Mitsubishi Electric and Cognex Alliance

Executive Overview ................................................................. 3
Machine Vision Aids Manufacturers in Production Challenges .......... 4
Expanding Machine Vision in Manufacturing Operations ................. 7
Machine Vision’s Role in Minimizing the Total Cost of Ownership .... 9
Cognex Machine Vision Integrated With iQ Platform ....................... 11
Mitsubishi Electric’s iQ Platform Adds New Control Disciplines ....... 13
Cognex and Mitsubishi Electric Use Leadership Positions to Form Partnership for Machine Vision & Control ................................. 14
Mitsubishi Electric Robotics Integrates Machine Vision with MELFA-Vision .......................................................... 19
iQ Platform is a Next Generation PAC System Built on Proven Technology
Executive Overview

Mitsubishi Electric’s partnership with Cognex™ brings two distinct product lines into one uniform environment from both a networking interface and an application programming environment. While Cognex’s In-Sight™ Machine Vision system is already highly integrated with both a camera, vision processor, and vision analysis, they have assured direct connectivity to the Mitsubishi Electric™ architecture using CC-Link and MELSEC Communication (MC) protocol on Ethernet. The networking hardware is integrated directly into the In-Sight, radically simplifying the integration into the automation system. While this is important, the partnership runs much deeper, as the application tools for Machine Vision are specifically developed for iQ™ Platform including Mitsubishi Electric Robotics. If a production application requires a general purpose automation solution, a turnkey robotic system, or both, the vision application programming is consistent and easy to use.

This partnership stretches the PAC concept to a truly multi-domain concept, which is becoming critical in today’s manufacturing environment. A rapid implementation of an automation solution with vision, controls, and robotics is critical in reducing the Total Cost of Ownership (TCO). Industry users have suffered long in the past when two technologies merged to create smart solutions because different technologies typically had multiple programming environments and consequently, manufacturers typically incurred high integration costs. Mitsubishi Electric-Cognex solutions offer manufacturers a standard set of “interoperable products”, rather than an untested set of components patched together to perform a specific function. These solutions have a single tool from which there is easy accessibility to all useful features and functions of logic, motion, HMI, vision, and robotic domains in a manner such that each task is a part of a single system.

Mitsubishi Electric-Cognex solution adds significant value in highly regulated production environments where validation is a significant concern.
By using a solution that is derived from the cooperation of leading suppliers, the number of touch points that need to be validated are radically reduced when production systems need to be upgraded or modified to adapt. In today’s highly competitive manufacturing environments, the Mitsubishi Electric and Cognex partnership provides a comprehensive solution that not only reduces downtime and maximizes productivity, but also ensures that procedures are in place for regulatory compliance.

### Machine Vision Aids Manufacturers in Production Challenges

The age of improving the bottom line by simply pursuing further cost reductions with supplier purchasing agreements has taken its toll on the manufacturing community over the last decade. The automotive industry has been one of the leading examples in this arena, as they continued to drive their suppliers’ component and subassembly prices steadily down. The food and beverage industries took a slightly different tack, with industry consolidation and the rationalizing of manufacturing facilities in an effort to gain from manufacturing scale. In the pharmaceutical industry, the age of the blockbuster drug is over and now the industry has placed a greater emphasis on manufacturing operations to improve margins. In tandem, every industry has pursued expansion into the global marketplace by seeking further growth in the emerging markets of Asia, South America and Eastern Europe. Each of these initiatives has placed a tremendous strain on manufacturing operations, as ensuring product consistency, quality, and regional regulatory compliance on a global scale has created pressures on these organizations that are unprecedented. The global expansion of markets, combined with industry consolidation in a wide range of industries, is driving manufacturing companies to seek best practices that can be applied consistently throughout each regional production facility that is independent of the labor force skills.

### Automation Best Practices

The best practice in virtually all industries has been to seek automation technologies that can be deployed globally, independent of the available
labor force skills. Many organizations have leveraged common manufacturing strategies that are engineered and proven in central engineering organizations and are deployed globally to confront the challenge of both satisfying regional market demands and ensuring businesses profitability. The business goals of raising the productivity of the labor force while lowering product costs and factory expenses is achievable when global manufacturing operations use consistent practices. Manufacturers are investing in automation technology that reduces overall costs and time to market while raising the quality of manufactured products. To get to the next level of capability in agility, flexibility, and production capacity, manufacturing organizations must add machine vision.

