

**DEVELOPMENT OF MACHINE LEARNING ALGORITHM FOR ACQUIRING
MACHINING DATA IN TURNING PROCESS**

By

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**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia
in Fulfilment of the Requirements for the Degree of Master of Science**

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Dedication

TO MY FAMILY, MY WIFE AND MY COUNTRY IRAQ

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment
of the requirements for the degree of Master of Science

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Faculty: Engineering

Manufacturing cost for machining components is affected by the available machining parameters which include the selection of appropriate cutting material, cutting tools, and machining data of cutting speed, feed, and depth of cut. Computerized machining data systems have been classified into two general types, the mathematical model and the database model. The database model is based on the collection and storage of a large quantity of data from laboratory experiments and workshop experience, which can then simply retrieve recommended cutting speeds and feed. The most widely used source of such data is the Machining Data Handbook (MDH) published by Metcut Research Association, (1980). Although the handbook approach is often a logical and effective solution to the requirement of machining data, but it has limitations.

The applications of computational intelligence in manufacturing, in particular, play a leading role in the technological development of intelligent manufacturing systems. In this study an intelligent learning system was developed to automate the collection of the machining data used by the skilled machinist. The Machine Learning Method

is utilized for this task, which gives the computer the ability to learn. Artificial Neural Network (ANN) was selected from Machine Learning Algorithms to be the learning algorithm. ANN is a computer-based simulation of the living nervous system which works quite differently from conventional programming. The design network is trained by presenting several target machining data that the network must learn according to a learning rule (algorithm). In designing the network, a combination of back propagation or generalized delta learning rule with sigmoid transfer function has been used.

The machining data available in MDH was used to train the designed network. One cutting material (medium carbide steel) with its complete set of cutting tools (High Speed Steel, Brazed Uncoated Carbide, Indexable Uncoated Carbide, and Coated Carbide) discretized into 243 data sets was used in one training session for the designed network. Building knowledge within the network was measured by calculating the total percentage of error between target machining data and the outputs from the network during the training process.

The process of building the machining data knowledge (training) was successfully achieved. A Comparison between the learned target machining data and data from MDH shows a low percentage of error. An Intelligent Learning System for the turning process was developed. Visual C++ object-oriented programming language was used to build the Intelligent Learning System for Turning. Live data can be fed into the system from indirect way (Keyboard, Internet) or directly from machine to computer. The developed system may open the door for automating the collection of machining data for all manufacturing processes.

Abstrak thesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk ijazah Master Sains

**PERKEMBANGAN ALGORITMA PEMBELAJARAN BERMESIN BAGI
MEMPEROLEHI DATA MESIN DALAM PROSES PEMUTARAN**

Oleh

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Kos pengeluaran bagi komponen permesinan dipengaruhi oleh parameter bermesin yang terdapat daripada segolongan alat-alat pemotongan yang sesuai bagi memotong peralatan dan data mesin untuk kelajuan, bekalan dan ketebalan potongan. Sistem data mesin telah menjadi salah satu komponen yang paling penting dalam pelaksanaan sistem intergrasi pengeluaran komputer. Sistem mesin data berkomputer telah dikategori kepada dua jenis iaitu modul bermatematik dan sistem pangkalan data. Sistem pangkalan data ini berpandukan kepada pengumpulan dan simpanan data dalam bentuk kuantiti yang besar daripada eksperimen di makmal dan pengalaman di bengkel, kerana ia akan mengeluarkan kelajuan potongan dan suapan yang dicadangkan. Buku panduan Data Bermesin (MDH) yang diterbitkan oleh Metcut Research (1980) merupakan satu sumber data yang luas digunakan. Walaupun, buku panduan tersebut memperkatakan tentang sesuatu yang logik dan penyelesaian yang berkesan kepada keperluan data bermesin namun penggunaannya masih terhad.

Aplikasi kecerdasan berkomputer dalam pengeluaran khususnya, memainkan peranan utama dalam perkembangan teknologi bagi sistem pembuatan pintar. Dalam penyelidikan ini, pembelajaran pintar telah dikembangkan untuk pengautomatan pengumpulan data pemesinan yang digunakan oleh juru mesin mahir. Kaedah Pembelajaran Mesin telah digunakan kerana kaedah ini telah memberi peluang kepada komputer untuk membuktikan kebolehan mesin ini belajar. Artificial Neural Network (ANN) telah dipilih dari pembelajaran mesin untuk pembelajaran algorithm. ANN ialah simulasi yang berasaskan sistem neuron biologi dan agak berlainan daripada pengaturcaraan konvensional. Rekaan rangkaian dilatih melalui latihan dengan data bermesin tertentu iaitu rangkaian mesti belajar mengikut undang-undang pembelajaran. Bagi menciptakan rangkaian, kombinasi rambatan kembali atau peraturan pembelajaran delta am dengan fungsi peralihan telah digubahkan untuk mereka rangkaian.

Data pemesinau yang terdapat di MDH telah digunakan untuk melatih rekaan rangkaian satu bahan potongan (keluli kabaid sederhana) bersama dengan set lengkap peralatan potongan, diselitkan kepada 243 set data yang digunakan dalam salah satu daripada sesi latihan untuk rangkaian yang direka. Pembinaan pengetahuan melalui rangkaian telah diukur dengan menghitung jumlah peratusan ralat di antara data bermesin dikehendaki dengan keluaran daripada rangkaian semasa proses latihan.

Proses membina pengetahuan data bermesin telah berjaya diperolehi. Perbandingan antara data ramalan daripada rangkaian dan data dari MDH menunjukkan peratus ralat yang rendah. Sistem pembelajaran kecerdasan untuk proses larik telah bangunan.

Bahasa pengaturcaraan Visual C++ berorientasikan objek diguna untuk membina sistem pembelajaran pintar bagi operasi larik. Data sebenar boleh dimuatkan ke dalam sistem secara langsung papn internet atau tidak langsung dari mesin ke komputer. Sistem yang dibangunkan mungkin membuka ruang untuk pengumpulan data pemesanan berautomatik bagi semua proses pengeluaran.

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I certify that an Examination Committee met on (September, 13 2004) to conduct the final examination of Hayder M. A. Ali Al-Assadi on his Master of Science thesis entitled “Development of Machine Learning Algorithm for Acquiring Machining Data in Turning Process” in accordance with University Pertanian Malaysia (Higher Degree) Act 1980 and University Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

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