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Big Data Enabled Intelligent Immune System for Energy Efficient Manufacturing Management

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Abstract

The Big Data driven approach has become a new trend for manufacturing optimisation. In this paper, an innovative Big Data enabled Intelligent Immune System (I²S) has been developed to monitor, analyse and optimise machining processes over lifecycles in order to achieve energy efficient manufacturing. There are two major functions in I²S: (1) an Artificial Neural Networks (ANNs)-based algorithm and statistical analysis tools are used to identify the abnormal electricity consumption patterns of manufactured components from monitored Big Data. An intelligent immune mechanism is devised to adapt to the condition changes and process dynamics of machining systems; (2) a re-scheduling algorithm is triggered if abnormal manufacturing conditions are detected thereby achieving multi-objective optimisation in terms of energy consumption and manufacturing performance. In this research, Computer Numerical Controlled (CNC) machining processes and industrial case studies have been used for system validation. The novelty of I²S is that Big Data analytics and intelligent immune mechanisms have been integrated systematically to achieve condition monitoring, analysis and energy efficient optimisation over manufacturing execution lifecycles. The applicability of the system has been validated by multiple industrial trials in European factories. Around 30% energy saving and over 50% productivity improvement have been achieved by adopting I²S in the factories.

Keywords: Big Data, Intelligent immune mechanism, Energy efficient manufacturing, CNC machining

1. Introduction

Ambitious goals to achieve significant energy savings in manufacturing have been widely set by major economies such as Europe, China and USA (Stark et al., 2017). Recent research has summarised that the energy efficiency indicators of manufacturing on a national or sectional level have been defined, but relevant sustainable process management solutions for companies have not been effectively implemented. There is a strong need to foster the relevant empirical applied research in manufacturing companies (Engert et al., 2016).

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