**Machine Vision by Industry**

Machine vision systems were first widely embraced by electronic components manufacturers who needed this technology to produce computer chips with decreasing geometries. Today, machine vision systems are being employed successfully for applications in many industries, including aerospace, automotive, electronics, food & beverage, healthcare, pharmaceuticals, semiconductors, and high-speed web inspection of materials such as metals and paper. However, these solutions commonly required engineering expertise with unique skills to perform the integration of the vision system, which drove up the cost of capital equipment expenditures as well as the Total Cost of Ownership.

Manufacturers are now seeking to minimize capital equipment expenditures by acquiring machinery that is capable of processing a broad range of finished goods. In the Consumer Packaged Goods (CPG) industry, the integration of robotics into the secondary packaging operations is providing agility and flexibility, but to gain the most from this type of deployment requires visualization of the process in order to reduce the reconfiguration of the automation equipment when product changeover is required. This environment of continuous innovation in retail products and short product lifecycles demands the ability for quick changeover or adaptation in a modern production line.

Conversely, automotive manufacturers seek to maximize customer satisfaction and quality to ensure increased sales and long-term growth. Among the hundreds of sub-assemblies that go into each automobile or truck, the
quality of the body panels plays an especially important role in getting and keeping a satisfied customer. Specifically, closure panels such as doors, hoods, lift gates and tailgates must be properly manufactured to meet crash safety requirements. Equally important is the need to keep dirt, water, and road salts out to prevent premature rust and corrosion. To this end, machine vision is used for automated inspection in production to ensure a high-quality finished product.

The importance of providing quality products for all manufacturers is no longer exclusive to industries such as pharmaceutical and medical devices. Quality has become an absolutely critical requirement in virtually every industry as brand value stands on the line. Manufacturers have long awaited for advances in technology and ease-of-use, combined with the decreasing cost of implementing vision applications, to leverage the benefits of machine vision that have been widely employed in the electronics and semiconductor industries.

Today, machine vision suppliers recognize that increasingly more general industrial manufacturers can no longer compete without the capability of machine vision systems as higher expectations are placed on finished goods. However, to provide the benefits of machine vision, suppliers are now seeking the expertise of traditional industrial automation suppliers to facilitate the integration with Programmable Automation Controllers (PACs), PLCs, and Motion Control Systems. This will make machine vision available to a broader range of users seeking to lower Total Cost of Ownership. Each manufacturer’s goal is to achieve lower Total Cost of Ownership of their factory equipment while fulfilling the greater business objective of rapidly producing more product variants in small lots on the same manufacturing line. Manufacturing operations need to employ technologies that offer more flexibility, greater agility, higher production speeds, higher efficiency, improved production and process controllability, tracking and traceability capabilities, and greater machine productivity. These are the many of the benefits achievable with machine vision systems today.

### Typical Benefits of Machine Vision

| **Improved quality** |
| **Reduced maintenance costs** |
| **Reduced waste** |
| **Lower manufacturing costs** |
Expanding Machine Vision in Manufacturing Operations

Manufacturers are taking the necessary steps of cutting costs, streamlining operations, improving manufacturing technology and refocusing their efforts towards world-class quality and service in order to maintain a competitive edge. Many industries are moving toward longer product warranties, zero defects in production, and seek compliance to regulatory requirements. The march toward improved quality continues. Manufacturers are under pressure to improve the quality of “pass through production” from outsourcing suppliers and internal production lines. This is driving demand for maintaining the production volume with less labor content while maintaining the quality of the final product.

Role of Machine Vision in Manufacturing

The requirements of many manufacturing processes have surpassed the limits of human eye, which performed various tasks in the past such as locating and positioning work, tracking the flow of parts, and inspecting output for quality and consistency. Now manufacturing operations are running at lightning speeds, and the tolerances requirements in many cases are too small to be analyzed by the human eye. Labor reductions and the shift to flexible workforces in factories over the last several years are an additional strain to these challenges. Manufacturers are taking this opportunity to selectively add intelligent automation on the factory floor that “reduces the dependency” on the unique skills of the labor force while also increasing the operational range of production operations. Robotics, automated material handling, and mechatronic machinery are all considered as part of the solution. What manufacturers are realizing is that these systems in of themselves are open loop. Automated processes that close the loop with machine vision systems today can achieve much higher quality and manufacturing efficiency by automating many critical steps in the production processes.
**Guidance, Inspection, Gauging, and Identification**

