A Tool Management System Based on RFID

Z.G. Wang*[a], L. D.Xu[a], D.S. Cai[a], L. Xu[a] and H.H. Yu[b]
[a]Mechanical Engineering Department of Harbin University of Science and Technology, P.O.Box 92,150080, China
[b]Harbin Measuring & Cutting Tool Group Co. Ltd., 150040, China

ABSTRACT

Built the RFID (Radio Frequency Identification) hardware system then developed a tool management system based on Labview in the paper. The software can control the read/write device to read/write data through the serial port and use the database management module to add, query, modify and delete record. So, the automatic identification and management of cutting tool is realized.

Keywords: RFID, tool management, database, serial communication, Labview

1. INTRODUCTION

CNC cutting tool and the holder is consumptive production in modern manufacturing. Its wide range of information includes the type, shape, geometry, tool life and tool wear. Especially with the CNC machine and work piece's varieties increasing, the corresponding information will become increasingly heterogeneous. RFID technology could provide the latest scientific method to manage the various tool information.

2. SYSTEM COMPONENTS

The system consists of RFID hardware and management software. RFID hardware includes the data carrier (tag), antenna, controller and interface (Fig. 1, 2). Management software is a tool information management system based on the hardware. Major modules of the software include rights management module, serial communication module, command generation module, encode module, data validation module, decoding module, error processing module and database management module. The identification and management information of this system is extensive, including direct information and supporting information such as the tool magazine position, shank type, holder type, tool geometry dimension, blade position, cutter type, cutter material and cutting tool performance parameters etc; and including the toolholder and tool's date of purchase, manufacturer, batch number, status and other production management information; also including the expected service life, wear, early warning and other information.

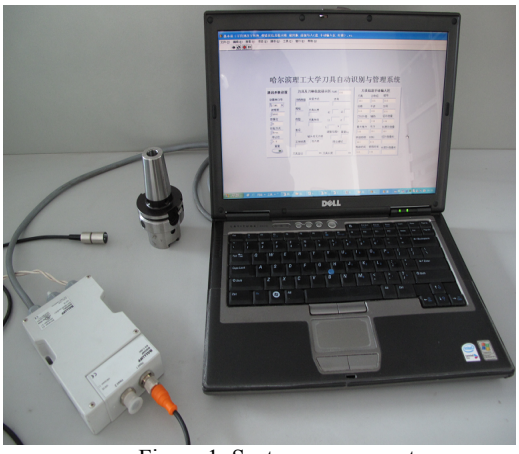

Figure 1: System components

Figure 2: Read/write device on the tool presetter

*Email:zgwhlmail@163.com; phone :+86 -451- 86390592

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3. INFORMATION MANAGEMENT MODE

The information can be managed in three modes, the tag mode, the tag and sheet mode and the tag and database mode (Tab. 1). The tag was written all the data about the tool in accordance with special format (Fig. 3) in the tag mode. A tool is composed of cutter, holder and accessory. There is a large amount of data to read and write in this mode by the communication between hardware, so the identification speed will be affected and the loss of hardware will be larger. The latter two modes rely on software to complete data acquisition, so data accuracy is slightly lower than the other two modes.

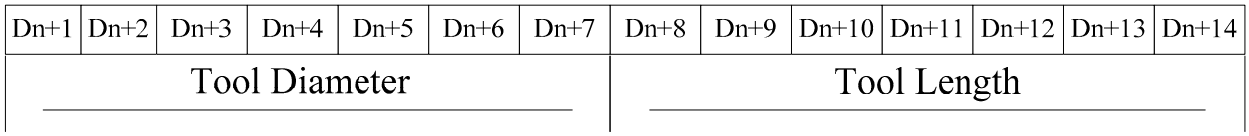

Figure 3: RFID tag encoding format in the tag mode

In the tag and sheet mode, all the information of the tool was stored in the sheet in accordance with special format. The tag just memories the tool number that can unique identify the tool. When the tool information was needed the software query the sheet with the tool number read from the tag and display the tool information (Fig. 4, 5, 6, 7). Less data is needed to read and write in this mode. So it is more efficient than the tag mode. But the flexibility of sheet operation is less than the database operation. The mode is applicable to the factory with a medium number of tools, especially to product lines.

