Web-based Cutting Tool Management System for Engineering Education

Haslina Arshad, Che Hassan Che Haron, Intan Syaherra Ramli

Abstract— **Information of cutting tools is very important for the effectiveness of cutting process. Previously, traditional search method by referring to the catalogues for the right cutting tool has been a burden to the user. As a result, the probabilities of choosing the wrong cutting tools were high. In this work, a new cutting tools management system for milling process has been developed for training students before they actually perform the milling process. With the specific parameters such as cutter, part number, dimension and material types and its properties, the user can easily get detail information of the cutting tools such as cutter dimension, insert types and its properties. User can also visualize the chosen cutter and inserts, interactively. This web application will help the user to find the best cutting tools. It can also help to educate students or any users in understanding the process of choosing the best cutting tools and the parameters needed for the cutting process. Visualization of the milling machine is also provided for the users before the cutting process is performed.**

Index Terms— **cutting tools, database system, milling process, machining parameters.**

I. INTRODUCTION

Selection process of cutting tools is important and critical in any machining processes. The selection process will require the knowledge of cutting parameters, types of work piece materials and ability of the machine tools. The wrong choice of cutting tools might lead to a big loss to a company in terms of the time and cost. This research was done in order to help users of milling machine who have faced problems finding appropriate cutting tools based on the manual catalogue provided by the cutting tools manufacturer. Some of the problems are to find the types of cutting tool material and to specify the right cutting tools for the specific work piece material as they have to go through page by page to find the result. Besides, this manual process also might take up a lot of time. The manual process might lead to the wrong choice of the cutting tools due to human error especially when cross-references had to be done between several catalogues.

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On the other hand, the manual catalog which is provided by the manufacturer is limited to single user only and when more than one user needs to use the catalog at the same time the problem will surface. This will be a waste of time that could delay the whole cutting process. Fast and accurate access to information about available manufacturing resources and data is critical to reducing production cost and maximizing machine productivity [1]. Problems also arise when new cutting tools are introduced for milling process. This might take a long time for the manufacturer to amend the information in the old catalog and produce the new one.

In this paper, a web-based system is introduced to reduce or eventually solve all the problems. It has the capability of choosing the right cutting tool from a virtual cutting tool catalogue. The cutting tool can be visualized in 3D using Virtual Reality technique. By doing this, we can actually help the user to search for the right cutting tools and also provide them the clear image of the cutter. We also presented the visualization for milling process and how the right cutter is fed into the milling machine for cutting purpose.

II. CUTTING TOOL DATA MANAGEMENT AND 3D VISUALIZATION

Cutting tool management is very important and a lot of research and information system had been developed in cutting tool management area. Ebrahim and Chao-Liang [2] have highlighted the needs for cutting tool database management in FMS and the requirements for successful cutting tool database. They presented a systematic way to design and develop a relational cutting tool database. The developed cutting tool database is implemented by using ORACLE database management system.

There are several significant issues which are suitable to successful FMS development. These include the availability of suitable system architecture, reusable software and the use of appropriate system design tools. With the advent of computerized manufacturing systems, Flexible Manufacturing System (FMS), it has become evident that tooling is a major constraint that prevents manufacturing systems from realizing their full flexibility. To increase the efficiency of cutting tool use in an FMS, it is necessary for the cutting tool database to support the information used in the whole tool life cycle and in cutting tool use [3]. Svinjarevic [4] highlighted the benefits of implementing a management system of cutting tools in a company which specializes in metal cutting process. It presents possibilities for improvement of the cutting tool management.

Visualization of the whole milling process starting from the selection of the work piece material and cutting tools up to the milling process provides users with a clear picture of the whole process. Several researches have been done on the visualization of shop floor operation and process. Wang et.al

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[5] had developed an Interactive VR Training for CNC Machining. Virtual reality training can dramatically reduce the cost of delivering training by decreasing learning time for students and instructors. This shows the important of visualization to facilitate understanding and simplify the work flow. Salvatore et.al [6] also presented 3D Visualization Technologies for Teleguided Robots and he showed that the use of 3D stereoscopic visualization could provide users with higher comprehension of remote environments in teleportation when compared to 2D viewing.

III. MATERIAL AND METHODS

To develop the cutting tools management system with the milling machine and cutter visualization, several references were done in the preliminary studies to identify the requirements and needs of the system. They are:

1. Information such as feed rate, cutting speed and cutting tools dimension were obtained from SECO manual cutting tools catalogue [7]. Data on how the users find the best cutting tool based on the standard cutting tools process has been obtained and analyzed.