Machine vision has been available for over two decades; however the first generation had a relatively limited range of capabilities. The semiconductor and automotive industries dominated the initial demand for vision technology for “Inspection” applications simply because it was impossible to meet production requirements without use of this technology. This situation has altered radically with the latest generation of machine vision as continued investments in R&D have resulted in advancements that provide quantifiable benefits at lower costs in a broader range of applications: (1) Guidance, (2) Inspection, (3) Gauging, and (4) Identification.

**Guidance**

Machine vision systems provide guidance by locating features and patterns on parts. The systems determine the exact location and orientation of a part and provide coordinate information to the motion controller. For example, it can determine the position of a printed circuit board so that a pick and place robot can automatically be guided to place electronic components correctly.

**Inspection**

Inspection covers a very broad category of applications that can be addressed with machine vision. Vision systems can detect flaws or defects on surfaces of parts, verify correct assembly of a product, and determine presence or absence of a feature of product. For example, it can verify the contents and seals of packaged goods for food, consumer, and pharmaceuticals.

**Gauging**

Vision systems can provide non-contact measurements of critical features of a part, and verify that a part meets specified tolerances. For example, vision systems can measure and verify critical tolerances of medical and surgical devices.

<table>
<thead>
<tr>
<th>Industries</th>
<th>Application Examples</th>
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<tbody>
<tr>
<td>Automotive</td>
<td>Inspection of gear assembly, engine block, mirror assembly, spark plug; Gauging CV joints, brake assemblies, piston valves; Guidance of robots, bin picking</td>
</tr>
<tr>
<td>Aerospace</td>
<td>Gauging aircraft engine blades, fuselage alignment; direct part mark identification</td>
</tr>
<tr>
<td>Electrical</td>
<td>Inspection of connectors, cables, component defects; Gauging lead length, pins</td>
</tr>
<tr>
<td>Electronics</td>
<td>Inspection of LCD, laser printer, circuit board, SMT components, LED, finger spacing; Component, board and module traceability.</td>
</tr>
<tr>
<td>Food &amp; Beverage</td>
<td>Inspection of bottles, product size, fill level and label placement</td>
</tr>
<tr>
<td>Metals</td>
<td>Gauging of parts, punch hole, stamping; Inspection of joints, threads</td>
</tr>
<tr>
<td>Pharmaceutical</td>
<td>Inspection of blister packs, containers, lids, date/lot code verification, ePedi- gree traceability</td>
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<tr>
<td>Plastics</td>
<td>Inspection of plastic parts, injection molding</td>
</tr>
<tr>
<td>Printing</td>
<td>Identification for color registration, printing quality check</td>
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<tr>
<td>Semiconductor</td>
<td>Guidance for position of wafer stage, pattern recognition; wafer identification</td>
</tr>
<tr>
<td>Textile</td>
<td>Identification of flaws, color variations</td>
</tr>
<tr>
<td>Paper</td>
<td>Identification of flaws in paper</td>
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</tbody>
</table>
Identification
Machine vision systems are used to identify objects and parts by reading and verifying alphanumeric serial numbers, decoding 1D and 2D barcodes, and by recognizing shapes of objects. For example, vision systems are broadly used to track automotive parts throughout the manufacturing process by reading 2D barcode symbols that are directly marked on the part.

Machine Vision’s Role in Minimizing the Total Cost of Ownership

The cost of “integration, commissioning, and application programming” for automation systems continues to weigh heavily on the overall price of individual machines and automated production lines. Advances made in general automation platforms have resulted in the integration of increasingly more sophisticated controls such as motion and safety. Integrated development environments, standard industrial communication interfaces, object oriented methodologies, and even simulation software have all brought tremendous efficiencies to machinery deployment. Each has brought a number of advancements in and of themselves that ensure initial designs can be adapted to the unique requirements of individual production environments. Through these advancements, many automation integrators have achieved a lower total cost of design and deployment of machinery.

The world has changed as production environments need machine vision for a wide range of purposes, but fundamentally the key driver is to ensure that “production quality” does not decline as labor skills diminish, production speeds increase, and product variability expands.

