INTEGRATION OF RFID TECHNOLOGY WITH NX SOFTWARE

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Abstract: The goal of this article is to outline the conceptual model of RFID technology integration with NX software. Presented ideas are motivated to achieve a seamless integration of CAD, CAM subsystems and DNC/CNC machine tool system. In the first part of this paper a short description of RFID technology is introduced. Further paragraph of the paper is focused on presenting some similar solutions of RFID technology in production process automation. Its main intention is to describe the concept of the RFID and NX integration.

Keywords: NX software, RFID, CA systems, CNC machine tool

1. Introduction

RFID is presently dramatically expanding technology that penetrated into different areas such as supply chain management, manufacturing, departments of defense and health care to ensure contactless identification and tracking of goods, property, but also people in real time. From the literature sources, there are also well known RFID solutions in an area of factory automation with aim to gather data from a shop floor layer to higher layers, especially to manufacturing execution systems (MES). The main scope of the article is to outline the possibility to combine RFID technology with NX software with a purpose of seamless integration of subsystems CAD, CAM and DNC to achieve an automatic change of part programs in CNC machine tool. The paper is structured as follows. In the first part of this paper a short description of RFID technology is introduced. Further paragraph of the paper is focused on presenting some similar solutions of RFID technology in production process automation. Its main intention is to describe the concept of the RFID and NX integration.

2. Brief description of the basic principles of RFID technology

The term RFID (Radio Frequency Identification) signifies the technology, that emploies electromagnetic waves to transmit information between the reader (Interrogator) and tag (Transponder) for automatic object identification. RFID tag can be identified without a line of sight in the range of several meters, while an object can be in movement. Objects do not require exact alignment on the conveyor belt as it is for reading barcodes.
The RFID tag uses a microchip to store information about a product or an item in the form of uniquely numbered code named Electronic Product Code (EPC). RFID describes a whole family of technologies based on the different types of tags used. The tags can be classified based on their operation, programmability and frequency band used. Based on the frequency band used RFID-tags can be classified as low medium or high frequency. The used

frequency of cause influences the data transmission rate and the possible distance between reader and tag. For further details on the technological aspects of RFID see for instance [1.]. RFID allows updates to be written to the tag, so it is constantly being updated without risk of operator error. For other reports on RFID implementations see for example [2.] and [3.]. Some aspects about implementation of RFID in smart manufacturing related to self identification, communication, quality, and concurrent process have been revealed in [4.].

3. Related work

It is generally indicated that RFID technology creates important part of manufacturing process automation. RFID applications are normally closely tied to the MES controlling the production process. The typical functionalities of an MES are described by several authors [5., 6., 7., etc.]. RFID technology may support most of these functionalities. In operations scheduling and production control, RFID can be used for guaranteeing process safety and interlocking. If materials or material containers are equipped with a unique ID (provided via barcode or RFID), the MES can ensure that all preceding process steps have been conducted successfully before starting the next manufacturing step. Furthermore, production order data and manufacturing parameters may be written to the RFID tag at the first manufacturing step and then read and updated them [8.].

Another area that can be improved by use of RFID is tracking parts using mobile readers. Each worker in charge of transporting parts is equipped with mobile reader. In a tracking application with mobile readers, moved parts are registered at the location where they are dropped. RFID can help automatically capture both the location and the identity of the respective part as it is dropped. When a part is dropped, the part ID and the position tags nearby are read out by the mobile readers. The back-end database could thus automatically be updated with the position of part. The live updates are realized using WLAN technology. Some mobile readers can optionally be equipped with WLAN connectivity and can thereby be permanently linked to the back-end system [8.].

An approach that is similar to our work presents solution of product driven-control in manufacturing systems equipped with RFID technology using Functionality Based Control [9.]. The mentioned approach gives capability to the products to decide their own control strategy by means of task schedules in a system process which paves a way to develop intelligent products. The interface between the RFID-reader reading the processing information from the product and the Scheduler is provided by a Task Processor. The Task Processor updates the task array given to the Scheduler which affects the next operations. An example of drill station with some cases of arrivals and kinds of products has been given in this work.

Another interesting solution was presented by company Ge Fanuc that developed ID controller, which is able to read the tooling information from the RFID chip on the tool holder, and move the information into the appropriate registers in the CNC control without having to modify the CNC control in any way. Controller enables an end user to cost effectively implement technology to automate their processes where the integration cost would have previously become grater. Additionally, ID controller allows the flexibility to reconfigure the application in just minutes to fit with the ever-changing needs of the manufacturing environment [10.].