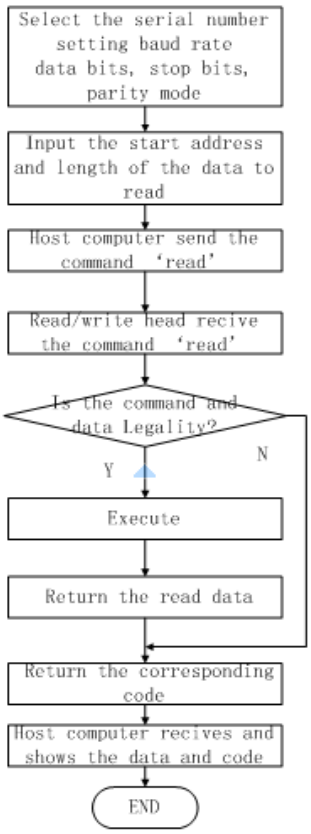

Figure 4: Read data

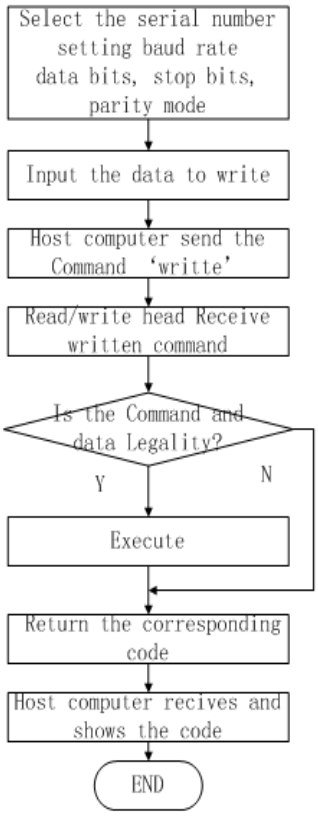

Figure 5: Write data

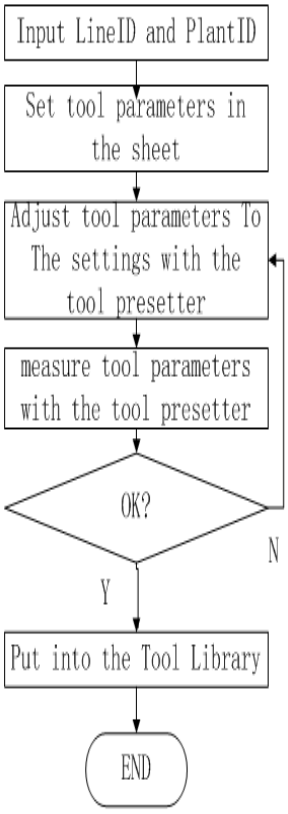

Figure 6: Add a new tool

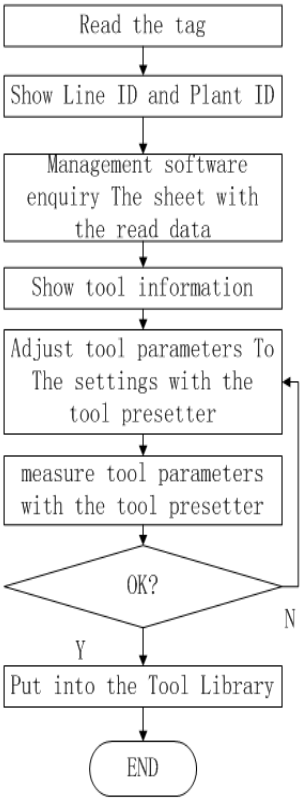

Figure 7: Tool Maintenance

In the database mode, all the information of the tool was stored in the database, a record memory all the information of a corresponding tool, the tag only record the tool number. When the tool information was needed the software query the database with the tool number read from the tag and display the tool information. This mode is very similar with the tag and sheet mode, but this mode is more flexible, larger data capacity, much easier to maintain therefore more suitable for the factory with larger number of tools.

