



Business challenge

The Advanced Manufacturing Research Centre (AMRC) sought to develop an AI-enhanced visual inspection system that could more quickly detect faulty parts with less waste.

Transformation

The AMRC helps usher in the Industry 4.0 era with an AI-driven manufacturing system for visual inspection. IBM® PowerAI Vision software on an IBM Power® Systems AC922 server, with security-rich, cloud-ready IBM FlashSystem® 9100 storage, helps the centre rapidly turn innovative ideas into manufacturing realities.

Results

Delivers image-transfer speeds of 5 GB/s

to support rapid development of an intelligent visual inspection system

Streamlines model training and data management

with intuitive IBM visual recognition tools on an IBM AI-optimized platform

5 days to deliver a proof-of-concept (POC) solution

to help a startup company bring its vision to life

Advanced Manufacturing Research Centre

UK drives Industry 4.0 innovations with world-class, factory-ready AI solutions

Established in 2001, the AMRC conducts world-leading research into advanced machining, manufacturing and materials. It brings together more than 600 researchers and engineers from around the globe to accelerate development of high-value manufacturing techniques and technologies. The AMRC is part of the AMRC Group, which promotes collaborative, industry-focused research involving universities, academics and businesses.

“With the FlashSystem 9100 connected to our AC922 server, we can download and process images straight away with the ridiculously fast throughput we have.”

— Sean Wilson, AI Technical Lead, the Advanced Manufacturing Research Centre

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Intelligent inspection systems

The AMRC is helping lead a revolution in the UK. Inside its glass-walled, state-of-the-art Factory 2050 facility in Sheffield, the centre develops digital-driven solutions that employ AI, Internet of Things (IoT), robotic and other emerging technologies, all with the aim to solve real-world manufacturing problems. Once considered futuristic, these solutions are ready for full scale deployment today, helping UK manufacturers increase their performance while fueling the Fourth Industrial Revolution.

“The whole ethos behind the AMRC is to maintain UK competitiveness in global manufacturing,” explains Tom Hodgson, Theme Lead, Inspection and AI, AMRC. “We take ideas that come out of the universities, where they’ve been developed to a prototype level. Then, with our partner companies, we conduct research projects to transition those technologies into production environments.”

Also known as Industry 4.0, this new era of technological innovation builds on the breakthroughs of the previous digital revolution by introducing dynamic, interconnected, intelligent systems that promise to further disrupt—and optimize—value chains across industries. This era also requires unprecedented processing power and storage capacity.

The AMRC is one of the country’s seven High Value Manufacturing (HVM) Catapult centers helping pave the way for Industry 4.0. Launched in 2011 by UK Innovate to revitalize the nation’s manufacturing sectors, the HVM Catapult initiative brings together researchers with companies of all sizes to pioneer solutions and ultimately stimulate global marketplaces.

“As part of the Catapult team, our obligation is to demonstrate cutting-edge techniques, tools and technologies to UK businesses,” says Hodgson. The AMRC thoroughly vets and develops emergent technologies, without bias for individual IT vendors. It then showcases many of the advanced solutions at Factory 2050, the country’s first facility dedicated to reconfigurable, digitally assisted assembly, component manufacturing and machining technologies.

One of the AMRC’s development projects involves automating manual-based processes used to detect flaws in manufactured structural components, especially in safety-critical industries such as aerospace and defense. Traditionally, factory workers have inspected parts using light beams and other labor-intensive methods. An automated, intelligent visual inspection system could enable faster detection of faulty parts at scale, resulting in fewer defects, less waste and reduced costs.

The project team required machine-learning visual recognition software to use in creating accurate models for

image classification and defect detection. The researchers built a dataset by capturing and labeling thousands of high-density images of components shot from multiple angles in standard settings, which they then used to test different visual recognition products available in the marketplace. Yet this classical approach to image processing did not adequately meet the researchers’ needs for their cutting-edge work. “All sorts of things can have a massive effect on traditional computer vision algorithms, such as lighting, where the item is positioned in the warehouse, and within which warehouse or factory,” explains Sean Wilson, AI Technical Lead, AMRC. “It can take weeks of fine-tuning a solution to the particular features of a fault. But what about new components or types of fault? These solutions do not generalize well.”

The AMRC’s standard, on-premises infrastructure—comprising CPU-based servers in a separate building with a 1 Gb/s network connection to Factory 2050—also hampered the team’s progress. The infrastructure could not rapidly process the massive image files the team generated, totaling approximately 20 GB for each component. Furthermore, many of the center’s business customers operate under industry regulations that require inspection images be safely archived for several years. The centre’s existing storage lacked modernized storage capacity to support this need.

