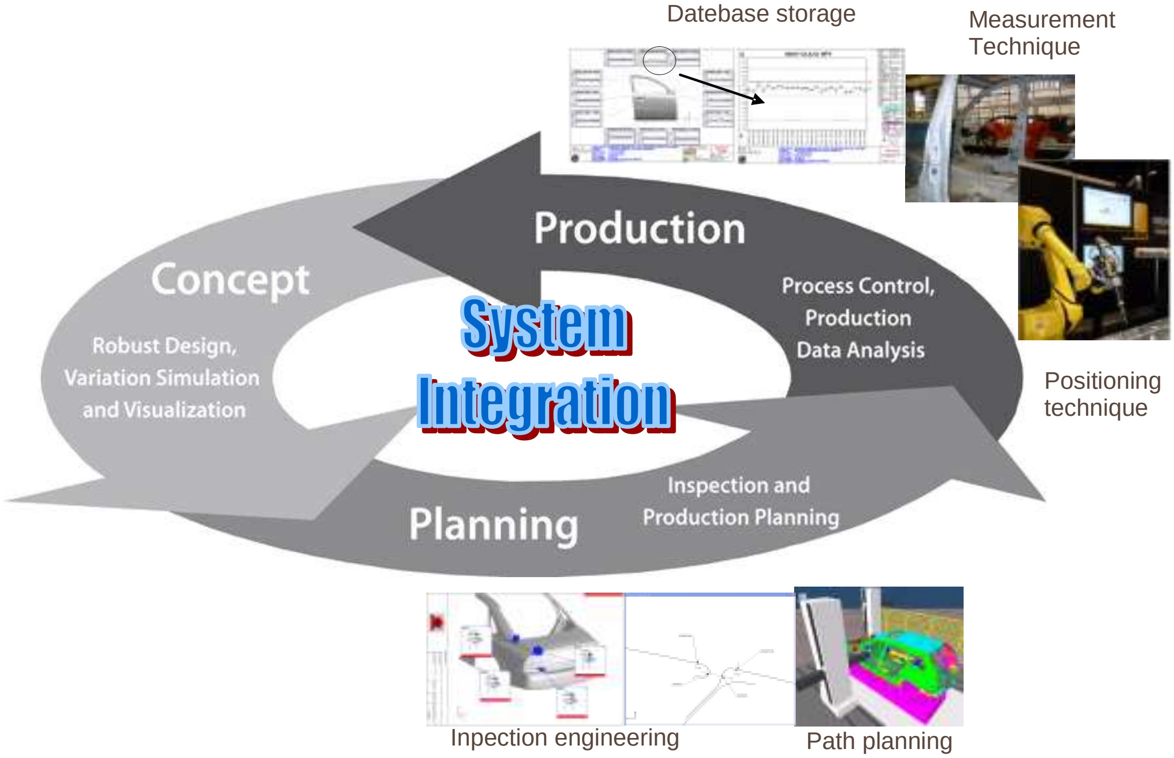
Robot based in-line measurement-InRob



Project within Sustainable Production Technology

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Date: 2013-03-25

FFI

Content

FFI in short

FFI is a partnership between the Swedish government and automotive industry for joint funding of research, innovation and development concentrating on Climate & Environment and Safety. FFI has R&D activities worth approx. €100 million per year, of which half is governmental funding. The background to the investment is that development within road transportation and Swedish automotive industry has big impact for growth. FFI will contribute to the following main goals: Reducing the environmental impact of transport, reducing the number killed and injured in traffic and Strengthening international competitiveness. Currently there are five collaboration programs: **Vehicle Development, Transport Efficiency, Vehicle and Traffic Safety, Energy & Environment and Sustainable Production Technology.**

For more information: www.vinnova.se/ffi

1. Executive summary

Increased demands on an efficient and sustainable automotive industry, driven by international competition and global demands on reduced use of resources, requires more efficient manufacturing systems.

All manufacturing processes have variation which may violate the fulfillment of assembly, functional, geometrical or esthetical requirements and difficulties to reach desired form in all areas. The cost for geometry defects rises downstream in the process chain. Therefore, it is vital to discover these defects as soon as they appear. Then adjustments can be done in the process without losing products or time.

By increased robustness in the manufacturing process, the material and energy consumption will decrease due the reduced amount of scrap and rework. Decreased material and energy consumption are beneficial from an environmental perspective with consideration of the decrease in use of available resources and reduced emissions during the production process. Furthermore, increased product quality will strengthen the competiveness of Swedish industry.

