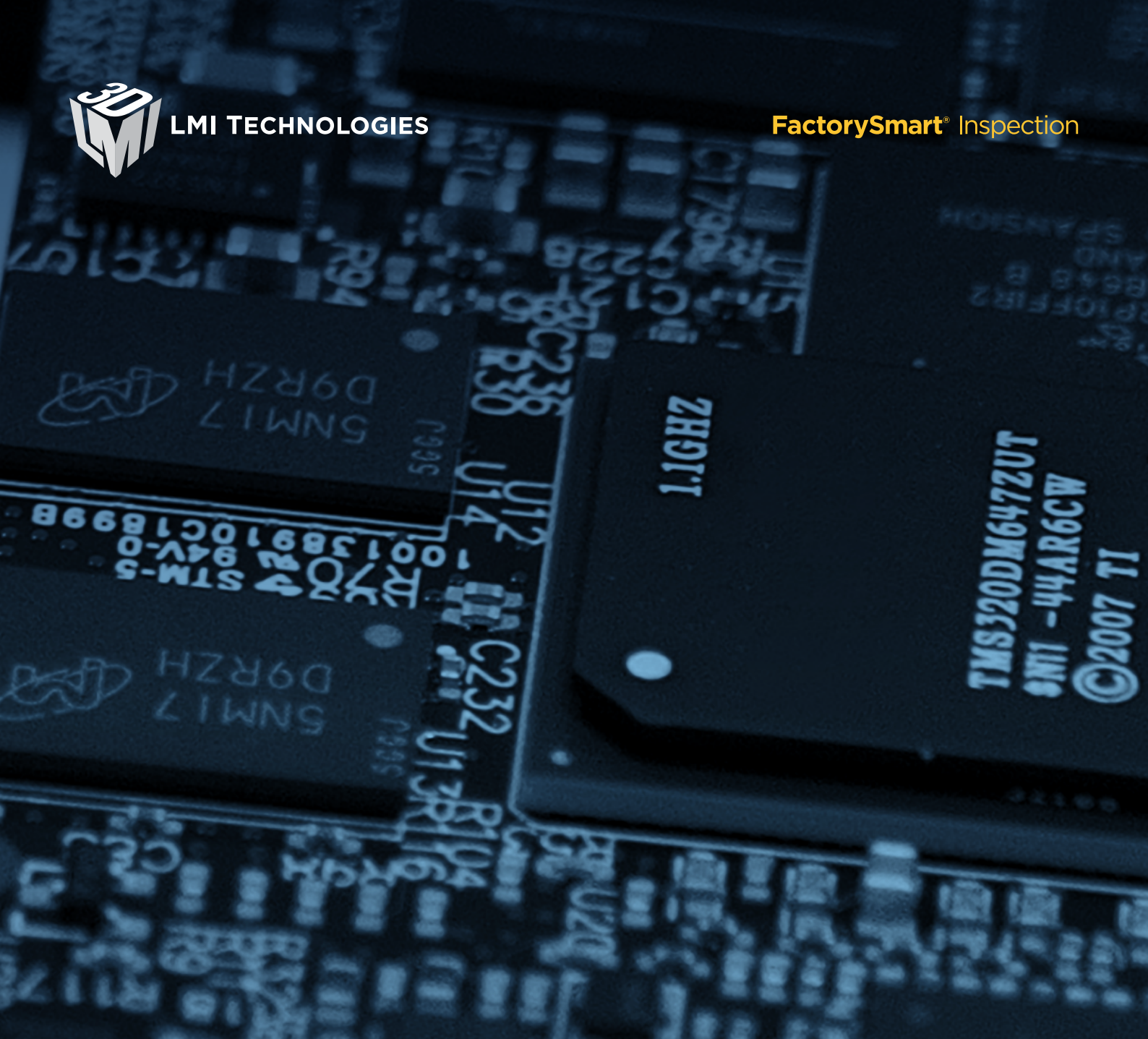
LMI TECHNOLOGIES

FactorySmart® Inspection



EMBEDDED VISION AND 3D SENSORS:

