

SIAS AUTOMATED SURFACE INSPECTION: APPLICATIONS & BENEFITS¹

Afchine Nasserian²
Olivier Deschamps³

Abstract

Automated Surface Inspection systems have become standard tools for the manufacturing of steel products. They are used at various steps of the manufacturing process: starting at the hot-rolling mill to detect and remove defective material from the process, until finishing lines for quality control before shipment to the customer. The benefit of using automated surface inspection is two-fold as it allows monitoring both the quality of the product and the process. This results in value for the systems users through process improvements and increased productivity.

SIAS, the Siemens VAI solution for surface inspection, has been developed to ensure that these two goals are met. The SIAS solution brings unequalled performance recognized by the most prestigious steel suppliers with unique functions. The paper presents the range of applications of SIAS and the benefits it brings in each case, as well as the tools that have been developed to pull the most out of the surface inspection system from the perspective of the maintenance, quality and production teams.

Key words: Hot-rolling mill; SIAS; Surface inspection.

SIAS SISTEMA DE INSPEÇÃO AUTOMÁTICO: APLICAÇÕES & BENEFÍCIOS

Resumo

Os sistemas automáticos de inspeção de superfícies tem se tornado ferramentas padrão para a produção de produtos de aço. Eles são utilizados em vários níveis no processo de fabricação: começando na laminação a quente para detectar e remover materiais com problemas do processo até linhas de acabamento para melhor controle antes do envio ao cliente. O benefício de se usar o sistema automático de inspeção é permitir o monitoramento da qualidade do produto e do processo. Isto resulta em valor para os usuários do sistema através de processos de melhoria e aumento na produtividade. SIAS, uma solução Siemens VAI para inspeção de superfície, tem sido desenvolvida para assegurar que os dois objetivos citados sejam atingidos. A solução SIAS representa um inigualável desempenho reconhecido por um dos maiores produtores de aço do mundo. Este trabalho visa apresentar uma gama de aplicações para o SIAS e os benefícios que ele pode trazer em cada caso, assim como as ferramentas que tem sido desenvolvidas a fim de colocá-lo na perspectiva dos times de manutenção, qualidade e produção.

Palavras-chave: Laminação de tiras a quente; SIAS; Inspeção de superfície.

¹ *Technical contribution to the 46th Rolling Seminar – Processes, Rolled and Coated Products, October, 27th-30th, 2009, Santos, SP, Brazil.*

² *Siemens.VAI MT France*

³ *Siemens. VAI MT France*

1 INTRODUCTION

SIAS is the Siemens VAI solution for automatic surface inspection.

Automated Surface Inspection systems have become standard tools for the manufacturing of steel products. They are used at various steps of the manufacturing process: starting at the hot-rolling mill to detect and remove defective material from the process, until finishing lines for quality control before shipment to the customer. The benefit of using automated surface inspection is two-fold as it allows monitoring both the quality of the product and the process. This results in value for the systems users through process improvements and increased productivity.

2 STATE OF THE ART IN SURFACE INSPECTION

Surface Inspection Systems have been designed for the surface quality monitoring of flat rolled products. They are vision systems capable of detecting and identifying in real time flaws in the acquired image. The SIAS is essentially composed of an on-line sensor (light source and cameras) coupled with image processing hard- and software. For each side of the product, everything starts with image acquisition. At a given point ("inspection point") one or several linear cameras are associated with a light source to capture the reflected image of the product. An "endless" image is thus built from the successive line scans that accumulate as product passes under the camera. As it is being acquired, the image is "normalised" to eliminate the negative impact of both sensor-related (e.g. electronic noise) and product-related (e.g. product aspect variations) phenomena. This normalisation, which can be preset differently by product types, applies both cross-web and down-web. Consequently, image processing is consistent and performed on an image that is free from external disturbances.

On the image, a detection algorithm is applied: each pixel is analysed to determine whether it is "suspect". The algorithm consists in a combination of filtering and thresholds, in real time, and here again the system's sensitivity is programmable and depends on product type. Additionally, during inspection of a given product (i.e. with a given detection sensitivity), thresholds automatically adapt to "normal" background variations in order to always remain as sensitive as possible.

After detection, localization consists in grouping together defects that have been detected individually, to form objects. Each object's image will then be analyzed by software to identify which defect category it belongs to.

The phase that consists in identifying detected objects is called classification.

The SIAS exclusive, patented classification method is a multi-stage approach for streamlined operation and maximum efficiency. It is fully traceable and highly accurate.