Undoubtedly, manufacturers in the automotive, aerospace, food & beverage, pharmaceutical, medical devices, and consumer electronics market are seeking machine vision for a wide range of reasons. But invariably, a system integrator or machine builder simply does not have the expertise to evaluate and integrate a 3rd party machine vision system. The cost of development is simply prohibitive, whether it is a traditional inspection application, or at the far end, a vision guided robotics solutions. The incli-
nation to accept the assignment to integrate machine vision for the customer is inspired by the fact that the field of machine vision has seen huge improvement in the last few decades leading to ease of use and deployment.

Manufacturers are filling soda cans at 120,000 per hour, inspecting weld defects in stents that must be perfect, sorting randomly placed objects out of a bin, or locating microelectronic components that are measured in microns on a conveyor. All these applications require expertise that takes a considerable amount of time to develop internally because machine vision requires a combined knowledge which encompasses the camera, algorithms, optics, and lighting. Producing defective products is not an option for global manufacturers. By deploying machine vision with the aim of defect elimination right down the production line, manufacturers have been able to reduce scrap, lower capital costs, and increase customer satisfaction by minimizing product recalls.

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Once a manufacturer determines that machine vision can be an effective tool for their application, they must decide the best path to take in configuring a system. Larger companies with skilled engineering staffs may pursue their own solution, assembling components purchased from various vendors, or even using new technology. However, a steep learning curve, a lack of industry standards, and time-to-market pressures make the in-house approach largely impractical. A vision system meant to add value to a production operation can become a serious drain on time, energy, and resources. Expert help must be called in to solve the problems.

Focus on Integration Time to Reduce Total Cost of Ownership

Minimizing the Total Cost of Ownership (TCO) for the customer is achievable by using solutions that are derived from systems that use interoperable subsystems to achieve rapid implementation. Interoperable subsystems allow for subsequent changes that optimize processes and provide development tools for integration of logic, motion, robotic, and machine vision tasks. The ease of achieving this integration is vital. For example, the integration of the robotic and vision space includes calibrating the vision systems grid to match robot coordinates and having a math algorithm for making vision data useful within the robotic coordinates. These tasks can become unwieldy and extremely costly if the integration framework is not
developed using a proper engineering discipline, which is typically rigorously followed in the product development phase. Specifically, automation solutions with machine vision and robotics developed from pretested interoperable components, rather than a solution developed simply by using independently developed components, are more likely to have lower implementation costs.

“Flexibility” in manufacturing operations continues to be the mantra that is driving automation solutions into “easy to use” integration platforms where the impetus is to lower the initial design and engineering effort while also directly translating into a lower total life cycle cost. Many automation solutions typically require frequent changes after installation, as more process issues surface over time. If system integrators used the “patchwork” approach, subsequent changes could create major problems, driving up life cycle costs. Manufacturers now associate the benefits of interoperable components and subsystems for easy integration as they yearn for lower TCO. Manufacturers must establish criteria in which they can evaluate automation solutions based on the ability to lower integration costs without compromising performance and reliability. More importantly, when machine vision is being considered, there is no room for compromise regarding interoperability, as this can have a direct impact on production quality and equipment utilization.

<table>
<thead>
<tr>
<th>Demand For Machine Vision Increases</th>
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<tbody>
<tr>
<td>Production Changeover</td>
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<tr>
<td>Product orientation and sizing variability is accommodated</td>
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<tr>
<td>Diagnostics</td>
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<tr>
<td>Monitoring machine performance</td>
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<tr>
<td>Synchronize vision capture with machine movements</td>
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<tr>
<td>Availability of Visual Information for both remote and local diagnostics</td>
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<tr>
<td>Maintenance</td>
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<tr>
<td>Reducing the machine complexity</td>
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<tr>
<td>Integrated solutions provides access for Maintenance personnel</td>
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**Cognex Machine Vision Integrated With iQ Platform**

Mitsubishi Electric has expanded the concept of a PAC by integrating “machine vision” into its versatile “iQ Platform”. In a partnership with Cognex, a leader in vision technologies, Mitsubishi Electric has expanded its iQ Platform with Cognex’s advanced machine vision system, In-Sight, along with robotics capability. Mitsubishi Electric is well ahead of the curve compared to most major global automation suppliers in anticipating the increasing need for vision capabilities in an automation platform. It is rare to have a single automation platform that can support all of these domains; however, the timing is right, as increasingly more manufacturing applications are
demanding a greater breadth of automation. Machine vision has been an area that many general automation suppliers have chosen not to integrate into their system architecture; however iQ Platform and Cognex machine vision is a solution that merges the capabilities of each supplier onto the integrated platform using the high speed network CC-Link.

