Abstract

Machining is the basic material removal operation to obtain desired final shape in manufacturing. With the advent of industrial automation, tool condition monitoring is gaining importance to maintain high product quality with less cost. Tool condition monitoring using machine vision is very much useful for its non-invasive, flexible and low cost nature. Of late, machine vision system has become very popular as the cutting edge technology due to the advancement of image acquisition system, image processing and decision making algorithms. Although there is several research work available in the field of machine vision to analyze tool wear and surface finish, monitoring of progressive tool wear by using machine vision needs to be investigated.

Therefore, in this present research work, tool condition monitoring is performed in turning, and as a case-study in end milling. Here, machined surface images are captured with proper image acquisition system and these surface images are analyzed using texture analysis techniques. Relevant texture features are then extracted as tool flank wear descriptors. These extracted features are utilized to predict tool flank wear in both the type of machining processes by using support vector machine based regression analysis.

Texture analyses by using gray level co-occurrence matrix, Voronoi tessellation and discrete wavelet transform are applied as statistical, geometrical and signal processing based analyses, respectively to obtain information of waviness, feed marks and roughness from machined surface images to describe tool flank wear. Two important features are extracted from each of the texture analysis techniques as tool flank wear descriptors. Turning experiments were performed with eleven machining conditions to cover a wide range of machining parameters, and each experiment was repeated thrice to determine the precision of the applied techniques.

A method to select optimized gray level co-occurrence matrix parameter is developed here for precise analysis. A methodology is developed to select the proper mother wavelet and proper decomposition level for discrete wavelet transform. A proper kernel selection method is also utilized in this research for accurate support vector machine based regression technique.

Finally, the average correlation coefficients between the measured and predicted tool flank wear are found out as 0.991 and 0.948 for turning and end milling, respectively.

Keywords: Tool condition monitoring, machine vision, texture analysis, support vector machine based regression, tool flank wear prediction, turning, end milling