Table 1: Comparison of three data management modes

Modes / Items	Tag	Tag and Sheet	Tag and Database
Expansibility	Hard	Easy	Easy
Tool management	not convenient	Easy	Easy
Hardware loss	Large	Small	Small
Change of data	Hard	Easy	Easy
Data security	Low	High	High
Tags capacity	Large	Small	Small
Theory tool storage capacity	Large	Small	Large
Maintenance	not convenient	Easy	Easy
Operator workload	Heavy	Small	Small

4. SOFTWARE COMPONENTS

The management software consists of two parts: the write data part and the read data part. Each part was integrated into the rights management module and the database management module. The write data part (Fig. 8) get the tool parameters such as tool diameter and tool length from tool presetter, then write into the tag together with other information after encoded (Fig. 9).

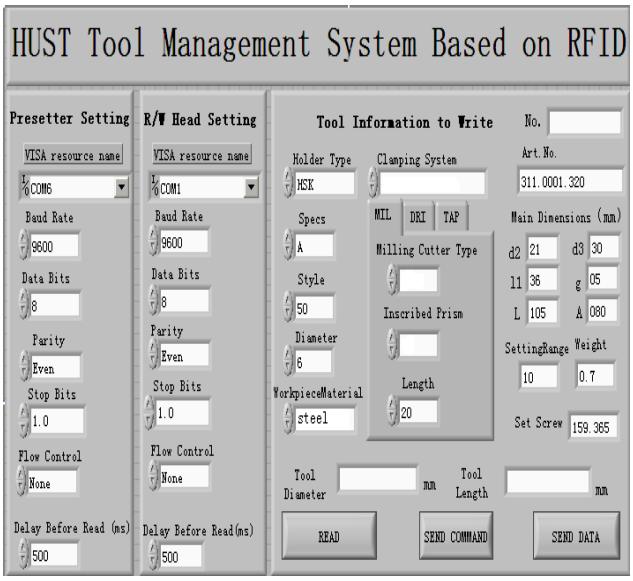

Figure 8: Write data part

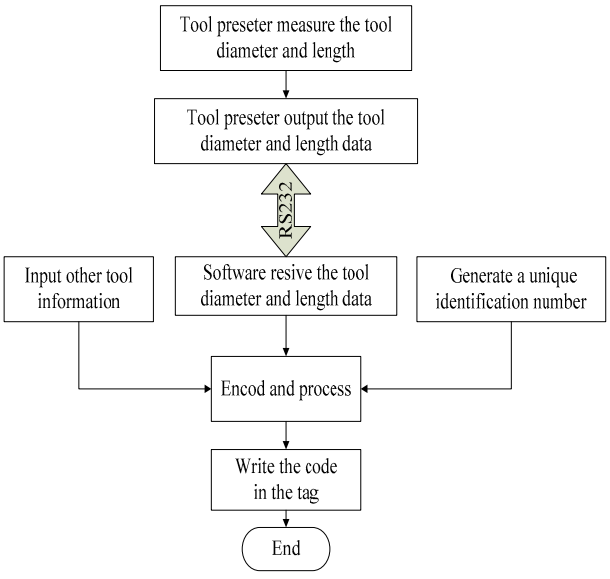

Figure 9: Flow chart of writing data in the tag

The read data part (Fig. 10, 11) read out the code stored in the tag then extract, decode and display the tool information, at the same time provide to the CNC system together with other information inputted. The CNC system can read the data

directly. This could significantly reduce the labor for data entry and increase accuracy of the data entry process, therefore could reduce the tool preparation time and prevent the mistakes of data entry.