A Systems Integrator, machine builder, or end user could certainly take on the task of integrating an automation solution with machine vision. This is not a casual task, as the qualification, verification and selection of subsystems and system programming tools must all be developed before valuable engineering talent can deploy the application on the production line or machine. Factors such as the time required for system development, installation, integration with the factory system, operator training costs, project management, maintenance, and software upgrades and modification, all contribute to the total cost of ownership for the system and should be taken into consideration. However, In-Sight Machine Vision with CC-Link connectivity is a true plug and play solution that ensures rapid deployment.

**CC-Link Adds Flexibility without Boundaries**

In this architecture, machine vision is a resource that is accessible by all the other domains of iQ Platform and supported by the iQWorks™ Integrated Development Environment (IDE). This is important, as the full range of vision capabilities in terms of “Gauging, Identification, Guidance, and Inspection” are fully accessible from an application programming perspective, making this not only a PAC automation platform with ma-
machine vision, but one of the most capable multi-disciplined automation platforms available.

Mitsubishi Electric’s partnership with Cognex makes iQ Platform an extensible platform that includes machine vision and robotics along with traditional logic, motion, and HMI domains to bring this platform to the forefront of solutions more suited to manufacturing requirements today. TCO is dramatically reduced, as integrated systems greatly reduce deployment time because:

- Application program development software is easier to use for set-up and configuration from single development tools
- Calibration is simpler to perform
- Configuration is robust and reliable, as equipment is pretested for interoperability and operation under the same iQ Platform
- Labor costs are saved, as less skilled technical personnel are required
- Automation development tools are able to be leveraged for multiple functions

Mitsubishi Electric and Cognex have developed a software library that provides access to the functions of the machine vision system as an integral part of the programming environment in iQ Platform. The addition of vision function blocks to Mitsubishi Electric’s programming environment, provide easy access to high-level vision tools for guidance and inspection applications to a much wider audience of users and manufacturing engineers.

**Mitsubishi Electric’s iQ Platform Adds New Control Disciplines**

Mitsubishi Electric has pushed the envelope with leading edge technology in the ARC definition of a PAC by creating “iQ Platform”, a system that exceeds the performance and capabilities of ARC’s PAC requirements. iQ Platform is designed with “high performance applications” in mind while it is also intended
to serve the requirements of a production operation with a scalable, modular, and extensible architecture. However, it is the high performance of the backplane that enables a multi-processor system to function as a unified controller. Manufacturers demand reliable interoperability between their automation products. This has led to a multitude of drivers, networks, and standards that have become prevalent in automation solutions over the years. Automation is an investment, and to ensure that both 3rd party and standard products will function properly, requires that an automation platform uses validated and pre-tested solutions. A lot of this depends upon the automation supplier, as they take on the responsibility of ensuring that partners adhere to the same levels of quality, performance, reliability that is expected.

Mitsubishi Electric’s partnership with Cognex is founded upon a common set of corporate values that blend quality and performance. Cognex has migrated the In-Sight Machine Vision system such that it can be integrated as a “networked machine vision system” in the iQ Platform architecture. The In-Sight Machine Vision system is designed to leverage the ease of connectivity over CC-Link and MC Protocol, dedicated protocol for Mitsubishi PLC, on Ethernet. Mitsubishi Electric has achieved both application software and hardware interoperability within a single programming and engineering tool, iQ Works, as well as a single programming language for the complete system. This is a solution that provides maximum transparency and access of all parameters and functions throughout the whole system using standard Function block programming and GOT™ dedicated screens for changing parameters.

