Available online at www.sciencedirect.com

ScienceDirect

Procedia Technology 25 (2016) 885 – 891

Procedia Technology

Global Colloquium in Recent Advancement and Effectual Researches in Engineering, Science and Technology (RAEREST 2016)

Quantitative Analysis of Grinding Wheel Loading Using Image Processing

Vipin Gopan[a,*], Leo Dev Wins K[b]

[a]Karunya School of Mechanical Sciences, Karunya University, Coimbatore-641114, India
[b]Karunya School of Mechanical Sciences, Karunya University, Coimbatore-641114, India

Abstract

Grinding is an abrasive machining process which can produce very fine surface finishes. The removed chips from the workpiece which get welded to the porosities between the abrasive grains can adversely affect the final surface finish of the machined component. Quantitative analysis of wheel loading can provide information about the cutting conditions of the wheel. With the development in the field of machine vision and image processing, this study focuses on developing a system for the quantitative assessment of wheel loading using image capturing and image processing. Images of the grinding wheel were acquired using microscope with a magnification of 20x. Image segmentation by global thresholding technique was utilized for segmenting the loaded portions from the rest of the wheel. Experimental results presented show the feasibility of the proposed system in the quantitative assessment of grinding wheel loading.

Peer-review under responsibility of the organizing committee of RAEREST 2016

Keywords: Grinding wheel, Machine vision, Image segmentation, Global thresholding, Wheel loading

1. Introduction

The abrasive particles present on the surface of the grinding wheel are responsible for producing fine surface finishes on the workpiece. During the grinding process, the removed chips from the workpiece get accumulated to the porosities between the abrasives, which is called as wheel loading. Cutting force and temperature increase with wheel loading which in turn accelerate the wear of the grinding wheel. As a whole, the surface finish of the workpiece deteriorates. Inorder to attain the original cutting capability of the wheel, it is necessary to carry out the dressing operation. Since the wheel dressing is a time consuming process, it is necessary to optimize the wheel dressing intervals. Therefore monitoring the condition of the grinding wheel for wheel dressing has got its significance.

* Corresponding author. Tel.: +91-8891710248;
E-mail address: vipingopan123@gmail.com

Peer-review under responsibility of the organizing committee of RAEREST 2016
doi:10.1016/j.protcy.2016.08.198

Many of the research works for the condition monitoring of the grinding process have been carried out by using techniques such as neural networks and fuzzy logic by measuring acoustic emission signals, cutting power signals, eddy current etc. Nakai et al. measured the wear of the grinding wheel using intelligent systems composed of four types of neural networks [1]. Acoustic emission and cutting power signals were acquired and tool wear was measured by imprint method throughout the tests. Warren Liao et al. used acoustic emission signals for the condition monitoring of grinding process [2]. AE signals were collected when the wheel was sharp and when the wheel was dull. Discrete wavelet decomposition procedure was used to extract discriminate features. Mokbel et al.used AE signals for monitoring the condition of diamond grinding wheels [3].An acoustic emission sensor was attached to the mild steel specimens and raw AE signals generated from the grinding wheel/specimen contact were then analyzed using a fast Fourier transform.Lezanski et al. monitored the condition of grinding wheel based on neural network and fuzzy logic based system [4]. For each measuring signal, a few statistical and spectral features were calculated and used as input for data selection and classification procedures.

Several researchers have used machine vision systems and image processing for measuring the grinding wheel wear. Abdalslam et al. developed a non-contact three-dimensional wheel scanning system for measuring and characterizing the surface topography of grinding wheels [5].Narayanaperumal et al. evaluated the working surface of the grinding wheel using speckle image analysis [6]. A simple speckle imaging arrangement was fabricated and fitted into the grinding machine to capture the images of the grinding wheel and speckle image intensity distribution captured the changes in the grinding wheel surface condition. The image processing techniques, including segmentation and blob analyses were able to extract the cutting edge density, width, spacing and protrusion height from the surface topography measurements. Chang et al. measured the characteristic parameters of form grinding wheels used for microdrill fluting by computer vision system [7]. The edge detection, the straight line detection, the contour separation, the circular arc fitting, and the circular arc angle evaluation were the five sequential steps used for the measurement.Tarng et al measured the wear of the grinding wheel using machine vision system [8]. SEM was used for capturing the images and edged detection technique was used in image processing for the wheel wear measurement. Lachance et al. measured the grinding wheel wear using machine vision system [9]. Binary segmentation technique was used for image processing. Fan et al. measured the wear of the grinding wheel using computer vision system [10]. Binarisation technique was used for image processing and 'mapping function method' was used to transform an image pixel coordinate to a space coordinate. In most of the machine vision systems for the condition monitoring of grinding wheel either a scanning electron microscope or optical microscope was utilized for capturing the images. SEM is highly accurate and can give very high magnifications so that surface conditions of the wheel can be monitored accurately. But it is very expensive and also wheel needs to be dismantled from the machine for inspection. Similar is the case with optical microscope. Also most of the works in this area are concentrated on the qualitative assessment of the grinding wheel condition.

Less work has been reported in the quantitative measurement of wheel loading. The present work focuses on developing a machine vision system for the quantitative measurement of the wheel loading. Image capturing was carried out using usb microscope with high resolution with an inbuilt LED source, so that there is no need to dismantle the wheel from the grinding machine for measurement and also is less expensive.

2. Experimental setup

Experiments were conducted on surface grinding machine with silicon carbide (SiC) wheel. Specifications and parameters of grinding are given in Table1.

Table 1.Specifications and parameters of grinding

Machine	Surface grinding machine
Grinding wheel	Silicon carbide (SiC)
Coolant	Soluble cutting oil
Speed	2500 rpm
Feed	0.06 mm/rev
Depth of cut	0.1 mm