ABSTRACT

Application of machine vision technologies got rapid progress with the recent advancement in the high speed computing power which has led solution of many critical and complex tasks in the field of robotics, aerospace, medical, surveillance, remote sensing and inspection with emphasis on modern industrial automation. However, researchers are facing challenges especially for the real time measurement of the machine parts and the surface inspection.

The online surface topography measurement in a paper and paperboard manufacturing industries is also one of the challenging research fields due to a number of reasons. Presently, the paper surface inspection and analysis is based on laboratory instrument which has certain obvious limitations due to offline measurements. Generally laboratory instruments are based on pneumatic, electric, mechanical and optical techniques including contact to non-contact methods. Recently many researchers have attempted to contribute in the development of the online measurement technique based on non-contact optical and image based measurement system (IBMS). A few online devices are available to inspect the surface defects, thus, there was a need to develop an online technique and device that can comprehensively measure the surface roughness and topography in the manufacturing floor which could lead to improve quality and reduce wastages.

We have developed a non-contact optical based technique and a device called as OnTop which directly scans high speed paper-web surface and computes roughness and characterizes surface in a wide scale of spatial wavelengths. It was successfully tested in the paper and paperboard industries in Sweden in real time during the manufacturing process. This method has effectively distinguished a number of different grades of surfaces, for example, newspaper, light weight coated LWC, base paperboard, and fine coated paperboards.

The developed technique is a new application for the paper industries and it is working on the principle of a line of light triangulation technique using two laser sources and three imaging sensors. The technique projects and scans a narrow laser line width onto the high speed moving paper web in the cross machine direction. The integration of optics, hardware, software, image processing and signal processing components made it possible to measure roughness and simultaneously characterise surface topography from 0.1 to 10 mm spatial wavelength in the harsh industrial environment. The wide scale topography covers surface properties such as micro roughness, macro roughness, cockling and waviness. Statistics shows surface roughness measurement uncertainty (2σ) in the OnTop is 0.05 µm for a smooth paper sample which provides 95% level of confidence in the result while measurements were done in the lab environment.

The developed technique would be benefitted and implemented as a feedback loop in real time for continuous monitoring in order to improve the surface quality and ensuring smooth, uniform and efficient production. This thesis describes the research background, detailed of the novel technique, challenges, limitations and uncertainty in the system.