NSF Highlights

ERC/RMS Reconfigurable Inspection Machine Installed on GMC Manufacturing Line

Highlight ID: 13235

Today's automotive engine technology is extremely sophisticated and requires manufacturers to maintain exacting quality specifications to ensure optimum engine performance and reliability. Hence, manufacturers are increasingly employing in-line inspection stations to inspect critical part features on 100% o the parts. In-line inspection minimizes the chances of defective parts reaching the customer and facilitates process control and process improvement. The best applications of in-line inspection are those where the quality is highly unpredictable.

One example of such an application is the need for in-line surface porosity inspection systems. Surface porosity is caused by tiny voids or pits at the surface of machined castings such as engine blocks and engine heads. Surface porosity begins in the casting process when gasses are trapped in the metal as the casting solidifies, creating voids in the material. If the void is exposed during machining, it leaves a small pit (i.e., surface pore) at the surface. Although they are typically smaller than 1mm, surface pores can create significant leaks of coolant, oil, or combustion gasses between critical mating surfaces and cause severe damage to engines and transmissions. If such a pore is not detected, the consumer will have a noisy engine with shorter lifetime.

As an outgrowth of its Reconfigurable Inspection Machine project, the ERC for Reconfigurable Manufacturing Systems (RMS) at the University of Michigan developed a prototype machine-vision system for in-line surface porosity inspection of engine blocks and engine heads. The system utilizes a specially designed vision system to acquire very high-resolution (300 megapixel) images of the part surface. The high-resolution images are then analyzed rapidly to detect, locate, and measure pores. This technology is very important to engine manufacturers because of the difficulty in objectively measuring the sizes and location of irregularly shaped surface pores at production line rates.

In July 2006, this technology made a significant leap forward. General Motors Corp., an ERC member company, installed an industrial system for in-line surface porosity inspection of engine blocks in Flint, Michigan. The system is based on the technology developed at the ERC/RMS. The inspection system is integrated into the production line, and a conveyor moves engine blocks through the inspection station. Therefore, every part is measured within 15-20 seconds. By using this technology the manufacturer expects to prevent defective parts from reaching the customer and also to collect meaningful data for process improvement.

With this ERC/RMS technology the human inspector is able to do a more thorough job. Instead of trying to detect pores on every engine block at a rate of two per minute, the inspector now inspects the images of just those engine blocks on which a defect was detected by the automated inspection system.

Engine block moves into the in-line porosity inspection station

Permission Granted
Credit: RMS ERC

An operator inspects the images of an engine block in which pores were detected and makes the intelligent decision as to whether the engine block is indeed defective

Permission Granted
Credit: RMS ERC

Primary Strategic Outcome Goal:

- Discovery: Foster research that will advance the frontiers of knowledge, emphasizing areas of greatest opportunity and potential benefit and establishing the nation as a global leader in fundamental and transformational science and engineering. (AC/GPA selected)

Secondary Strategic Outcome Goals:

How does this highlight address the strategic outcome goal(s) as described in the NSF Strategic Plan 2006-2011?:
By reducing manufacturing time and cost and improving the quality and reliability of automotive engines, this advance has the potential for major economic impact for U.S. auto manufacturers, parts suppliers, and manufacturing equipment builders. The underlying research is highly cross-disciplinary and required a rigorous systems approach.

Does this highlight represent transformative research?
Yes

Any major change in large-scale industrial assembly lines is extremely risky and expensive, and therefore infrequent. This automotive manufacturer was sufficiently convinced of the transformative nature of the new machine that it made such a change in the production line.

ENG/EEC 2007

Program Officer: Lynn Preston

NSF Award Numbers:

9529125
Award Title: Engineering Research Center for Reconfigurable Machining Systems

PI Name: Yoram Koren

Institution Name: University of Michigan Ann Arbor

PE Code: 1480

NSF Contract Numbers:

NSF Investments: American Competitiveness Initiative (ACI), Sensor Research

Related Center or Large Facility: ERC for Reconfigurable Manufacturing Systems

Submitted on 01/31/2007 by Courtland S. Lewis
EEC: Approved 02/01/2007 by Allen L. Soyster
ENG: Approved 02/28/2007 by Joanne D. Culbertson