INCREASING PRODUCTIVITY IN CERAMIC TILE INSPECTION WITH BI-VALENT VISION SYSTEMS: AUTOMATIC INSPECTION AND PROCESS MONITORING WITH THE SAME TECHNOLOGY

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1. THE EARLY DETECTION OF QUALITY PROBLEMS BEFORE THE KILN

It is common wisdom among production engineers that bad quality should be detected as far up-stream as possible in the production process. Camera-based inspection systems for the automatic sorting of ceramic tiles do a fine job by eliminating poor quality tiles from first choice and by packaging tiles into classes of same visual appearance. However, these systems are installed at the far end of the production line: the tiles are ready to ship, there is nothing more to do about quality but sorting. In order to improve this situation, we have analyzed two important positions for monitoring the production process and eject bad tiles before they enter the kiln:

a) the press, where problems with the correct embossing and particle distribution are common.

b) the decoration, where almost 50% of all defects are produced.

Based on our modular multisensorial CeraVision® inspection and sorter, we have designed a family of small, identical looking, low-cost and highly profitable bi-valent camera-based systems to monitor the tile production before the kiln and to eject bad tiles before they continue to consume precious production capacity (figure 1).

Figure 1. A family of small and low-cost before the-kiln inspection systems have been derived from the automatic tile sorter

2. WATCH THE PRESS

The correctness of the embossing is monitored through a fuzzy image comparison of the 3D topology of the embossing, as well for periodic as for pseudo-random embossing patterns (figure 2). A large number of reference embossing images can be learned. The system automatically identifies the required reference and checks the actual tile 3D topology to the matched reference using a fuzzy image comparison technology. As a by-product, flat surfaces and tile shape integrity are also checked. Grading this system with a colour camera and different software turns it into a monitor for the homogeneity of coloured particle distribution. All the quality data are visually displayed and databased. The system generates alarms and triggers ejectors to remove the bad tiles from the conveyor.

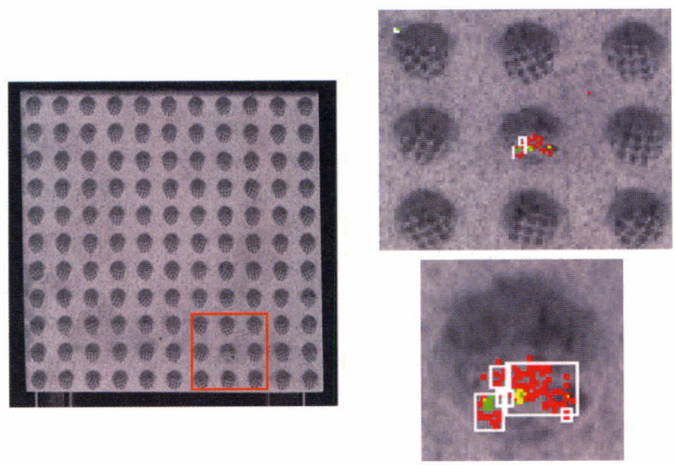

Figure 2. Defects in the embossing patterns are detected after the press

3. WATCH THE DECORATION

It is well known that the decoration process is responsible for almost half of all the defects occurring in tile production. Tiles decorated either by a flat or cylindrical screen printer can show a large variety of defects such as misregistration of the printed image with regard to the tile edges, small to large glaze spots due to broken screens, glaze stripes due to local screen obstruction etc... We have integrated the powerful colour camera technology of our tile sorter into a low-cost vision system which is placed immediately after one or several screen printers and which checks the printed image with a high-resolution colour scanning of the aniline dyes used to make the otherwise invisible glazes noticeable to the eye of the human operator. The system works on repetitive patterns using our fuzzy image comparison technology and on random decorations using colour texture statistics (figure 3).

Figure 3. A screen printer is monitored for defects in the decoration pattern

4. WATCH SHADES ON NON-FIRED TILES

Our company has developed a patented so-called "imaging colorimetry" which is able to track minor differences in multi-coloured surfaces. The system is currently in use in carpet industry and will be introduced in a near future into the industry of decoration paper printers. Due to its very high sensitivity, this technology is able to monitor stability problems of the tile colours before the kiln, i.e. before the visible colours are generated through the firing process. A very stable colour-camera/illumination module scans the nearly transparent and non-coloured glaze of the tiles after the decoration and compares these faint colours to a previously learned reference. A relative deviation measure is computed which informs the operator about the stability of its decoration and of forthcoming tonality problems (figure 4).

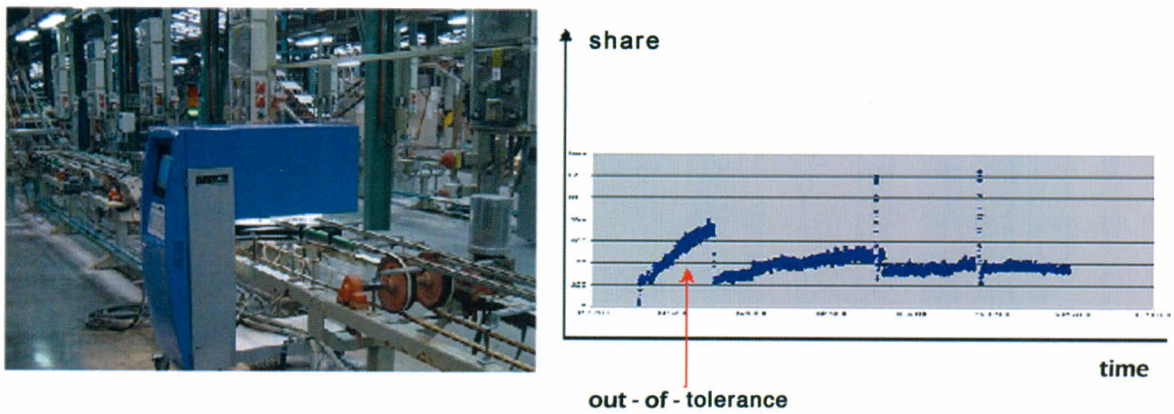

Figure 4. The stability of colour shade is monitored on the non-fired tiles

This allows him, well before the tiles are fired, to take counter-measures and to prevent large batches of tiles with a wrong shades being produced.