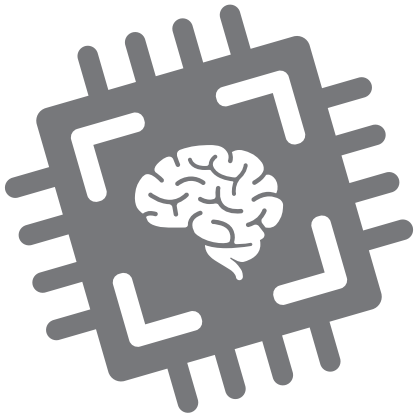
WHAT IT MEANS TO BE SMART

INTRODUCTION

Adding embedded processing to simple sensors can make them “smart”—but that is just the beginning of the story.

Fixed Sensor Design and the Machine Vision Status Quo

Today’s simple sensors (including ultrasonic, capacitive, inductive, temperature, accelerometer and more) are built with a single purpose to measure and deliver a specific output. In the world of machine vision, the basic sensor is the camera chip for which manufacturers add sufficient hardware to control and deliver raw images from the camera to a PC. Developers then add other machine vision elements such as optics, lighting, a PC, and 3rd party image processing to solve real world problems.



How Embedded Processing Makes Hardware “Smart”

By adding an embedded processor, memory, and flash to a fixed hardware design, it is possible to add new functionality and extend the use of a low level, single purpose sensor into a broader market—making the hardware “smart” in the process. This idea is not new. Embedded processing drove the development of 2D smart cameras, however, the implementation of “smart” has fallen short of many user needs. This paper presents ideas that will drive the smart hardware industry and evolve user experience to the next level.

So what exactly is **“smart”** hardware? It takes more than just adding embedded components to earn the distinction.

SMART: IT STARTS WITH THE USER INTERFACE

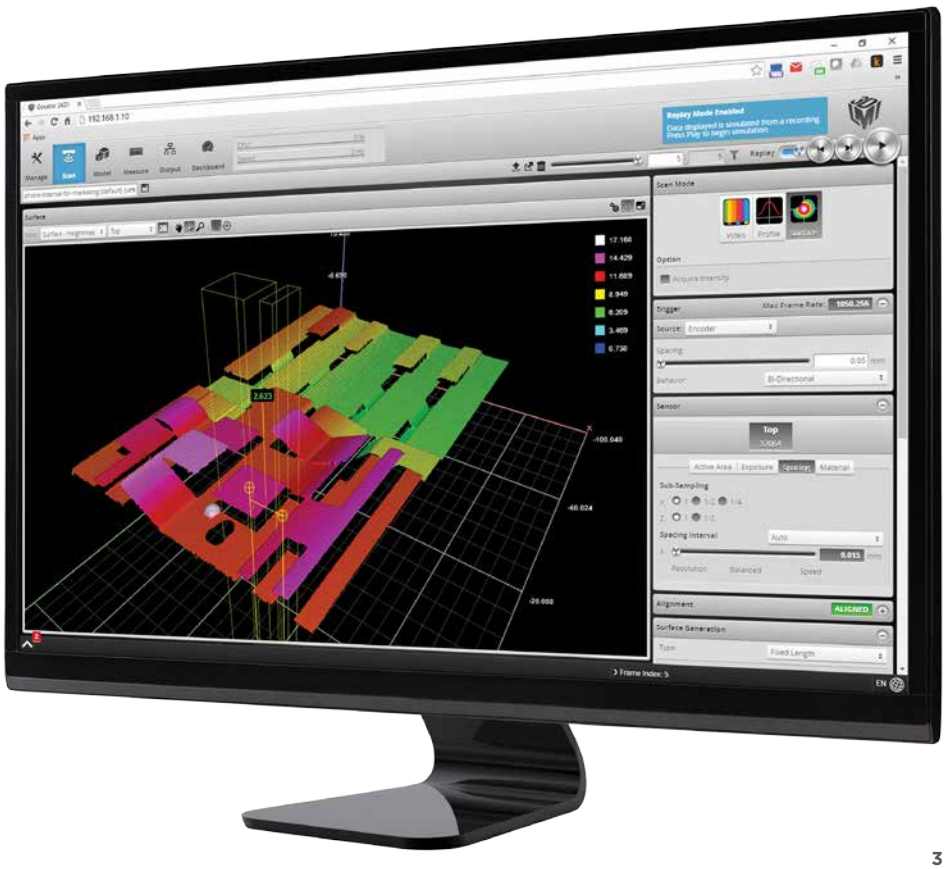
Embedded processors need to run software, and this software has to offer a user interface that makes setup of hardware functions easy-to-use.

