THE FUTURE OF BARCODE SCANNING

How AI Is Redefining Barcode Performance in Challenging Environments

Honeywell

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EXECUTIVE SUMMARY

Barcode scanning has long been treated as a solved problem. In reality, it remains one of the most operationally sensitive links in the data-capture chain. Across warehousing, transportation, manufacturing, retail, and field operations, scanning performance is still determined by a complex combination of optics, illumination, decode logic, motion, symbol quality, environmental conditions, and operator behavior.

That complexity matters because the cost of failure extends beyond a single missed scan. A no-read can trigger re-aiming, rescanning, manual entry (with dramatically higher error rate), workflow interruptions, delayed throughput, and, in regulated environments, higher risk of process error.

Consequently, Honeywell Productivity Solutions and Services (PSS) is witnessing an increasing trend toward AI-enhanced scanning solutions. Artificial intelligence is not replacing the fundamentals of barcode reading, rather it is strengthening them. Across the scanning pipeline, AI and machine learning are being applied to image enhancement, barcode localization, exposure and illumination control, decode optimization, and fleet-level analytics. The goal is not just to include AI, it is to improve operational performance: faster reads, fewer rescans, stronger first-pass success, and more consistent capture under real-world challenging conditions.

In Honeywell's view, the market is beginning to move beyond experimental claims toward measurable outcomes.

In industrial applications, especially those involving rugged environments and difficult direct part marks, AI is beginning to show measurable impact. Honeywell states that the Granit™ Ultra family delivers an average 45% scanning speed increase versus Granit XP, based on internal benchmarking across multiple reference barcode sets. With Granit Ultra, PSS is uniquely positioned to combine proven ruggedized design with advanced AI capabilities, delivering performance improvements aligned to measured benchmarks in the most demanding industrial environments.

THE TAKEAWAY IS CLEAR

AI creates value in scanning when it removes friction from the workflow. It matters when it buys back seconds, improves first-pass read rates, reduces operator workarounds, and makes rugged devices more resilient to the variability of the field.

For Honeywell, this shift presents more than a product story. It is a category-defining moment. In rugged scanning, leadership belongs to the company that can combine AI-enhanced with physical survivability, fleet manageability, benchmarked performance, and credibility under pressure. That is where the market is heading. And that is where Honeywell is positioned to lead.

WHY SCANNING PERFORMANCE STILL MATTERS

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Barcode scanning can be viewed as a back-of-mind technology within an enterprise's operation. When it works, nobody notices it. When it fails, the operational consequences surface immediately.

A failed scan on a loading dock can slow dispatch. A missed direct part mark on a manufacturing line can interrupt traceability. A poor read on a damaged label can force manual intervention in a high-volume workflow. In a healthcare setting, unreliable or inaccurate scanning can introduce an entirely different category of risk.

Despite the market's maturity, the effectiveness of barcode capture continues to rely heavily on the operational conditions. Labels may be dirty, torn, scratched, poorly printed, wrapped on curved surfaces, covered in stretch wrap, exposed to glare, or moving at speed. Devices may be used in cold storage conditions, in bright sunlight, in dusty warehouses, or after repeated drops onto concrete. In industrial environments, ruggedness is not merely a specification sheet exercise. It is a fundamental requirement for ensuring consistent performance.

The modern 2D imager is not simply a scanner with better optics. It is a software-defined sensing platform capable of interpreting far more of the real world than earlier generations could and capable of interpreting modern 2D barcodes, which lasers could not.

And now, with AI entering the stack, that capability is accelerating again.

THE SHIFT FROM OPTICS ALONE TO INTELLIGENT CAPTURE

For years, scanner performance was discussed primarily in terms of scan engine, depth of field, field of view, motion tolerance, sensor quality, illumination, and rugged sealing. Those factors still matter but have now become crucial ingredients for business success.

Now, performance is shaped by what happens after the image is captured.

That includes:

- Image enhancement of blurry, damaged or poor contrast images
- Adaptive exposure and illumination control
- Localization (barcode finding) of barcodes within cluttered scenes
- Prioritization of multiple codes in one field of view
- Telemetry that identifies emerging no-read patterns across fleets

In other words, scanning performance is no longer only about seeing the barcode. It is about interpreting the conditions around it, compensating for degradation, and doing so in real time on the edge.

That is what makes AI relevant.

In the scanning context, AI should not be misunderstood as a futuristic add-on. Its value is practical. It supports the moments where traditional systems face their hardest conditions: glare, motion blur, low contrast, difficult DPM marks, skew, clutter, and variation.

The real commercial test is not whether a scanner contains AI. It is whether that intelligence changes what happens on the warehouse floor, on the production line, or in the loading yard.

Sources

1. ImageNet Classification with Deep Convolutional Neural Networks (AlexNet, 2012
2. Deep Residual Learning for Image Recognition (ResNet)
3. You Only Look Once: Unified, Real-Time Object Detection (YOLO)

WHAT AI ACTUALLY CHANGES IN BARCODE SCANNING

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Much of the market still talks about AI in broad terms. Buyers need something more concrete.

