論 文 の 要 旨

題 目　Drilling Process Monitoring ---- drill wear prediction and drilling conditions recognition with newly generated features (ドリル加工のモニタリング　―工具摩耗予測・加工状態認識の新方法―)

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The automation of machining processes has made great progress in the last several decades, and the future direction of machining technology development is the intellectualization. In this research, the term “machining” is constrained in the scope of conventional “metal cutting processes”, which specifically are turning, milling, drilling, sawing, planing, grinding, etc. There are 3 basic fundamental functional actions for machining processes which are monitoring, decision making and control.

This dissertation concerns the monitoring of drilling process. The prediction of drill corner wear and the recognition of drilling conditions are both investigated. New features generation, extraction and selection methods, how are these features are affected by the drilling condition, and the result of the prediction of drill corner wear and recognition of drilling conditions are mainly discussed in this dissertation.

In chapter 1, at first, related back ground is introduced, new ideas and methods are proposed, and the purpose of this work is announced, then the research design is explained, at last, the organization of the dissertation is summarized.

In chapter 2, a state-of-the-art literature review on tool condition monitoring is offered. Different methodologies and technologies applied are categorized and compared.

In chapter 3, the methodologies applied in this research are detailed. First the sensor system and the general experimental set up are introduced, and then the signal processing method and detailed feature generation procedure are discussed. After that the feature extraction method using wavelet packet transform is presented and then the feature selection methods are explicated. At last section the artificial neural network (ANN) model based regression and recognition approaches are specified.

In chapter 4, how the generated and extracted features are affected by drilling condition parameters such as workpiece material, drill diameter, spindle speed, feed rate and the drill corner wear are revealed.

In chapter 5, the prediction of drill wear and the recognition of drilling condition parameters are carried out. Two different features selection methods are applied, and one is using principal component analysis (PCA) for sub signals in each frequency band, the other is directly using ANN to select the major feature cluster and major frequency band.

In chapter 6, conclusions are made.

This dissertation examines the integrated procedure and methods for drilling process monitoring on the scopes of drill wear prediction and drilling conditions recognition. It is found that the dynamic features are more sensitive to the drilling status than static features, and they also contribute to the principal components more than static ones, but the change of drilling conditions leads to a more clear change of static features than dynamic ones. Good drill wear prediction and drilling condition recognition results are obtained.