The project consists of seven different work packages (besides a report package). These work packages address different areas which are necessary to fulfill the overall scope of the project – development of a robot based in-line measurement system including path planning and inspecting engineering applicable for the system.

All individual goals from resp. WP was reached the within the project, a methodology and tools have been demonstrated which can handle in-line robot based measurement from inspection engineering to visualization of results. The technique developed in the project is ready for commercialization. The technique needs to be packed and adjusted to customer specifications, but the technique base will be same independent of customer.

The overall project goals were also achieved.

- Reduction of measurement time in-line compared to traditional CMM-solutions with 75%
  Results: The potential for a decreased measurement time of over 75% was shown. Decreased measurement time compared to CMM together with the possibility to add a multiple of systems working together shows the potential of decreased measurement time.
- Increased possibility to feature measurement with 100% compared to tradition fixed camera systems.

Results: All features could be measured which cannot be done with traditional fixed camera systems (including weld bolts)

- Decreased lead time for geometry verification process regarding generation of measurement programs and measurement time for a BIW with 50%
  Results: The lead time for measurement program generation was decreased with 75% in the inspection engineering phase. Regarding path planning, it is has been automised but not adapted to robotbased measurement system before. Therefore, it can not be compared.
- Decreased rework-/scrap rate with 10% for related products.
  Results: This has not been verified, since the tools not have been implemented to the market yet. However, the potential reach over 10% of decreased scrap rate, since it is possible to measure many more BIW than before.

2. Background

Good and secured quality is vital for the Swedish automotive industry. All actors involved in the automotive industry and therefore, projects which lead to increased quality, is of vital interest for increased competitiveness for Swedish companies. Increased quality can be obtained in many different areas, this project focus on geometry assurance.

Examples of areas which are affected of geometrical deviations are: tire wear, noise, vibration, and sound (NVH), problem with closing doors, optical quality, production disturbances, increased cost due to large tolerance settings, increased wear of production equipment, scrap rate and rework of parts.

A lot of efforts are done in this area today, but available tools for in-line verification are limited in efficiency, both regarding the project phase (definition of measurement process) and in production (efficient measurement process). The normally used tools is probe based measurement devices. This creates limitations regarding the features which can be measured and the cycle time for measurement. Measurement in-line is mainly done either by fixed cameras or with coordinate measurement machines (CMM-machines). These verification processes are limited to either measure a very limited number of points (fixed cameras) or long cycle time (CMM).

In this project, we will develop an efficient process for geometry verification in-line for all required features. It involves work from the project phase with path planning, inspection engineering work to the production phase with capability to geometry verification of necessary features within available cycle time.

The individual techniques exists already today, e.g. path planning, inspection engineering, measurement of features in-line, but no process are available which combines these techniques efficiently enough to measure all features within normal cycle time.

The technical step we propose involves development of technology for path planning, sequence optimization, inspection engineering, measurement device, positioning technique of the robot head which are applicable for measurement with non contact devices. This does not exist today, but have a large potential to decrease lead time in the measurement cycle (both preparation and execution). By increasing the inspection rate, we can also improve the process control which reduce scrap, production waste, energy consumption, environmental effects and also increase quality of the products.

3. Objective

Expected results from this project will be:

- Reduction of measurement time in-line compared to traditional CMM-solutions with 75%
- Increased possibility to feature measurement with 100% compared to tradition fixed camera systems.
- Decreased lead time for geometry verification process regarding generation of measurement programs and measurement time for a BIW with 50%
- Decreased rework-/scrap rate with 10% for related products.

4. Project realization

The main result of this project will be an efficient process for in-line geometry verification. Decreased project lead-time, more robust processes and increased quality of the products are examples of benefits from the project. Usage of robots in the measurements process magnifies the usage (i.e. reduce the lead-time) by the number of robots compared to a stationary in-line CMM-machine. If the robot solution is compared with a station with fixed cameras, the robot solution is much more flexible and can handle several models in the same line.

By increased robustness in the manufacturing process, the material and energy consumption in the manufacturing process will decrease due the reduced amount of scrap and rework related to quality deficiencies. Decreased material and energy consumption are beneficial from an environmental perspective with consideration of the decrease in use of available resources and reduced emissions during the production process. Furthermore, increased product quality will strengthen the competiveness of Swedish industry.

