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PERFORMANCE MONITORING IN TURING NIMONIC75 USING COATED CARBIDE INSERTS BY MACHINE VISION SYSTEM

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ABSTRACT
Nimonic75 is basically nickel base super alloy extensively used in aerospace industries, attributable to their performance in elevated temperature. In the present study Nimonic75 has been chosen as work materials. The turning trails on Nimonic75 have been carried out in a high speed, automatic precision lathe using coated carbide tools in dry machining conditions. Each turning was carried out over the entire tool life of cutting tool insert, further tool images were captured by machine vision subsequently, machined surface feature Ra is measured. Image feature were extracted using image processing software. The work is expected to bring out the trend (correlation between tool status, machine vision signals and Ra) for several work-tool combinations under the given operating conditions in practical applications for maintaining the quality and preventing many other undesirable outcomes.

Keywords: Tool Status, Machine Vision and Nimonic75

INTRODUCTION
Machine tool automation requires reliable tool condition monitoring techniques for automated manufacturing. Thus, tool condition monitoring systems in cutting operations have been the topic of research over the decades. Monitoring the performance status in order to prevent downtime due to tool failure is a very important economical consideration. The cost of tool failure can be significant compared to the price of a cutting tool. The use of machine vision in the visualization of tool status is fairly wide spread in the literature. Several researchers have examined the usage of machine vision for the monitoring of tool wear state. For example, H. Makki et.al., [1] have addresses the need by measuring tool run-out and tool wear using machine vision and image processing techniques. Geometric union of sequences of images of a rotating tool captured by a CCD camera enabled the determination of a single image depicting maximum tool wobble. The optimum edge detection algorithm for identifying the edges of a wobbling tool was investigated. Points on the tool profile were determined from the pixels of the unionized image and Lines/curve fitting, segmentation was simultaneously carried out. The distance between two opposite best fit lines was calculated to determine the maximum run out. Comparison of the areas under the curved region of the profiles of used and new tools was employed for detection of tool wear. The results show that the technique can accurately determine tool diameter, run out and tool wear. F Luk et al., [2] have developed a method of surface roughness assessment using micro computer based vision system for use in a production environment. This method employs a vision system to analyze the pattern of scattered light from the surface to derive a roughness parameter. a number of tool-steel samples which were ground to different roughness to obtain The roughness parameters. Also, they have established a correlation curve by plotting the roughness parameters against the corresponding average roughness (Ra) readings obtained from a stylus instrument. Further, Similar correlation curves were plotted for different materials such as copper and brass. Several researchers have carried out their work using image processing by machine vision system [4-7] to quantify the wear level in cutting tools, the proposed methods provides a fast and accurate results. In the present study, a new technique to monitor performance in terms of tool and work piece status in turning processes, using machine vision, through processing and extracting the machine vision based image features.

METHOD & MATERIAL
Turning experiments were performed on Nickel Base Super Alloys having a 300mm length by SNMG 120408 coated carbide inserts, in dry machining conditions. In this experiment, feed rates were varied since; it has got

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significant effect on surface finish. From the literature it is found that little significance of cutting speed on surface finish variation for dry turning. Therefore, in the present work, only one cutting speeds and three feeds are chosen for turning at constant depth of cut 0.2mm. Each turning was carried out over the entire tool life of cutting tool insert. VBmax of cutting insert was measured with the help of toolmakers microscope. According to standard tool life criterion, 3865:1977 or BS 5623:1977 worn tool is considered with VBmax greater than 0.6mm, in semi finish turning.

Table 1: Chemical Composition of Nimonic-75

Work material	NIMONIC75
Chromium	Cr 18-21
Iron	Fe 5.00 max
Silicon	Si 1.00 max
Manganese	Mn 1.00 max
Titanium	Ti 0.2-0.6
Copper	Cu 0.5
Carbon Nickel, Ni	C 0.08-0.15 Remainder

Table 2: Specification of NIKON D-90 Digital camera

Sensor	• 12.3 million effective pixels
Image sizes	• 4,288 x 2,848 (12 MP) • 3,216 x 2,136 • 2,144 x 1,424
Sensor cleaning	• Image Sensor Cleaning • Image Dust Off
Autofocus	• Nikon Multi-CAM1000
Lens servo	• Single-servo • Continuous-servo • Automatic Manual focus (M)
Continuous	• 4.5 fps
White balance	• Auto