AI-optimized processing and storage

The researchers found that IBM could deliver the high-performance solutions they needed. The AMRC had no sooner set up a Power Systems AC922 server to demonstrate to visitors when Wilson decided to use it to test PowerAI Vision software.

“I quickly took about 500 images using a normal camera, uploaded them into the PowerAI Vision software and tagged the location of the specific components we wanted to inspect,” Wilson explains, adding that the software then created a trained vision model within approximately 20 minutes. The model’s accuracy stunned Wilson. “Lo and behold, the software managed to accurately identify all the objects from one test image. And this was an image that I hadn’t color-calibrated or worried about the lighting or anything. It was at this point I showed our team how amazing and incredible this software and hardware is.”

Kieran Edge, Technical Lead for Machine Vision at the AMRC, oversees the project. “We started to look at using PowerAI Vision software for its classification as well as detection capabilities, and we found we had a tremendous amount of success quite straight off the bat,” he agrees.

PowerAI Vision software provides the team with an open-source, intuitive framework and tools for building and managing computer vision models, including functions for installation and configuration, data labeling, model training, inference and deployment. Located onsite in Factory 2050, the Power Systems AC922 server offers a fully optimized platform to support the massive throughput the project's workloads require. The backbone of some of the world's largest supercomputers, the server pairs POWER9™ CPUs and NVIDIA Tesla V100 with NVLink GPUs, which delivers up to 5.6 times the input/output (I/O) performance of x86-based servers.

To further boost throughput speed and storage efficiency, the team also implemented a FlashSystem 9100 solution, which is collocated with and directly connected to the Power Systems AC922 server in Factory 2050. "FlashSystem 9100 will really increase our ability to do training and iterations on the models that we're generating," says Wilson. The enterprise-class storage solution combines the performance of flash and Non-Volatile Memory Express (NVMe) with the solid foundation of IBM FlashCore® technology.

Designed for security, the solution features built-in encryption and FIPS 140-2 certification. In addition, it integrates well with IBM Spectrum Storage™ capabilities, enabling highly scalable, tiered storage solutions in the cloud—another plus for the AMRC and its customers who

want to modernize their infrastructures using new private and hybrid cloud models. "Cloud solutions suit many of our customers' needs by eliminating the hardware investment required to adopt intelligent automation. For others, the quantity, nature of the data, and frequent model improvements mean that a hybrid cloud approach provides them the perfect balance," says Wilson. "The containerized architecture implemented at the AMRC allows us to offer both to our customers."

From showroom to factory floors

With a modern, agile and security-rich infrastructure in place to analyze working images, the team can take its visual inspection project forward, including continuing to rapidly train and validate models. The new solution delivers transfer speeds of 5 GB/s, compared with 70 MB/s as provided by the on-premises infrastructure located in another building. "When it comes to our research, we need to be as fast and efficient as we possibly can," says Wilson. "Now, with the FlashSystem 9100 connected to our AC922 server, we can download and process images straight away with the ridiculously fast throughput we have."

The researchers will develop a standardized visual inspection system, including a robotic imaging solution, for knee joint replacements. However, the system will have

cross-industry applications. "The main purpose behind this work is to demonstrate how businesses can effectively implement such technologies and the difficulties that they might have," Edge says. Ultimately, the new system will potentially help a variety of manufacturers improve product quality, increase shop floor productivity and reduce waste at a reduced cost.

Beyond this project, the AMRC team can use its onsite IBM server and storage solution to assist manufacturers with other AI-focused initiatives. The ability to offer on-premises IBM server and storage capabilities is particularly important to customers with sensitive data. "Thanks to IBM, we've been able to collocate a top-of-the-art AI server and storage in a tiny amount of space within our factory rack," says Wilson. "The fact that we now have these on-premises capabilities provided by IBM means that our customers can start to innovate in areas such as AI and Big Data, happy in the knowledge that their data is safe."

The team can also better fulfill its mission to help small and midsize businesses innovate across the manufacturing lifecycle. Recently, one startup company shared its idea for an AI-driven solution with Wilson's team. Using the PowerAI Vision software running on IBM infrastructure, the researchers completed a successful POC solution for the customer in just five days. Wilson notes that that without the

IBM solution, the team would have needed five days to just label the datasets.

The AMRC team is more enthusiastic than ever about their work at the forefront of Industry 4.0 innovations. "Factory 2050 is basically an open shop," explains Wilson. "It's exciting to be able to stand on our showroom floor and tell a company that [this innovation] isn't in the future. It's now. It's something that they can actually start to use in their factories and in their processes."

Solution components

- IBM® FlashSystem® 9100
- IBM Power® Systems AC922
- IBM PowerAI Vision

Take the next step

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