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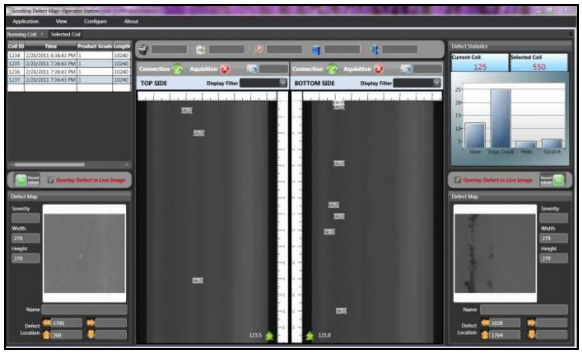
Surface Quality Inspection System (SQUINS)

The dynamics in the global steel market has increased over the last years. A precondition for a competitive steel business is to have world-class processes and aim for surface defect free products. Inspection systems play important roles in this respect. Continuous improvement of product properties, quality level, reliability and customer focus will be more important than ever. On-line measurement systems are becoming increasingly popular and will provide more useful insights for the subsequent processes in production chain, including customer processes.

The development of Surface Quality Inspection System (SQUINS) is intended to help CRM in inspecting the quality of the CR sheets and to identify various surface defects. Some of the salient features of indigenously developed 'SQUINS' at Automation are as follows:

- Design and implementation of distributed computing network architecture. The entire SQUINS system is hosted on 7 different servers (12 core blade servers, 2.9 GHz) for computation, storage, display and analysis.
- Microprocessor based development of line rate controller for synchronization of camera line rate with the coil speed.
- Operator station module for defect profiling of the coil, retrieval of defect maps and statistical analysis of defect patterns. This module also provides the facility to enhance the defect image to facilitate the decision making.
- Feature extraction module for extracting relevant defect features for the purpose of classification. Sixty seven such functions have been implemented for extracting various geometrical, textural, histogram and moment features.
- Classifier module which consists of implemented functionalities for feature space analysis, classifier model selection, learning, predictions and adaptation etc.
- To meet the requirement of real time, high volume data processing, a dynamic core allocation technique has been developed and implemented. It automatically distributes the job into various computing units (cores) based on load and ensures mutual exclusion and synchronization between competing processes.



Operator Station's Screenshot

Development of Stack Building Programme for BAF

Batch Annealed coils accounts for more than 60 % of the output of CRM in Jamshedpur. Being a batch process and relatively slow, efforts are always made to increase the through-put by improving the optimality of process conditions. The most deciding step in ensuring quality and throughput of batch annealing process is making optimal *stacks* – the groups of coils- which would be charged in different furnaces.

The coils have to be grouped together based on criteria governed by grade, dimensions, end property requirement and, productivity of plant. Most ideal condition would be to fill each furnace to the brim (max productivity) with coils whose heat treatment cycles are suitable for fastest

annealing of the stack. However, this is easier hoped for than really happen because of non-homogeneity of available coils in terms of dimensions, grade, heating cycle etc. So making the most optimal stacks with given pool of coils becomes a very difficult task. Operators make stacks by following certain rules (which have evolved from operational practice).

However, it would be very difficult for humans to evaluate all possible combinations of coils considering every aspect of optimality. More so because we may have to compromise the *best* optimality of one single stack in order to ensure a *better* optimality of a number of stacks. Hence, not only making optimal stacks but comparing all possible annealing scenarios with respect to productivity and other business considerations becomes important aspect of stack making and obviously it is not something which can be done without automation.

Tata Steel Europe (TSE)-RD&T team has developed a stack building program to achieve this task. This program named '*Esther*' was further customized by Automaton Division with guidance from TSE team to incorporate business rules of Jamshedpur BAF. Also, a Human Machine Interface (HMI) was made for user friendliness. The program is in use for past few weeks and early results are encouraging.

Super Computing using GPU

The end result of any R&D activity is either a new product development or deployment of a deeper insight into a process by the way of online or off-line mathematical models and simulations. Both these activities, in most cases, involve usage of fast computational facilities. Although the researchers finally come up with an excellent mathematical model or simulation of some process, having the potential to significantly improve the process efficiency, they are rendered useless owing to the high speed computation requirements. Typically Super Computers are used for such solutions.

However, the major disadvantages of such facilities are their prohibitive costs and the physical space that they occupy besides their high power consumption. The idea here is to use the relatively new CUDA desktop super computing technology by NVIDIA (a global leader in video and image processing technology products) for the first time world-wide, in process modeling and control. CUDA technology involves harnessing the inherent parallelism present in Graphical Processing Units (GPUs) found in graphic display cards for general purpose computing

Automation Division has developed a model to estimate the wear in the lining of the hearth in a blast furnace. A mathematical model to estimate the hearth lining has been developed using thermodynamic calculations and genetic algorithm which will give a real picture of the hearth lining to enable control of hearth wear. This model takes around 24 hrs to run to calculate the lining of the hearth in 3-D.

An attempt has been made to reduce the speed by at least 5 times using NVIDIA CUDA. The time consuming portions of the algorithm have been successfully migrated into the CUDA platform and a speed up of '2X' has been achieved without memory optimizations. Currently we are in the process of performing memory optimization which is expected to speed it up by at least 10 times.