2. Cutting tools management systems from previous works were referred. Based on the research, a client-server environment was set up and the system let the users to search for the right cutting parameter based on the work piece material, machining process and cutting tools. It also allows the administrator to update the cutting tools data online and also help to distribute the latest data effectively. However, the simulation on how the milling machine works and also the 3D image of cutting tools is not included in the system.

3. XL-MILL machine model from MTAB Engineers (P) LTD company was examined from their website to get its real structure. Each angle of the machine model has been analyzed in order to come out with the best 3D visualization of the milling machine. The information on cutting tools, types of materials and the speed of machine tools were obtained throughout this website.

4. Environment Setup: The system is a web-based client-server application. Installation of XAMPP-Win32-1.5.5 (a package for web-based application which includes apache (client-server), mysql_start and PhpMyAdmin 2.9.1.1 for database purpose) is needed and analyzed. For the system interface, Macromedia Dreamweaver 8 software is analyzed. For 3D visualization purpose, AutoCAD 2008 software has been chosen as a good platform to draw a 2D and 3D image with .dwg format of cutting tools and XL-MILL machine. Then, 3D Studio Max 8 is the software that will be used to transform the format from .dwg to .wrl and to specify the movement of cutting tools and the milling machine. Lastly, Cortona Client will be used to run the component which has been transformed to .wrl format. From this stage, the visualization can be tested whether it meet the user requirement or still need some adjustment.

IV. SYSTEM DEVELOPMENT DESIGN

In this stage, a data flow and DFD contact diagram was designed to show the relationship between the user and administrator function. Basically, the user can retrieve the cutting tools information (dimension, cutter, cutting parameters) base on query criteria like material no and part no while the administrator also has access to update the cutting tools information in this system. With this structure, the administrator can keep the cutting tools information record up-to-date from time to time. The user can also retrieve the cutting tools information all in one time by providing the right key for part no and material no. The logical dataflow diagram to show the relationship between the user and administrator is as in Fig. 1.

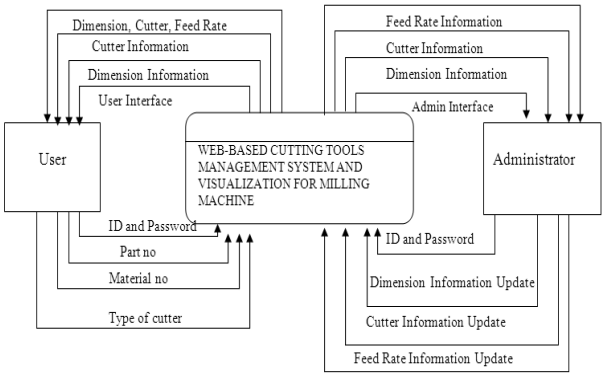

Fig. 1: Data Flow Diagram to show the relationship between user and administrator.

Data dictionary which represent the details about the data storage and also the information about the entity that involves in the system is as in Table 1.

Table 1: Data structure for Dimension

Data Structure	Element	Type of Data	Data size	Comments
Dimension 1	*Part_No*	varchar	20	Cutter code
	Dc	int	215	Cutter Dimension
	Dc2	int	8	Bottom Cutter Diameter
	I1	int	3	Cutter Height
	Ap	int	3	Cutter Depth
	No_of_inserts	int	3	No of Cutter
	Kg	int	3	Cutter Weight
	Type_of_insert	int	3	Type of insert

V. 3D COMPONENT DESIGN AND VISUALIZATION PART

In this research the cutter and the milling machines were designed in 3D component by using AutoCAD 2008 software. This is to show the effectiveness of cutting tools system to help the user to understand the cutting process by milling machine and to find the right cutter for selected materials. The detail about the 3D drawing process is shown in Fig.2. For visualization, 3D studio Max software has been applied to visualize the 3D component. Fig.3 shows the 3D object which has been exported from AutoCAD2008 to 3D Studio Max8 presented in 3 views: front, side and perspective view. In order to specify the movement coordinate, rotate command was executed using this application. Then, the time

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line need to be adjusted for each movement according to the visualization timing requirement. After that, the rendering process begins to provide the real effect to the 3D component. After the rendering process completed, the 3D component is exported to .wrl format. Within this format, it allows the 3D component to run in Cortona software. With this application, the 3D object can be viewed in various angles. Now, the 3D milling machine together with the cutter is ready to be integrated with the system.