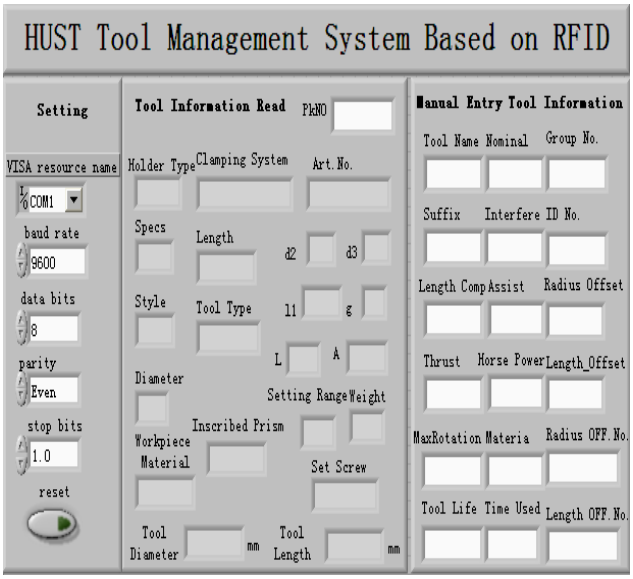

Figure 10: Read data part

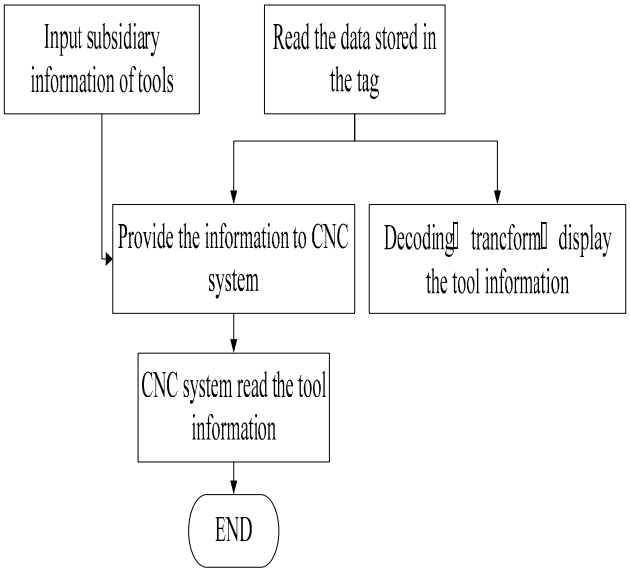

Figure11: Flow chart of reading data from the tag

5. SOFTWARE MAJOR MODULES

The management software major modules include rights management module, serial communication module, command generation module, encoding module, data validation module, decoding module, error processing module and database management module (Fig. 12). Each module can be made in the sub-VI; the main module can be made in main VI that can call the various sub-VI in Labview. Sub-modules are called by the main module, coordinated and complete the functions of read/write device control and management of the database.