AI in scanning is best understood as a series of improvements across the capture and decode pipeline.

1. Better image input to the decoder

A significant share of scanning success is determined before decode logic even begins. If the barcode image is noisy, blurred, underexposed, overexposed, or distorted by glare, no downstream logic can fully compensate. AI-assisted image enhancement is designed to help improve the quality of the input itself. That can include denoising, deblurring, dynamic contrast correction, and adaptive exposure handling. The practical outcome is better readability under non-ideal conditions. In addition to image enhancement, AI based exposure and illumination control can be used to initially capture a better image for further processing.

2. Faster and more accurate barcode localization

In industrial environments, the scanner often sees more than one possible target. There may be multiple codes on a pallet, small codes on reflective components, or labels positioned at inconsistent angles. AI-based localization helps the device identify where the relevant barcode is within the frame and orient decode logic accordingly.

That matters because time lost in target acquisition can contribute to workflow inefficiency.

3. Stronger performance on damaged, difficult, or low-contrast codes

This is where AI becomes commercially meaningful. Difficult readings are the ones that cost time. The perfect barcode is not the problem. The partially torn label, the faded print, the dot-peen DPM on an uneven surface, or the low-contrast mark under bad light is the problem.

When AI helps decode those edge cases faster and more reliably, it can help improve scanner performance and support operational efficiency.

4. Visibility beyond the point of scan

AI's value is not limited to the reading event itself. Fleet-level analytics can surface trends in no-reads, identify declining label quality, detect printer drift, and reveal environmental factors affecting performance. This shifts scanning from a reactive support issue into a measurable operational discipline.

That transition, from scanner as tool to scanner as insight-generating endpoint, is where long-term value begins to compound.

Sources

4. CRNN – Image-Based Sequence Recognition
5. Scene Text Recognition Benchmark Analysis

WHY RUGGED ENVIRONMENTS CHANGE THE AI CONVERSATION

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AI claims are easy to make in controlled conditions. Rugged environments are where those claims are tested.

In ultra-rugged scanning, performance depends on more than algorithms. It depends on whether the device can continue delivering clean inputs after impacts, tumbles, dust ingress, temperature swings, scratched windows, condensation, and repeated daily abuse.

This is why rugged scanning is becoming the most credible proving ground for AI-enhanced data capture.

In theory, many vendors can talk about AI. In practice, only a smaller number can combine:

- Rugged physical design
- Wide light tolerance
- Strong motion handling
- Difficult-code performance
- Long-range flexibility
- Fleet-wide manageability
- Benchmarked productivity gains

That combination is what buyers increasingly need.

This is also where Honeywell's market position becomes especially relevant. In rugged scanning, authority does not come from introducing AI language into a datasheet. It comes from making that intelligence operationally trustworthy.

Sources

6. Deep Learning-Based Barcode Detection and Recognition
7. QR Code Recognition Using Deep Learning
8. Real-Time Detection of Multiple Barcodes Using Deep Neural Networks

THE NEW PERFORMANCE BENCHMARK: FEWER NO-READS, LESS VARIANCE

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> **Historically, scanner marketing has over emphasized ideal-condition speed claims. But sophisticated buyers are asking a different question now: how does the device perform in my worst-case conditions?**

That is the question that Honeywell has invested decades of research and development in answering.

In real workflows, the true cost comes from variability. One delayed read is not just one delayed read. It creates interruption, re-aiming, hesitation, and loss of rhythm. Across a shift, that variance accumulates.

AI matters because it reduces variance.

It improves the probability of first-pass success in the situations most likely to trigger a workaround:

- Low-contrast codes
- Poorly printed labels
- Motion-heavy scanning
- Cluttered scenes
- Damaged barcodes
- Reflective packaging
- Variable DPM conditions

This is the most important story behind AI in scanning. It is not about turning scanners into futuristic devices. It is about reducing the long tail of failure that quietly erodes throughput.

Sources

9. IEEE Publications
10. Springer – Pattern Recognition Journal
11. Elsevier – Computer Vision and Image
12. GS1 Standard

WHAT THE EVIDENCE SHOWS

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The market is now entering a more mature phase of AI adoption in scanning, where claims are increasingly supported by measurable indicators.

Honeywell positions the Granit Ultra family as combining high-speed processing, AI algorithms, and decoding enhancements to deliver an average 45% scanning speed increase versus Granit XP. That matters not just as a speed claim, but because it ties AI directly to workflow productivity.

Academic research in computer vision and barcode detection demonstrates that machine learning techniques can improve detection accuracy, recall, and readability under degraded conditions (e.g., blur, noise, low contrast), which directly aligns with the technical challenges addressed in industrial barcode scanning.

Studies on lightweight barcode detection models and QR-code super-resolution show measurable improvements in recall, detection accuracy, throughput, and readability under blur and noise conditions. These are not one-to-one substitutes for industrial deployments, however, they provide supporting evidence that machine learning techniques can enhance image interpretation and decoding performance in conditions analogous to real-world scanning challenges.