The results will mainly be used at VCC and Scania, but since the work is carried out with partners within other technology fields (e.g. LK) and also together with institutes and academia as FCC, Chalmers and LiU, the results will also be available for Swedish industry.
The project will be a project with both institutes and companies from different branches involved. VCC will be the project manager. Furthermore, VCC, Scania and LK will supply the project with existing equipment. If any new equipment needs to be purchased, the project will fund this.

Party	Role and area of responsibility	Personnel and other resources
VCC	Project management, test-case, test cell, installation, database storage, verification	Adj. Prof. Alf Andersson, Dr Johan Segeborn, Stefan Axelsson
Scania	Test-case, database storage, verification	Niclas Josefsson
LK	Measurement system, system for positioning verification	Janne Linden
FCC	Path planning	Dr Johan Carlsson, Johan Torstensson
Chalmers	Inspection engineering	Professor Rikard Söderberg, Dr Lars Lindkvist
LiU	System integration, Robot solution	Professor Mats Björkman, Dr Marie Jonsson, Sebastian von Gegerfelt, Dr Kerstin Johansen

5. Results and deliverables

5.1 Delivery to FFI-goals

Increased demands on an efficient and sustainable automotive industry, driven by international competition and global demands on reduced use of resources, requires more efficient manufacturing systems.

The opportunity to verify products and production systems has the potential to drastically reduce the scrap rate, amount of rework and lead time. Therefore, the development of tools and methods for efficient geometry verification in-line is of highest priority. This contributes to the programs targets higher productivity in the engineering process.

With increased use of geometry verification in-line, it is possible to improve the processes to be more robust and generates higher productivity efficiency. By increased stability in the manufacturing process, it also will decrease the material and energy consumption in the manufacturing process due the reduced amount of scrap and rework due to quality deficiencies. Furthermore, the increased quality will also increase the competiveness of Swedish products and strengthen the Swedish industry. This contributes to the program targets of decreased environmental influence of the manufacturing process.

The knowledge and results from the project is directly transferable to other automotive companies but also to other industrial segments like building, construction and biotech. Success in reaching the goals of the project will open up new research and market opportunities. Increased long-term collaboration with partners from new segments is expected.

The research team has a good track record when it comes to project management, research, technology transfer and implementation.

6. Dissemination and publications

6.1 Knowledge and results dissemination

The results have been distributed in several articles and also presented at MAX-mässan 2012. During the project, one PhD-thesis (Marie Johnsson) was presented.

At MAX-mässan, a robot station with the InRob demonstrator was shown. At a large screen, the virtual process was syncronised with the actual robot movement with a measurement head mounted. These could be followed together to demonstrate the strength of the technique developed in InRob. The demonstration cell was highly appreciated with many visitors and the cell was also included as focus area for the press demonstration before MAX-mässan opened. Together with this, a presentation was made on the exhibition.

A movie which presents the technique has been presented and is placed on You Tube (http://www.youtube.com/watch?v=IsGDnfsytgY&feature=share&list=PLB56F8485BC1F87D8

http://www.youtube.com/watch?v=lqtPNaE_35k&feature=share&list=PLB56F8485BC1F87D8

6.2 Publications

Jonsson, Marie, 2013, On Manufacturing Technology as an Enabler of Flexibility, Doctoral thesis, Linköpings University, Sweden.

Jonsson, M., and Johansen, K., On emerging manufacturing technology as enablers of Lean, submitted for publication in Journal of Manufacturing Technology Management 2012.

7. Conclusions and future research

The project have developed a system solution for a robot based non contact measurement system from inspection engineering to visualization of results.

All targets for ingoing WP have been fulfilled and the methods are ready for commerzialisation after customer demands. The methods are not coupled to a specific system and can therefore be adapted to different systems.

A problem with scanning curved surfaces is that when the curvature of the sheet metal gets to steep not enough light from the laser is reflected back to the scanner to get a good reading. There is a setting in the software where this angle can be adjusted in the settings of the scanner in Focus Handheld which can be used, but has limited impact. Other problems which have not been addressed are proposals for corrective actions and not only define problems. Another problem which not has been addressed is measurements of final demands.

Proposal for new research questions:

- How can we match best parts together by using measurement together with sorting and best choice?
- How can we use measurement results for corrective actions or marking of errors in running processes?
- How can we use measurement results for final demands?

8. Participating parties and contact person

Volvo Car Corp Alf Andersson	Scania Niklas Josefsson	LK Scandinavia Janne Lindén	Chalmers Lars Lindkvist
Fraunhofer Chalmers Research Centre Johan Carlsson	Linköpings University Mats Björkman		

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