Classification basically consists in comparing the newly detected flaw with a "knowledge base", i.e. a defect library, a group of defect images assembled by Quality people that is typical of what can be seen on the line. Following this step, the newly-detected flaw is assigned a type and severity, with a confidence level that reflects the degree of similarity between the object and the closest defect in the knowledge-base.

Additional rules may as well be implemented to take into account the experience of Line inspectors. Those rules allow obtaining better classification accuracy.

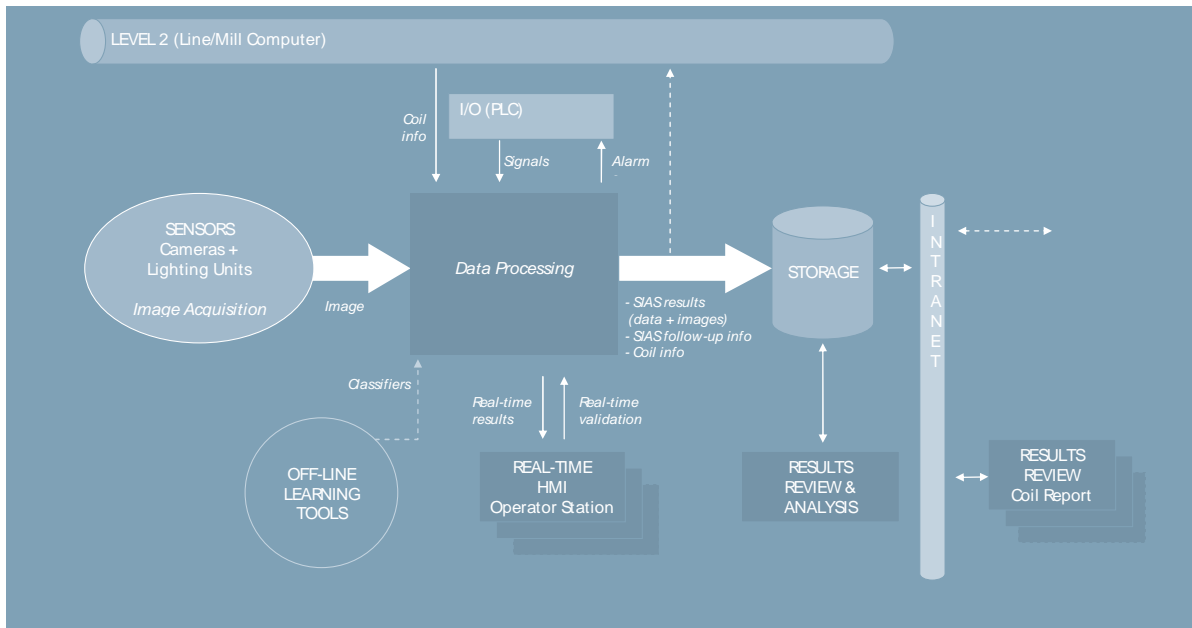


Figure 1: SIAS standard architecture.

In Figure 1 we can see the typical architecture of the SIAS system: on-line sensors (cameras & lighting) provide the image that is processed by the image processing hard- and software (“Data Processing”).

The SIAS results include for each defect

- Type,
- Characteristics (repeating, through strip ...),
- Severity,
- Localization (side, position),
- Size (+ repeat period if repeating),
- Associated image, if applicable.

In parallel, a series of indicators are recorded: speed, image contrast, brightness... These values are stored periodically to provide an indication of the conditions in which inspection was performed. These values form the “Follow-up Information” and allow putting in perspective the inspection results. This exclusive feature of the Siemens VAI MT system provides total traceability and monitoring of the inspection process, which is key for both high confidence in the results and Quality management (e.g. ISO) of the measurement.

Inspection results and follow-up both relate to the inspected product: they are linked through the “Product Information”, a message directly received from the line’s Level 2/3 containing in particular the coil ID.

The display and storing of data and results are synchronized with line events such as weld (=start/end of entry coil), shear (start/end of exit coil). The presence of an accumulator can also be managed in order to manage the potential difference between speed at the point of inspection and at the operator station (in case the looper is in between).

Finally, system alarms can be triggered by certain events (specific defect types or system fault), warning the operator who can then establish a diagnostic a troubleshoot the cause of the problem.