Traditional vs. Smart Embedded Vision Solutions

In most embedded vision solutions today, you need to be a software developer willing to create dedicated applications using an SDK. To design a true smart sensor, however, requires an understanding of all the potential use cases for the hardware, and the ability to deliver a user experience that offers built-in processing tools to solve a broad set of problems. Such a set of tools requires an intuitive user interface for configuration.

From the Start: User Interface is Key

A smart user interface should provide rich visualization of the sensor's data and a means to process this data in a way that makes decisions, reducing dense streams of raw data to a simple output. Ideally, there should be no dependency of running such a user interface on a specific host OS (e.g., installing a device driver or installing an app on Windows). The embedded software (or firmware) should deliver all of its user interface components and handle user setup interaction through ubiquitous technology in the form of a web browser.



SMART EMBEDDED CONTROLLERS

Programmable hardware is the key to delivering the high-speed data processing required in today's inline automated quality control applications.

The Challenge: Reconfigurable Imaging Pipelines

Building a reconfigurable imaging pipeline using onboard embedded processors requires a lot of knowledge in the area of image processing and analysis. The key processing steps and how they may be dynamically configured to serve a broad range of applications is challenging to identify and implement in order to deliver real-time inspection solutions. Any imaging pipeline design must consider everything from data acquisition to measurement and real-time decision processing.

Standard Vision Solutions Use 3rd Party Vision Libraries for Data Processing

Most companies rely heavily on 3rd party imaging libraries to establish this layer of processing on an embedded processor supporting a general CPU (such as an ARM) or DSP.

Why Standard Embedded Processors Fall Short of the Mark

An embedded processor offering 32-bit or 64-bit CPU, however, is not sufficient to keep up with today's high speed CMOS megapixel cameras. In addition, GPUs are not generally available on embedded platforms as they consume significant power and produce a lot of heat. In fact, as a developer, you will face a limited set of embedded resources—e.g., memory limitations of 512MB-1GB, and CPU clocks running at less than 1GHz.

The Solution: Smart Embedded Controllers

To overcome processor limitations, embedded controller designs must combine both FPGA (field programmable gate arrays) and CPUs (preferably multi-core) to achieve real-time performance in many of today's machine vision applications.

FPGAs offer hardware logic, memory, clocks, and transceivers that are configured at boot time to directly interface with megapixel camera architectures and apply real-time filtering and reduction algorithms. Although dedicated hardware—such as an ASIC—is another alternative to an FPGA for high-speed pixel processing, the fact remains that designing the right mix of embedded image processing tools that is frozen into hardware and capable of being used in a broad number of markets requires significant investment.

THE EMERGING SMART PARADIGM: EXTENSIBLE FIRMWARE

Toolsets that support extending firmware functionality are at the forefront of today's smart sensor design.

The New Layer of Smart: Extensible Firmware

On top of designing a firmware software architecture that supports high-speed pixel processing, and offers built-in user interfaces to connect arbitrary processing steps that reduce high data loads to simple decision outputs, there is a new level of "smart" emerging: extensible firmware. Extending firmware means allowing customers to add their own software algorithms to factory firmware and thereby perform custom processing.

The Barrier to Making Better Sensors

Unfortunately, closed firmware environments are currently the industry norm because extending firmware requires a level of sophisticated development tools that most companies are unwilling to expose and support.

