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An Automatic Density Cluster Generation Method to Identify the Amount of Tool Flank Wear via Tool Vibration

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Determining the amount of tool flank wear (TFW) of a tool during operation is an important and cost-sensitive factor for maintaining the efficiency of the machine and product standards in Industry 4.0. Therefore, a variety of predictive analysis tools have been developed in this regard, with the objective of taking corrective action quickly and efficiently. In this paper, we present a TFW amount estimating method via plotting vibration generated during the cutting process on big data visualization and density cluster generation method known as Graphical Knowledge Unit (GKU). GKU generates density clusters by incrementing the RGB color values in the intersected markers due to data overlapping. In our previous work, the TFW amount of a cutting tool attached to a Computer Numerical Control (CNC) turning machine was checked. A workpiece of grey cast iron with an initial outer diameter of 110 mm was cut until it reached 60 mm. This process was repeated until the TFW amount, which was measured according to ISO 4288, met the recommended value range (0.3 ± 0.005 mm). After each cut, TFW amount and the surface roughness were measured following ISO 4288. Vibration was recorded using a triaxial accelerometer attached to the tool shank of the turning machine. In the present work, out of 29 cutting circles, vibration along the x-axis against vibration along the y-axis of selected cuttings were plotted using GKU. The density of the center of the plot (fixed point, FP) and the density of the highest density (dynamic point, DP) were measured using the color values of pixels as an index. The results showed a very strong linear correlation (0.95) between the TFW amount and vibration data density projected via pixel color values at FP. This shows that processing of vibration with GKU is a promising method to estimate TFW amount.

Keywords: *bigdata, industry 4.0, machine learning, predictive analysis, process optimization*