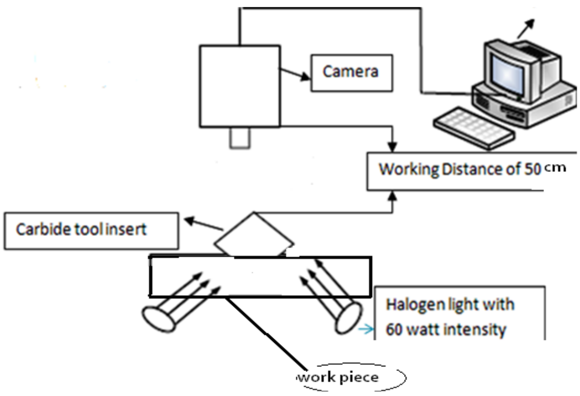

Figure 1. Experimental set up

Tool images were captured by machine vision after completion of each length of cut. Subsequently, surface roughness is measured using stylus method. Image feature i.e wear area is extracted using image processing software; View Flux. The spindle speed considered is 710 RPM. Feeds considered are 0.05 mm/rev, 0.06mm/rev and 0.07 mm/rev. Experimental set-up is as shown in the Figure.1Table 1 show the chemical composition of work material in percentage by weight. And Table 2 shows the specification of NIKON D-90 Digital camera used in the experiment.

Figure .2 Surfcom FLEX 50-A

Figure.3.Surface profile obtained fom Perthometer

Surfcom FLEX 50-A (Figure.2) is a compact, probe type surface tester. It is capable of measuring, evaluating and documenting surface roughness. The surface parameters measured with this system are roughness average (Ra), average maximum height of the profile (Rz) and maximum roughness depth (Rmax), etc.Figure.3Shows Surface profile obtained from Perthometer

Characterization of tool wear status using image feature by machine vision

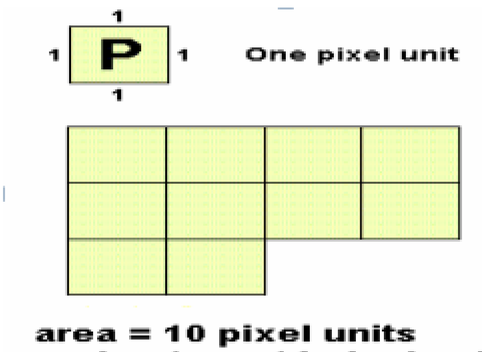

Figure. 4 wear are image feature

In blob analysis it is assumed that an un calibrated image contains pixels that are 1 unit by 1 unit in size. Therefore, the area of any pixel is 1 unit squared as shown in figure 4. In this case, the area of a blob is the sum of the pixels in the blob. Images of the tool insert is acquired using machine vision, processing has been done using view flex image processing software and feature extraction is done. Wear area is the image feature that characterizes the tool wear state accurately.

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Wear Area =Area of the tool wear region, the number of pixels within the tool wear region. Tool status visualization using machine vision system for considered cutting conditions shown in figure.5

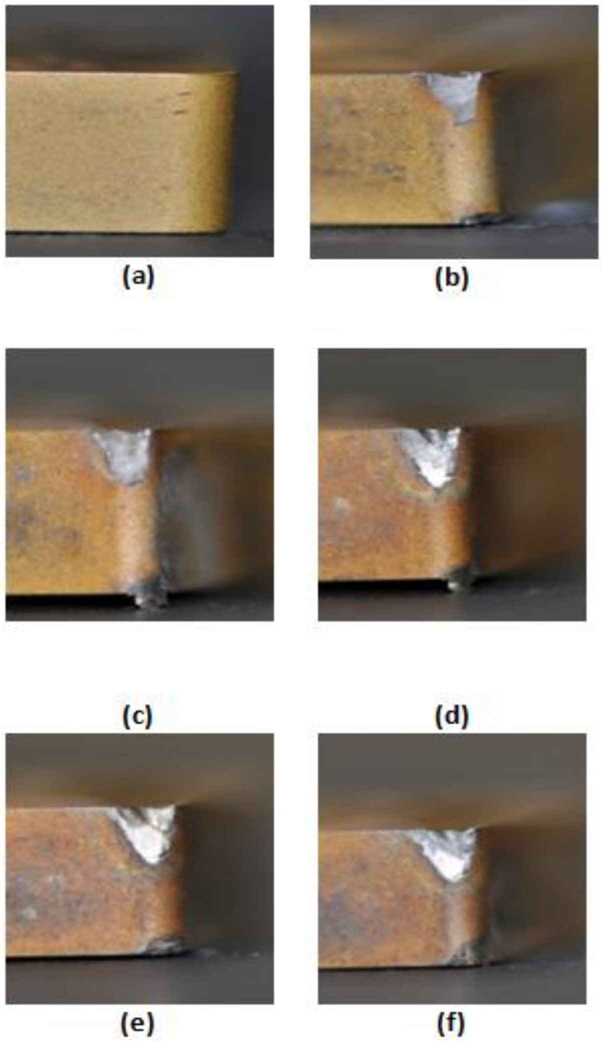

Figure 5: A series of images, taken during turning with the speed of 710 RPM and Feed rate of 0.05 mm/rev and depth of cut of 0.2mm to visualize the wear progress. The first image represents the new (fresh) tool and others present the worn out tool