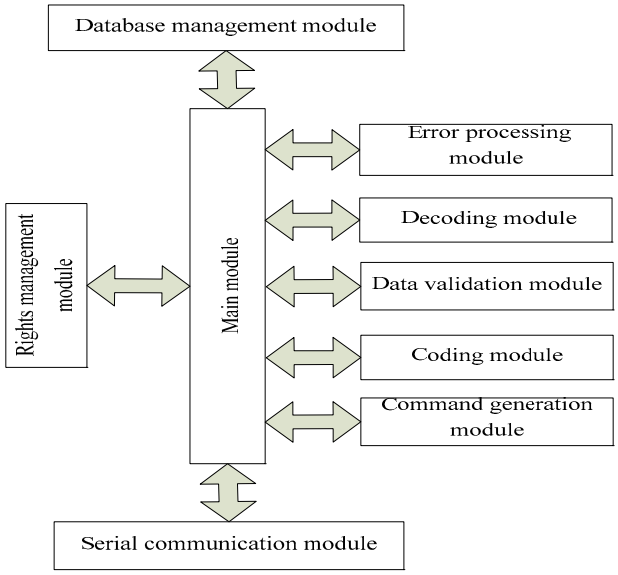

Figure 12: Software framework

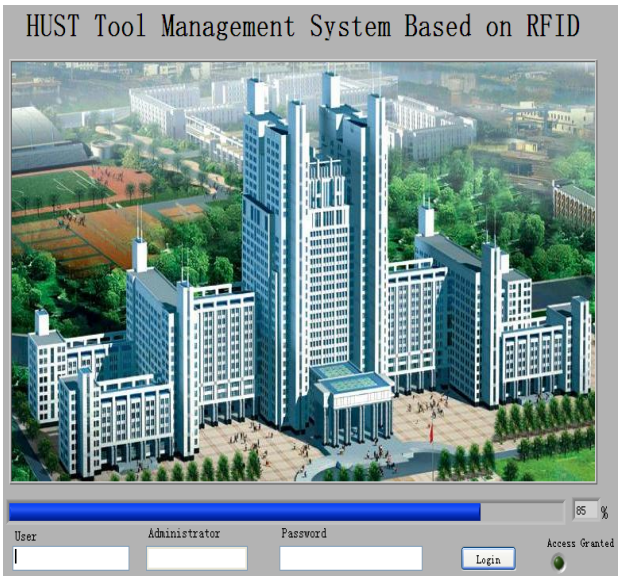

Figure 13: Login interface of the software

The main module coordinate the work of each module .It is made in a main VI while the other modules are made in sub-VI in labview. Main module control, manage and coordinate each module by the different structures.

On the rights management module, only authorized person can operate the software (Fig. 13). It can prevent data from being modified maliciously and increase data security.

VISA is a standard I/O language for instrumentation programming. VISA by itself does not provide instrumentation programming capability. VISA is a high-level API that calls into lower level drivers. One of VISA's advantages is that it uses many of the same operations to communicate with instruments regardless of the interface type. VISA is also designed so that programs written using VISA function calls are easily portable from one platform to another. Another advantage of VISA is that it is an object-oriented language which will easily adapt to new instrumentation interfaces as they are developed in the future. VISA's greatest advantage, perhaps, is that it is an easy language to learn and use. Its object-oriented structure makes the language and its operations intuitive to learn.

Serial communication module (Fig 14), it is responsible for the communication between the host computer and the lower compute. After a simple configuration VISA can communicate with read/write device. Mainly use the following controls: VISA Configure Serial Port VI that initializes the serial port specified by VISA resource name to the specified settings and wire data to the VISA resource name input to determine the polymorphic instance to use or manually select the instance; VISA Write Function that writes the data from write buffer to the device or interface specified by VISA resource name; VISA Bytes at Serial Port that returns the number of bytes in the input buffer of the specified serial port; VISA Read Function that reads the specified number of bytes from the device or interface specified by VISA resource name and returns the data in read buffer; VISA Close Function that closes a device session or event object specified by VISA resource name**.**