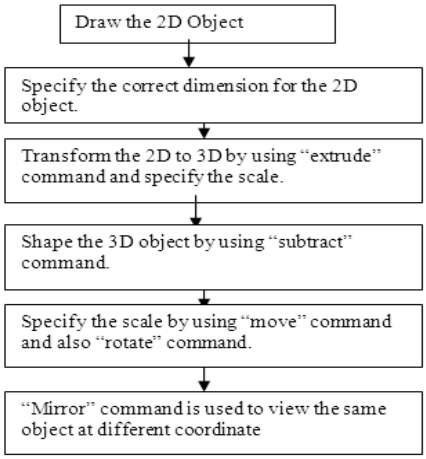

Fig.2: Details about 3D drawing process

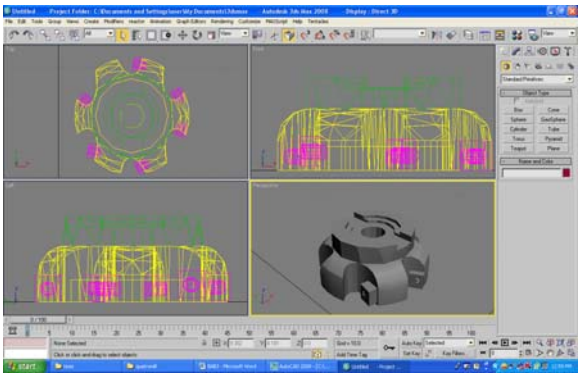

Fig.3: Image of 3D object exported from AutoCAD2008 to 3D Studio Max8.

VI. RESULT AND DISCUSSION

By using the cutting tools management system, user can easily get the detail information about the best cutting tools by inserting the required information in the system such as cutter dimension, material no, part no and metal grade as in Fig.4. Instead of getting the cutter information, user also manage to view the virtual model of the cutter to get the clearer picture about the design as shown in Fig.5. The visualization part allows the user to interact with the display to view the cutter 3D model from different angles. Besides that, user also can view the milling machine process through the visualization of milling machine process to learn on how the cutter is attached and fixed to the machine as in Fig.6.

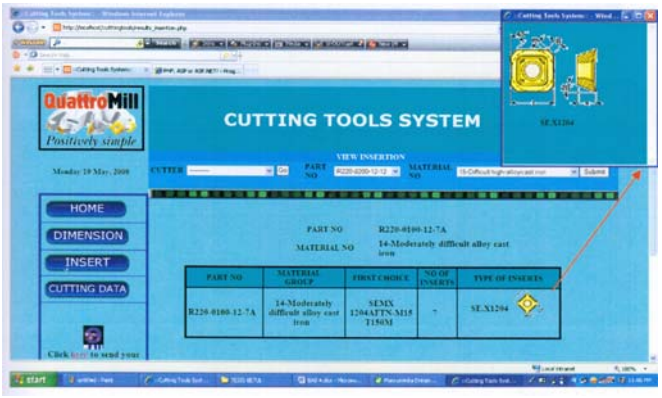

Fig.4: The cutting tools information based-on the selected work piece material.

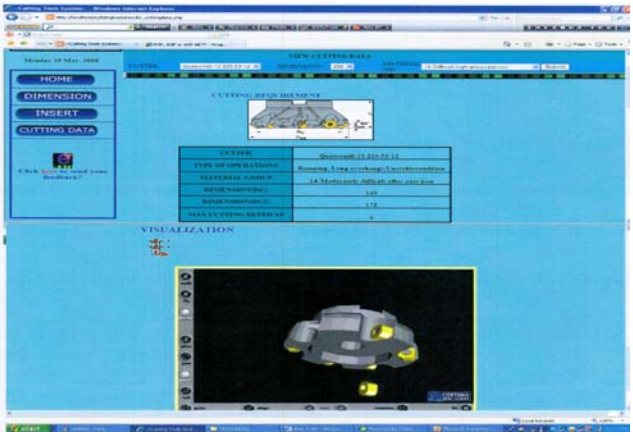

Fig.5: The cutter in 3D view

Fig.6: Visualization of Milling Machine

VII. CONCLUSION

The web based cutting tool management system and visualization for milling machine has met the objective for this research. Besides of having client-server feature which is flexible to access at anytime through the web browser, this system also provide the visualization for milling machine and the cutter. From these two main features, user not only can access to the database and search for the cutting tools efficiently; they also can view the 3D visualization of cutter and milling machine. Through this, more than one user can

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access to the database and they can also view the 3D cutter from each angle and learn better the milling process through the visualization part. It is hope that this system can give benefit to the institution of higher learning and industry to reduce the time consume in choosing cutting tools and can help in their daily work to become more efficient.

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