**Cognex and Mitsubishi Electric Use Leadership Positions to Form Partnership for Machine Vision & Control**

Cognex, headquartered in Natick, Massachusetts USA, is a leading global supplier of machine vision systems, or computers that can “see”, which are used to automate a wide range of manufacturing processes where vision is required. Cognex designs, develops, manufactures, and markets machine vision systems. Cognex vision systems are used in factories around the
world to capture and analyze visual information in order to automate tasks, primarily in manufacturing processes for a wide range of items, and to ensure their quality. Since its founding in 1981, Cognex has generated over $1 billion in cumulative revenue, shipped more than 150,000 vision systems, and acquired more than 110 patents, with over 140 U.S. and international patents pending. Cognex’s strategy has been to boost its presence worldwide through product development and strategic acquisitions. Product development efforts have been focused on lower-price-point products, which are easier to use by incorporating menu-based programming features, network capabilities, and standardized interfaces. Cognex has also pushed the development of systems, which incorporate a specialized digital camera, board, and software, in effort to expand the market. Acquisitions have typically added customer access or engineering know-how. DVT, Honeywell, Rockwell Automation, and Komatsu have all sold their machine vision businesses to Cognex. Cognex continues to retain a leadership position in the machine vision market by offering a broad product portfolio, continuous product development, and strategic acquisitions to expand its technical resources in the field and penetrate new markets. Cognex is strong in many industries including food & beverage, pharmaceutical, electronics, semiconductor, automotive, and machinery.

**Mitsubishi Electric’s Broad Portfolio**

Mitsubishi Electric is a leading worldwide provider of factory automation systems and products. Mitsubishi Electric’s Industrial Automation Business unit has a broad product portfolio ranging from controllers, HMIs, motion control, robotics, and drive components to complete machines such as EDMs (Electric Discharge Machines) and laser processing machines. Mitsubishi Electric’s strategy is to succeed as a products oriented business. Mitsubishi Electric believes that its extensive in-house use of its own products, combined with its deep collaboration with OEMs, end users, system integrators, and other partners, provides the same level of insight and customer feedback that other companies obtain from service engagements. Mitsubishi Electric is confident in the competitive positioning of its products. Adopting the strategy of a product company allows Mitsubishi
Electric to maintain a symbiotic and non-competitive relationship with its service partners.

**Mitsubishi Electric Provides a Wide Range of Automation Products**

While this level of product-oriented strategy is unique among major automation suppliers, Mitsubishi Electric products are not limited to drives or other products at the “edge” of production. Mitsubishi Electric’s e-F@ctory™ enabled products are used to provide “vertical” integration and enterprise connectivity for all types of Mitsubishi Electric automation systems and production equipment. Similar to the automation products, e-F@ctory technologies are used extensively in Mitsubishi Electric’s own manufacturing operations. One of Mitsubishi Electric’s hidden strengths as a manufacturer of state-of-the-art products is that it must use its own technology to build its products. Mitsubishi Electric’s factory sites and manufacturing operations are proof points that Mitsubishi Electric products can contribute to efficient and high quality manufacturing.

**Strength of Partnership**

Mitsubishi Electric and Cognex’s partnership for machine vision & control puts two giants together in the industrial arena. Specifically, it puts Mitsubishi Electric in a unique position in providing automation equipment for a broad range of applications compared to other major global automation suppliers. As the complexity of industrial manufacturing operations rise, automation solutions require not only traditional logic, motion, and HMI domains, which are offered by major suppliers, but also the “vision domain.” This partnership has raised the bar for all players in this arena. Adding vision greatly expands the automation solutions capability in a wide range of industries. In addition, Mitsubishi Electric’s capability is expanded even further with its robotics capability under the same iQ Platform.

Cognex has worked with Mitsubishi Electric to develop specially configured versions of Cognex In-Sight machine vision systems that
will be designed to seamlessly connect with Mitsubishi Electric's factory automation products over CC-Link and MC protocol. In addition to collaborating on product development, the two companies will also jointly promote their integrated solutions at tradeshows and seminars demonstrating an even greater commitment to the partnership. As a result of this collaboration, Mitsubishi Electric's factory automation customers will be able to purchase Cognex machine vision systems and quickly deploy them in their manufacturing operations, while also getting support and service that will solve integration issues when they arise. Cognex expects that this partnership will significantly accelerate the sale of its vision systems globally including Japan and the fast-growing markets throughout Asia.

**In-Sight Machine Vision Leverages Connectivity of the CC-Link Network**

Mitsubishi Electric released control of the specifications for CC-Link in the year 2000. As a result, the CC-Link Partner Association (CLPA) was formed that year with Mitsubishi Electric and five other companies serving as foundation partners. The number of CLPA members and the number of CC-Link nodes has grown steadily since then. Today, over 4.5 million CC-Link certified nodes have been shipped, and over 850 products from hundreds of manufacturers are certified as CC-Link compliant.

