

ABSTRACT

Automated non-contact inspection of engineering products is a necessity when 100% inspection is preferred over sampling inspection, production rate is very high, and bad consequences of physical contact between the measurement system and the parts or components being inspected are required to be avoided. Research carried out in this area is directed to proposition of several approaches, mainly based on computer vision technology coupled with prediction models, for inspection of surface roughness and defects and physical dimensions of engineering products. Addressing a few critical issues, the objectives of the research work pertain to proposition of a computer vision-based generic methodology for automated non-contact measurement of surface roughness, surface defects, and physical dimensions of a part or component in an integrated manner with an acceptable level of accuracy, proposition of a machining parameter-independent computer vision-based generic approach for measurement of surface roughness ensuring an acceptable level of accuracy, and proposition of a computer vision-based generic approach for detection and classification of surface defects with an acceptable level of accuracy.

The thesis describes in detail a computer vision- and 100% inspection-based generic methodology for non-contact measurement and evaluation of quality characteristics of engineering products. Validation of the methodology as proposed is done through experimentation on product features for both metallic and non-metallic parts and components. Detailed description of the development of the hardware and the software required for employing the proposed methodology is also presented. Several image processing algorithms, based on computer-vision, and a large number of predictive models, based on adaptive neuro-fuzzy interference system and artificial neural network, are developed for prediction of surface roughness, surface defects, and physical dimensions utilizing various combinations of image features. The models thus developed are validated and compared statistically through hypotheses tests.

The image processing algorithms developed facilitate in extraction of various types of image features by processing a single image frame thereby aiding in the integration of the required inspection tasks. Comparison between the predictive models brings out the superiority (in terms of the accuracy level of measurement) of carrying out effective combinations of various image features in the inspection areas considered.

Keywords: Automated Non-Contact Inspection, Computer Vision, Image Processing, Surface Roughness, Surface Defects, Physical Dimensions, Engineering Products, Adaptive Neuro-Fuzzy Interference System, Artificial Neural Network.