All this information is delivered through four main channels:

1. Real-time Operator stations
2. Alarms (digital outputs)

3. SIAS local storage
4. The plant network

3 SIAS APPLICATIONS AND BENEFITS

SIAS technology is applied to all flat-rolling operations:

- Hot rolling
- Cold rolling (a first system is being installed at CORUS IJmuiden’s KW22 cold mill)
- Strip processing (pickling, annealing or metallic/organic coating)

Benefits vary from application to application, but can be grouped in generic categories:

3.1 Improved Product Quality Control and Increased Productivity

The introduction of SIAS means replacing partial, random surface quality monitoring by constant, repeatable, systematic inspection of 100% of the production. SIAS users have a perfect knowledge of what is being produced.

The Coil Grading application is used to automatically assign a global quality level (grade) to coils, based on their surface quality as determined by the SIAS Surface Inspection system on line. To achieve this, the application tests a given coil’s surface inspection log with various user-defined defect tolerance rules. Based on these tests’ result, the coil’s grade is determined.

The Coil Grading application is thus composed of two software modules:

- The Coil Grading Setting module is used to configure the whole application and, particularly, to establish the various sets of rules, or Rulesets, that will be used to determine the different grades.
- The Coil Grading Viewer module is used to apply the rules determined in the previous application, and to view the results; the user may also perform basic re-work simulations (e.g. cut) or select another ruleset to be applied, in order to check if the coil grade can be changed. The Coil Grading Viewer module is fully integrated into the Coil Report software (see paragraph 5.4.2, “Coil Report”).

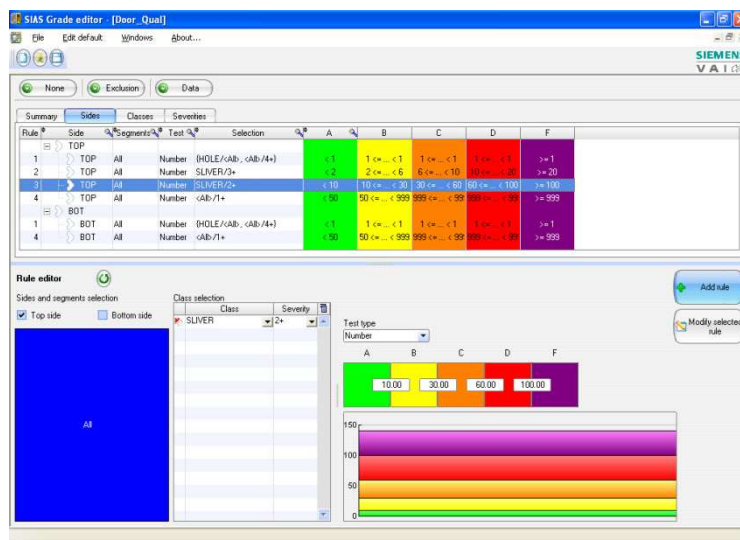


Figure 2: Coil Grading Setting module

With the coil grading application coupled to the SIAS system, an immense reduction in the number of coils sent to re-inspection will quickly justify the system. The inspection line becomes an actual repair line as the system provides in advance all the information required to perform the removal of defects from the coil.

3.2 Process Monitoring

An indirect benefit of the SIAS is that it provides an eye on production and hence can alarm users on process drifts. Defects such as stains from the process, roll marks... are immediately detected; the cause of the problem can be quickly solved and subsequent production is not affected.

The benefit is tremendous when applied in situation where there is no alternative to automated surface inspection. This is particularly true of surface inspection at the hot mill where a defect like scale or a roll mark would be really hard to detect before several days until the next inspection downstream.

Reciprocally, the impact of a change in process parameters can be observed on the product immediately and monitored, allowing an optimization of the same parameters to reach the right level of Quality at minimum cost.

As a part of the SIROLL Completely Integrated Solution, the role of surface inspection by Siemens VAI MT has evolved from a stand-alone gauge to a key component of the Manufacturing Execution System and Quality Management processes. This paves the way for an improved knowledge of the manufacturing processes, their drifts, and these drifts' origins and causes, i.e. a better understanding of the process/quality link. This improvement is supported by various developments by Siemens VAI MT, with SIAS-related aiming at a better usage of the gauge, but also with Level 2 improvements that allow pulling maximum benefit from the SIAS technology.

4 CONCLUSION

This paper presented the range of applications of SIAS and the benefits it brings in each case, as well as the tools that have been developed to pull the most out of the surface inspection system from the perspective of the maintenance, quality and production teams.

SIAS, the Siemens VAI solution for surface inspection, has been developed to ensure that all client goals are met. The SIAS solution brings unequalled performance recognized by the most prestigious steel suppliers with unique functions. In this article we will explore the state of the art in surface inspection technology, and then have an overview of the many applications that this technology covers, and the value it brings.