It is through the CC-Link network that CC-Link leverages features such as fast response times, large data transfer capabilities, and a very high level of determinism. For example, a network of 64 stations can be updated in about 4 ms. The CC-Link network is suited for large applications, managing distances up to 1.2 km and further using repeaters. CC-Link features a user-friendly memory mapped profile, enabling simple network configuration as well as various RAS (Reliability, Availability, and Serviceability) functions and diagnostic features. One of the key reasons why CC-Link is so widely used is its high degree of determinism, stable scan time, and high immunity to electromagnetic noise. In fact, all certified products must pass noise testing as part of CC-Link conformance certification.
Cognex machine vision systems are already being used together with Mitsubishi Electric factory automation products to help guide robots, to direct motion control systems, and to automate a wide range of manufacturing processes. This new partnership, which will result in dramatically improved connectivity between the respective products, is expected to benefit users of factory automation products. The combined power of Cognex’s machine vision and Mitsubishi Electric's factory automation equipment will make it easier and faster for customers to improve the overall performance of their manufacturing processes.

**Facilitating Vision Data Movement**
Mitsubishi Electric’s partnership with Cognex is insurance to many automation users, as the collaboration overcomes the most significant issues of vision data throughout the entire e-F@ctory architectures. Along with the Mitsubishi Electric iQ Platform, the Cognex machine vision system also has connectivity to the “GOT1000 Series” of Human Machine Interfaces. In many applications vision data is stored for regulatory reasons as well as quality tracking and tracing. Using a File Transfer Protocol (FTP) interface, the GOT1000 leverages its much larger storage capacity to handle vision data file functions as a short term repository of information for each product in a batch. With the enterprise connectivity provided by e-@Factory, vision data files can be transferred easily between the GOT and enterprise servers. This connectivity helps manufacturers meet their overall objective of reducing system engineering time for both the production line automation, as well as integration with the enterprise, by providing a variety of pre-tested tools that optimize the connectivity between Cognex and Mitsubishi Electric products.

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<thead>
<tr>
<th>Capability</th>
<th>Mitsubishi Electric</th>
<th>Other Automation Suppliers</th>
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<tbody>
<tr>
<td>Logic</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Servo Motion</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>AC Drives</td>
<td>Yes</td>
<td>Some</td>
</tr>
<tr>
<td>HMI</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Vision</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Robotics</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Integrated Vision and Robotics</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Vision-Guided Robotics</td>
<td>Yes</td>
<td>No</td>
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**Capabilities Comparison of Major Automation Suppliers**

**Automation Configuration and Development Tools**
With the capabilities of function block extensions in iQWorks, a general purpose vision system such as In-Sight machine vision is transformed into an expert vision system well-suited for an unlimited number of applications throughout the entire production line. This is part of a software abstraction obtained by using function blocks that have embedded applica-
tion code specifically developed to work with In-Sight machine vision systems for applications requiring vision, motion, and logic control.

**Mitsubishi Electric Robotics Integrates Machine Vision with MELFA-Vision**

Mitsubishi Electric’s factory automation business unit offers not only product lines of PLCs, CNCs, motion control systems, and operator interfaces, but also an extensive line of turnkey robotics. Mitsubishi Electric is a leading manufacturer of light duty, five and six axis articulated robots, as well as SCARA robots. Mitsubishi Electric’s robots are used in a variety of applications, including machine tool assistance, laser soldering, laboratory assistance, wafer handling and inspection, high speed vision tracking, sealing, and high speed pick and place.

Robotics have been prime contributors of manufacturing flexibility. However, Vision Guided Robotics (VGR) offer an even greater value proposition in this area by allowing a higher degree of flexibility, while simultaneously reducing the cost of tooling. Machine vision and robotics technologies have progressed for the last several years in parallel, but independent paths. Robotic applications on the factory floor are now providing flexibility that manufacturers today cannot live without.

Advancements in technology and increased robustness have pushed adoption of both machine vision and robotics. However, a lack of “ease of use” has encumbered the widespread adoption of machine vision. Mitsubishi Electric’s robotics group understands these challenges and has taken a giant step forward with their partnership with Cognex to create an application environment that blends robotics and machine vision.