RESULT & DISCUSSION

Performance status monitoring by machine vision approach

Tool status visualization and monitoring of the coated carbide insert during turning nimonic75 was done using Machine vision Tool status was quantified using tool maker's microscope for which trend will be generated and comparative study will be carried with the Machine vision results. The experimental results which were acquired are presented below. The cutting conditions considered in this experimentation are feed rate from 0.05 to 0.07mm/rev at spindle speed of 710 RPM and Depth of Cut 0.2 mm. The uniqueness of the performance monitoring strategy proposed here is that features are extracted and monitored only from certain sections of the turning and not the entire machining. This idea is based on the fact that the measured tool wear exhibited a very obvious change in relation to machining time, the image feature i.e wear area and tool wear data were recorded from the first cutting until the flank wear reached 0.3 mm

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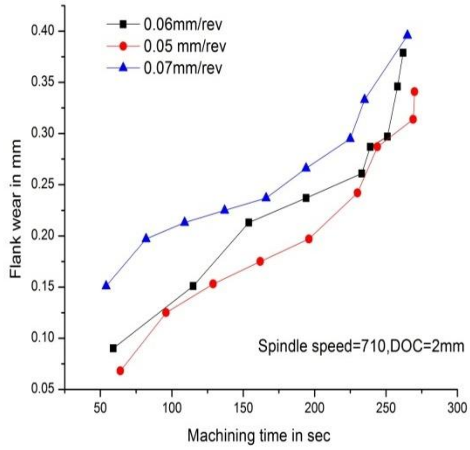

Figure 6. Average flank wear curves at different feed rate

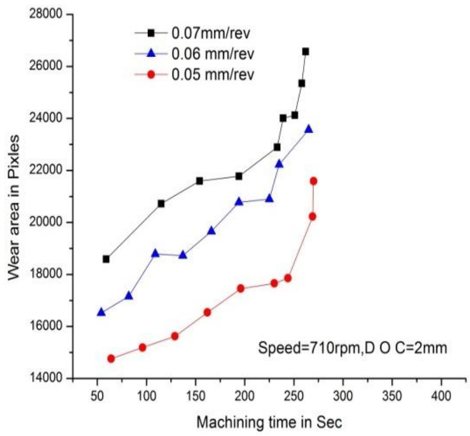

Figure 7. Wear area (in pixels) curves at different feed rate

The overall results of the machining processes were recorded, the related figures were shown in Fig.6&7.From these figures, it can be clearly seen that the flank wear and wear area(in pixels)of the cutting tools can be divided into three stages, run-in wear, steady wear and rapid wear. The flank wear measurement reaches 0.3 mm faster with the increase of machining time. It can also be observed that as the feed rate increases, wear values increases.

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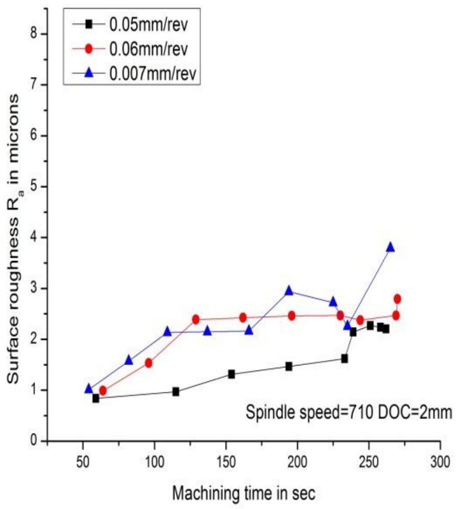

Figure 8 Ra against machining time

To obtain an overview about performance monitoring surface roughness values and the development of flank wear in relation to machining time, the graph as shown in Figures 8 is plotted surface roughness variation during turning, the development of flank wear nearly proportional to the cutting time. One way or another, the Ra values are steady and oscillate in a smooth range. Once the flank wear state exceeds the 0.3mm, machined surface roughness value also propositionally increases with respect to time. Hence developed performance monitoring system is capable of exploiting tool and machined surface status information.

CONCLUSION

- In the present study, experiments have been conducted on automatic precision lathe by considering different feed rates, constant spindle speed and depth of cut.
- R_a and flank wear were measured using perthometer, tool makers microscope respectively The variation of roughness($R_{a)}$,average flank wear and tool image feature (wear area) parameters with machining time, for which trend has been generated
- Performance assessment of tool with noncontact techniques, the image processing method can be used to automate tool status monitoring

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