Breakthrough: An Extensible Approach to Firmware

Adding software algorithms generally requires comprehensive knowledge of the firmware execution environment (real-time OS, memory management, graphics engine, hardware architecture). A carefully designed smart firmware approach, however, can expose just enough of the underlying framework to achieve a level of customization that is uncommon in the embedded vision world, without exposing valuable intellectual property.

EXTENSIBLE FIRMWARE ALLOWS YOU TO:

- Develop and embed custom measurement tools with the same ease-of-use as native built-in tools
- Convert standard products into custom products by installing custom firmware
- Remove PC or add-on hardware and embed all processing in a single smart sensor

SMART SENSORS LEVERAGE WEB-TECHNOLOGIES

A 3D sensor has to be completely integrated with Web-based technologies in order to be truly smart.

The Power of the Web

Today's latest smart sensors leverage web technologies to deliver a fluid and responsive user interface experience. This means that users can simply connect a web-enabled sensor to a web browser. The smart sensor firmware then delivers web pages to the browser, which define an effective user interface for setup and visualization of the underlying hardware. In the case of 3D smart sensors, interactions with 3D display of scan data (zoom, rotate, pan) with drag and drop measurement tools are implemented with today's web technologies to set up and monitor quality control decisions.

Traditional approaches to user interfaces rely on tools that run on PCs whereas web-based technologies can run on virtually any platform including mobile devices like tablets or smartphones.

The Future of Automated Quality Control

Smart sensors offering built-in web servers deliver out-of-the-box solutions to a broad range of applications. Furthermore, smart sensors offer tools for customization of the underlying algorithms to create special firmware builds that offer native performance within a real-time environment.

THE 3D SMART SENSOR ADVANTAGE:

- Pre-calibrated, out-of-the-box, quality control delivering the value of 3D
- Embedded controllers offering hardware acceleration and built-in measurement tools
- All-in-one functionality through a common web browser delivering fluid, responsive user interfaces for rapid setup, visualization, and monitoring

THE POWER OF EMBEDDED VISION

Embedded vision technology is at the core of 3D smart sensor design that is advancing automated material optimization and quality control.

Easy-to-Use

Features such as web-browser driven point-and-click environment for rapid configuration, built-in measurement tools and rich I/O for communicating results make it easy for factory technicians to get the results they need.

Low Latency

Real-time measurement capabilities minimize lag between data acquisition to decision outputs, which means factories can consistently meet their throughput targets.

Built-In Measurement Tools

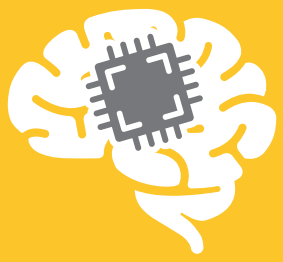
Built-in application-specific tools provide a drag and drop environment with full 3D visualization to support part detection and measurement and deliver highly accurate and repeatable results.

Customizable

Sensor customization allows users to develop and embed their own custom measurement tools directly into the Firmware itself—with the same functionality and ease-of-use as built-in native tools.

FactorySmart®

Today's 3D smart sensors connect seamlessly with networks to communicate results, display diagnostics and statistics over web browsers, access upgrades over Internet, and interface with factory equipment.



WHAT IT MEANS TO BE SMART

In a smart sensor, all of the processing pipeline elements deliver real-time, streaming performance—from 3D point cloud generation to filtering, part segmentation, part rotation, part sectioning, projection, measurement, and pass/fail decision outputs.

IT'S BETTER TO BE SMART

contact@lmi3d.com

ABOUT LMI TECHNOLOGIES

ADVANCING 3D MEASUREMENT WITH SMART SENSOR TECHNOLOGY

At LMI Technologies we work to advance 3D measurement with smart sensor technology. Our award-winning, FactorySmart® sensors improve the quality and efficiency of factory production by providing fast, accurate, reliable inspection solutions that leverage smart 3D technologies. Unlike contact based measurement or 2D vision, our products remove complexity and dramatically reduce implementation cost.

To learn more about how LMI's inspection solutions can benefit your business, we invite you to contact us at contact@lmi3d.com or visit us at www.lmi3d.com to explore the possibilities of smart 3D technology.

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