**Networking and MELFA-Vision Make Machine Vision Plug & Play**

Traditionally, there are two hurdles that need to be addressed when integrating machine vision with a robotic solution: physical interface and application programming. The partnership with Cognex has enabled Mitsubishi Electric to address both of these issues in a way that effectively
eliminates any complexity during the integration process. All Cognex In-Sight machine vision systems have supported Ethernet connectivity since 2001. Ethernet is supported at the physical layer which enables the “plug” part of the equation. Secondly, the application programming environment has been augmented with MELFA-Vision, which is the play part of the equation.

Custom developed application programs are being replaced with a machine vision library that is fully aware of the capabilities of the In-Sight Machine Vision system. In addition, configuration tools are built into the MELFA-Vision environment in order to perform image adjustments, calibration, and registration of the work pieces. All of this is combined into an Integrated Development Environment (IDE), thereby providing a single programming and configuration platform for both robotics and machine vision. The benefit to the system integrator or manufacturer is that they have one point of support and a single development tool for what is effectively a collaborative multi-vendor solution.

**Vision Guided Robotics is beyond Inspection and Identification**

In its simplest form of an example of VGRs, a fixed vision system finds position coordinates of a fixed object in a container and presents it to a robot controller, which guides a robot arm to the part for pick up, and moves it to another designated location for the next operation. In the next level of VGR complexity, a fixed vision system maps an area on a moving conveyor, computes the relative location of all objects, and then provides information to a robot controller, which calculates the future location of moving parts and guides the robotic arm to pick up parts and places on a location for assembly or palletizing. Typically, such applications use 2D imaging or 2D camera technologies. If more accuracy is desired when parts on a conveyor are placed randomly and with unknown orientation, more sophistication may be applied using 3D imaging or 3D camera technology.

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**Features for Easy VGR Implementation**

- **Common programming environment for vision and robotics**
- **Single programming tool for vision and robot tasks**
- **Ability to make easy integration of robotic and vision space**
- **Availability of general-purpose algorithms to address standard vision tasks**
- **Easy calibration tools for vision grid and robot coordinates**
- **Built-in software toolsets for applications such as product and assembly verification**
Most robotic applications, without a vision domain, provide repeatability, but not necessarily accuracy, raising the flexibility level of a material handling operation.

Use of VGRs is expanding in many industries. For example, in the automotive industry, VGRs are used in the assembly of engine and body components. In the food & beverage industry, VGRs are used to pick products from conveyors for packaging and palletizing. In the pharmaceutical industry, VGRs are used for packing and shipping medical supplies from moving belts. In the metal working industry, VGRs are used to locate metal castings on pallets and load it on CNC machines.

**VGRs Lowers Cost While Raising Flexibility**

Most robotic applications, without a vision domain, provide repeatability, but not necessarily accuracy. Robots are generally taught to go to a specific point and return to the same taught point. VGRs give accuracy, because vision systems provide accurate coordinates for a point where the robot must travel. This feature, unlike a robot without vision, saves significant hard tooling costs in material handling of both in-line and end-of-line operations, while raising the operational flexibility levels significantly.

In material handling operations, VGRs remove constraints on how parts are placed on a conveyor or in a bin. With increased accuracy and visual knowledge of the surrounding environment using vision systems, VGRs can handle a broad range of parts associated with product variations, raising the flexibility of an operation. Unlike simple robotic operation, VGRs do not have to be taught each time a new part is presented, but the proper algorithm can identify a type of part and modify motion accordingly.

A complex and costly arrangement for part placement can also be eliminated, because parts are now allowed to be placed randomly. Additionally, because VGRs can recognize the orientation of parts with greater accuracy, parts can be placed in a generic bin rather than special bins that must be specifically designed for those parts. This, in turn, eliminates the cost of hard tooling for extruding these special bins for each part that must be handled. This further raises the flexibility, because production lines now can accept a greater variety of parts without the need for specialized bins to hold parts.
VGR technology basically removes manual and hard-tooled operations, which are still common in many assembly applications. The automotive industry is aggressively upgrading their operation to add flexibility using VGRs to meet market demands of make-to-order, and lowering the investment costs associated with varying product models. Similar market forces are driving rapid adoption of VGR technology in the food & beverage, pharmaceutical, and metal working industries to satisfy consumer demands.
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