requirements of a digital quality control record.

Proposed Solution

The solution involved integrating a Keyence VS-500 machine vision camera previously used in one of the inspection processes to take measurements of the battery cells or "cans" and the sub-assembly width. The battery cells/cans are surrounded by copper fibers, which create irregular surfaces with varying brightness and reflectivity, making it challenging for the legacy camera to capture accurate measurements. Due to the difficulty of capturing accurate measurements from the legacy machine vision camera, the SMM partnered with Auburn's Interdisciplinary Center for Advanced Manufacturing Systems (ICAMS) to provide engineering and technical support with the project.

To perform the cell can inspection, the Keyence VS-500 was mounted directly above the cell cans, taking measurements against a 3D printed alignment puck that uses in their process. ICAMS redesigned their alignment pucks to include black reference layers. These layers in the alignment pucks allowed the camera to more easily detect shifts during the cell alignment while also allowing for automatic scaling in inches/pixel. After black layers were added to the pucks, a measurement tool in the VS camera software was used to determine the cell can alignment, as shown in Figure 2.

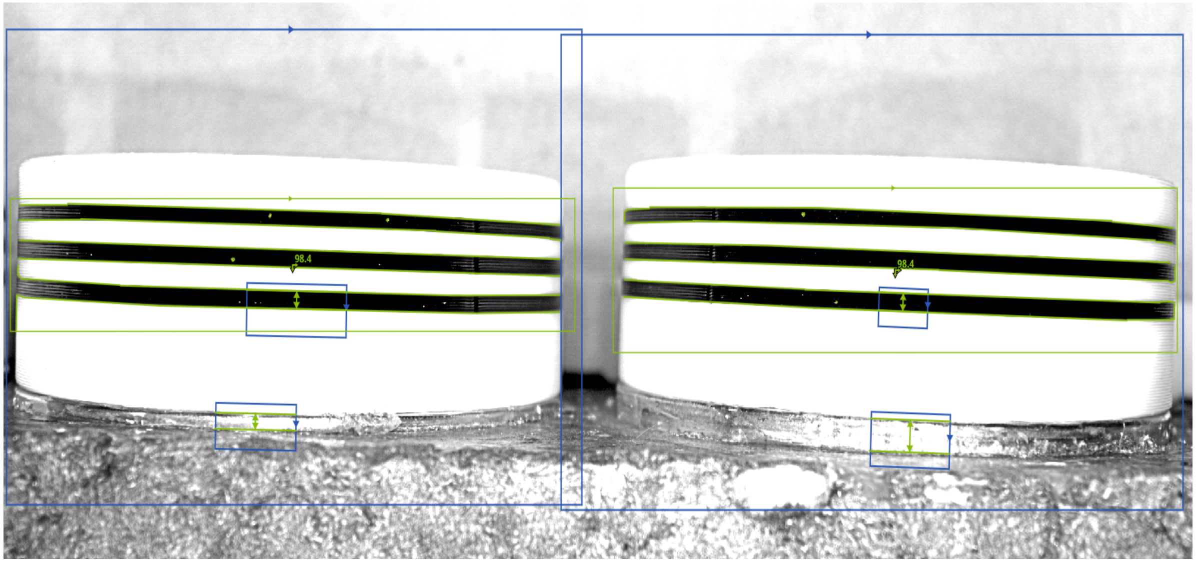

Figure 2: Can Inspection using 3D printed caps.

To further inspect any irregularities during the alignment, an AI detection tool was used within the updated VS-500 camera software, where the camera was trained on good/bad can alignment. After the programming for the cell can alignment was complete, the overall height of the internal battery subassembly was measured using the same AI tools discussed previously. This required extensive training of the AI detection tool in detecting the “fuzzy” edges of the copper fibers, shown in Figure 3.

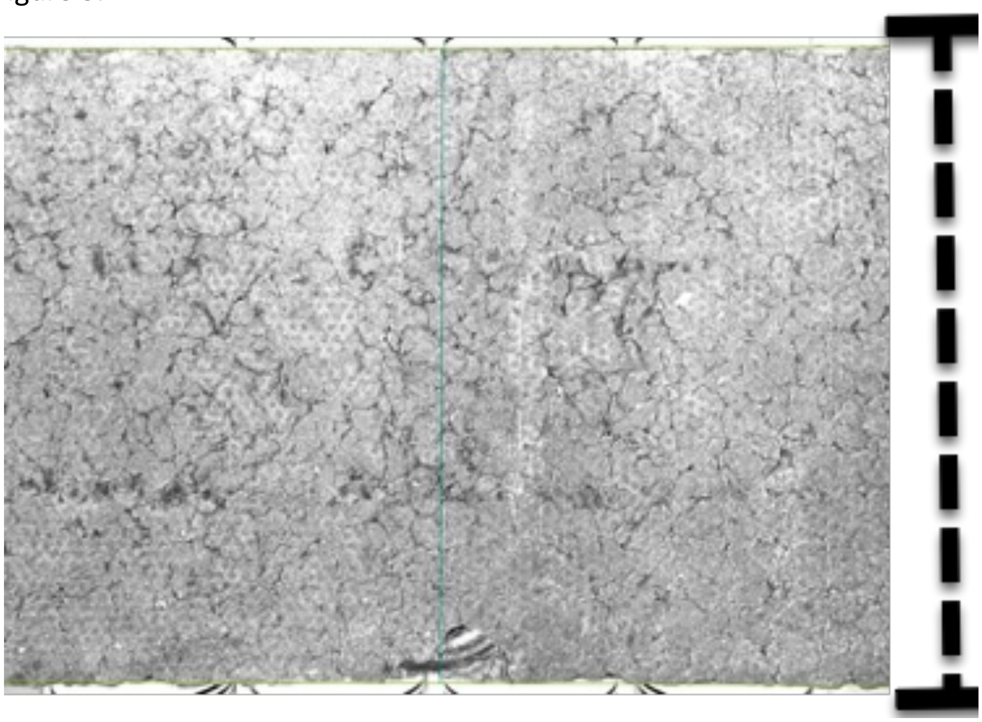

Figure 3: Overall Subassembly Inspection.

Impact and Return on Investment

This TAG project utilized a legacy camera system to eliminate manual operator variability in process quality control measurements, reducing the time to perform the process by five to ten minutes per operator per part. Additionally, the solution succeeded in decreasing false positives in process quality control measurements while also providing a digital audit trail to manage process and product quality. The resulting solution represents a 15x time savings on average, which translates to a labor cost savings of $17,080 for every deployable unit manufactured. With ICAMS' assistance, the SMM saved $11,358 by being able to use the existing camera system. The SMM can expect to see a Return on Investment (ROI) of 253% from their contributions towards the project and can expect to save approximately $180,000 on the first 10 deployable units. The ROI for the entire TAG project, which includes the contributions by both partners, is 46%.

Conclusion

This TAG project illustrates that new hardware is not always necessary when software is involved. A change to the software, along with an understanding of the AI methods built into the upgrade, enabled significant cost savings to the company while also realizing a reduction in man-hours and an increase in overall quality records and performance.