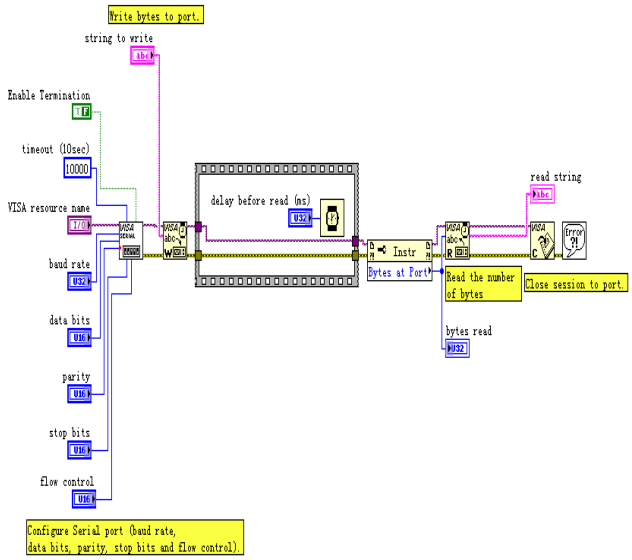

Figure 14: Serial communication module

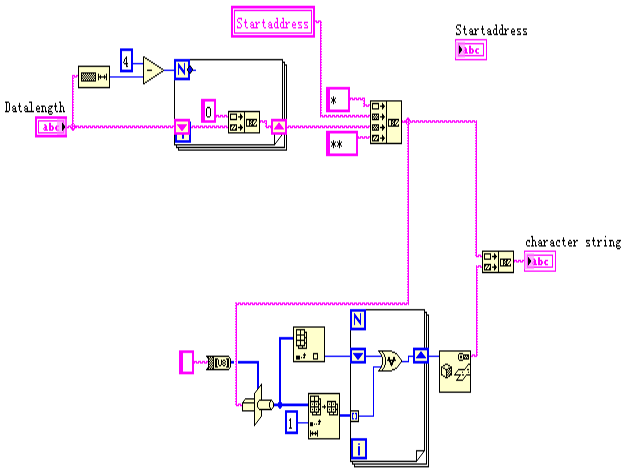

Figure 15: Write command generation module

Command generation module, it includes write command generation (Fig. 15) and read command generation. Write command which can be processed by lower computer is based on the parameters inputted.It is dynamic. There are two types of read command dynamic and static. For the length of the code to read is fixed, a static read command can be used. It is necessary if the processer is not so powerful. Dynamic read command like write command can be also used if we want to improve our software later. The dynamic read command gives more reusability but less efficiency of the module than the static one.
Database management module, it exchanges data with the database. Transforms the code to tool information and add it to the database, provide query record, add record, delete record and other functions (Fig. 16, 17). It is convenient for the management of large tool library.

In addition, the management software is the integrated code automatically generated module that can generate a unique identification number automatically. The module avoid the tool information management trouble that caused by enter the

same identification number twice. Data verification module that checks the data to ensure the accuracy of the data received. And CNC machine data exchange module that share tool diameter, length and other parameters with the CNC machine.

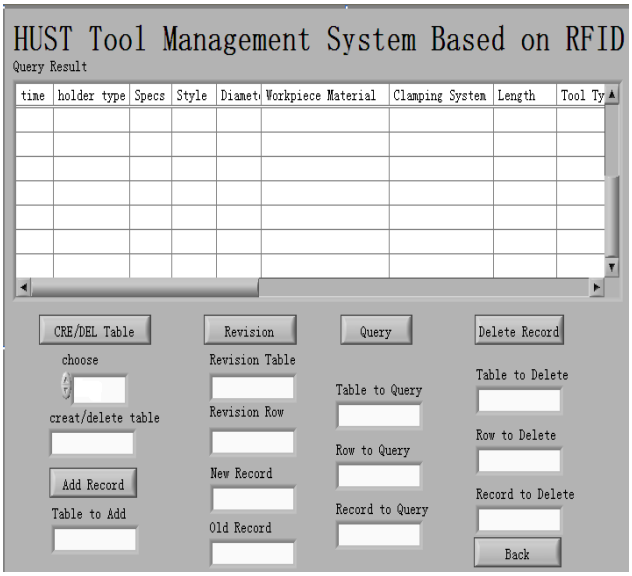

Figure 16: Database management module front panel

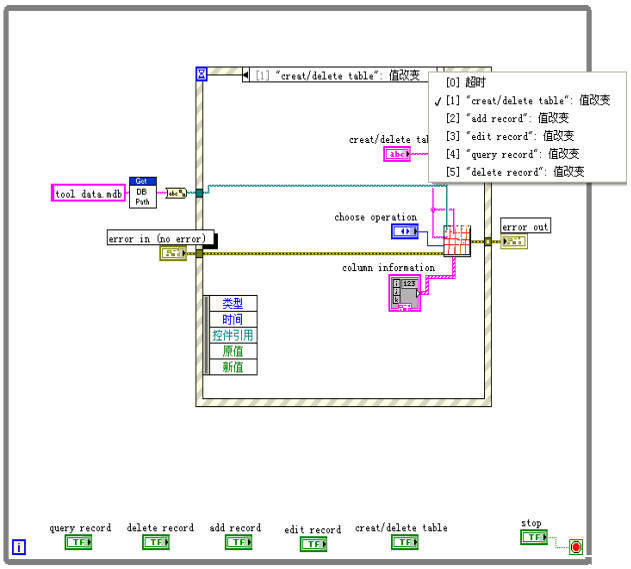

Figure 17: Database management module block diagram

6. CONCLUSIONS

The friendly software interface and Chinese menu make it to be operated easily. Using a modular design, improved the reusability, expandability and maintainability of the software. The system can record a variety of real-time tool dynamic information, and provide to related equipment timely. The tool management system based on RFID can also be integrated into existing enterprise management systems, such as ERP, CRM and SCM systems to improve the management level and production efficiency.

7. ACKNOWLEDGMENT

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