The Granit Ultra platform also pairs that productivity story with the kind of rugged operating envelope that industrial buyers care about: motion tolerance up to

4500 mm/s

low print contrast capability down to

15%

and performance under ambient light up to

100,000 lux

This is important because AI only creates operational value when the device remains stable under real working conditions.

WHERE BUYERS SHOULD LOOK BEYOND THE CLAIM

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> **As AI becomes more prominent in scanning, the strongest buyers will look beyond headline numbers.**

They will ask:

- What exact workflows were tested?
- What barcode sets and damage conditions were used?
- What happens at the edge of the frame, under motion, or in glare?
- How is no-read telemetry surfaced and used?
- Does the vendor combine AI with rugged mechanical reliability?

These questions matter because AI-enhanced scanning is not only a feature decision. It is an operating model decision.

The right scanner today is the one that fits the reality of how your environment works, how your fleet is managed, how your workflows are measured, and how your failure points are diagnosed.

This is where Honeywell has an opportunity to lead the category conversation more forcefully. The market does not need more generic AI language. It needs a more rigorous definition of what trustworthy AI in rugged scanning actually means.

That definition should include:

- Benchmarked performance tied to real workflows
- Ruggedness that protects image quality over time
- On-device intelligence where latency matters
- Update mechanisms that support governance at scale

HOW HONEYWELL LEADS

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> **Honeywell is well placed to help shape the category narrative because rugged scanning is one of the characteristics where credibility still must be earned the hard way.**

Leadership in AI-enabled rugged scanning will not be defined by the company that sounds the most futuristic. It will be the one that proves intelligence under pressure.

That means demonstrating that AI-enhanced decoding performs not only in a lab, but on a forklift, on a loading dock, in bright light, in a freezer, in a dusty distribution center, and after months of repeated abuse.

It means showing that rugged design, optics protection, decode performance, and fleet manageability are not separate stories. They are one story.

That is the story Honeywell can tell with conviction.

The Granit Ultra family is not just compelling because it uses AI. It is compelling because it connects AI to the outcomes buyers care about:

- Faster reads
- Fewer rescans
- Stronger first-pass performance
- Rugged durability
- Operational continuity
- Scalable fleet management

This is the difference between product marketing and market leadership. Product marketing says the scanner is smarter. Market leadership shows why that intelligence changes the economics of work.

CONCLUSION

> **Barcode scanning is evolving from a hardware-led category into a systems category—one where optics, imaging, algorithms, edge intelligence, and fleet analytics work together to determine performance.**

AI is accelerating that shift.

Its value is clearest where workflows are least forgiving: high-speed environments, difficult codes, harsh conditions, and high-cost no-read events. That is why rugged scanning is becoming the most important battleground in the next phase of barcode innovation.

For buyers, the strategic implication is straightforward. The future of scanning performance will not be defined by speed claims alone. It will be defined by who can reduce friction, sustain reliability, and create measurable visibility into performance across the fleet.

For the market, that raises a more important question: Who is best positioned to define that future?

Honeywell has a credible answer. With Granit Ultra, we are strongly positioned to combine proven ruggedized design with advanced AI capabilities, delivering superior performance in the most demanding industrial environments. Furthermore, AI is a foundational technology building block that enables more frictionless barcode handling. It is being applied across selected scanning platforms and scan engines—to help improve performance in defined use cases, particularly in challenging reading conditions.

By combining AI-enhanced decoding with rugged hardware, high-motion performance, low-contrast capability, wide ambient light tolerance, and fleet-ready management, Honeywell is not simply participating in the shift toward intelligent scanning. It helps define what industrial buyers should expect from it.

That is the posture of a company seeking to define category standards in AI-enabled rugged scanning.

And in a market increasingly crowded with AI claims, authority will belong to the vendors who can prove one thing above all else: not that their scanners are more intelligent, but that their intelligence performs where work is hardest.

LEADERSHIP BYLINE

> **AI is becoming a meaningful force in barcode scanning, but only when it is applied in service of operational outcomes. In rugged environments, that means improving first-pass read rates, reducing no-reads, and sustaining performance across the real variability of industrial work.**

THE HONEYWELL VIEW

The future of rugged scanning belongs to systems that think, adapt, and endure.

This is where Honeywell believes the industry is heading.

The next generation of scanning solutions will not be defined by isolated AI features. It will be defined by integrated systems—where optics, illumination, decode logic, rugged design, and edge intelligence work together to perform under pressure.

That belief is reflected in the Honeywell Granit Ultra family. By combining AI-enhanced decoding with ultra-rugged engineering and fleet-ready management, Honeywell is helping to set a higher standard for what industrial organizations should expect from rugged scanning.

In the years ahead, the vendors that lead this category will be the ones that make intelligence practical, measurable, and durable.

Honeywell intends to be one of them.

For more information
automation.honeywell.com

Honeywell Industrial Automation
855 S Mint St
Charlotte, NC 28202
800-582-4263
www.honeywell.com

Honeywell