4. Possibilities of RFID integration with the system NX

The innovation of RFID technology in production opens doors to new opportunities of automation. The following model describes the possible application of RFID technology in

cooperation with NX software (originally called UNIGRAPHICS). NX is complex CAD/CAM/CAE software that supports wide range of activities in design, manufacturing and engineering. It represents also a modular system, which means that each workstation can be configured as required, with full associativity to all cooperating modules. This allows simultaneous work for the team of investigators, what in effect means that in some stage of semi-finished model can be performed simultaneously strength and kinematic calculations or further analysis and simulations. In addition, the individual modules can be shared over a local network (so-called floating license) and configured as necessary [11.].
NX CAM environment provides practically unlimited possibilities in a process of determination of technological operations. Technologist disposes besides the whole line of fully automated machining processes also a multifunction apparatus for generating user specifically requested types of machining and special technologies. Generated cutting tool paths are fully associative with the model and any accepted changes made in the model lead to a cutting tool path change.
We can use the model that is created by combining bulk solids, surface or curves, but also imported model from the other CAD systems to generate NC program. The length of cutting tool path is unlimited. The system provides output of NC program to a machine of all major manufactures, and also allows to suit of special demands by general postprocessor generator (Postbuilder). NX supports also advanced high-speed machining and the automatic creation of shop floor documentation in HTML (see Fig. 1), the contents of which are methods, operations, cutting sequences, cutting tool list and others.

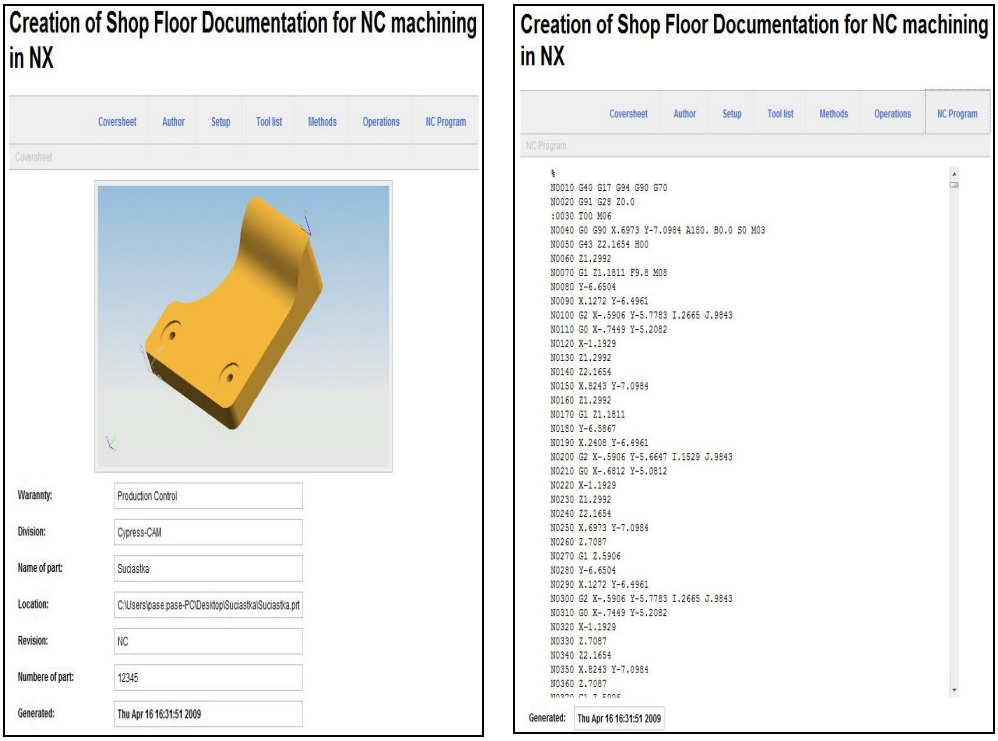

Figure 1. Shop Floor Documentation in HTML [12.].

Module of Shop Documentation generates shop floor documentation in HTML or TXT with use of created templates that was written in the script language called Tcl (Tool Command

Language). Author of this script language is John Kenneth Ousterhout. (The manual of creation of templates for Shop Documentation module is elaborated in detail in the literature [11]).
Module Shop floor documentation can be also used in connection with SQL database. The link between module and SQL database is provided by Tcl-SQL library, which consists of series of procedures and functions. That's why the outputs such as files of NC programs, cutting tool lists, methods, technological operations, images of virtual 3D model of parts, etc., can be added and stored by the SQL database managed at the database server. It is very efficient to assign unique ID code to constituent data stored in the SQL database.
Conceptual model RFID integration with NX system as shown on Fig. 2. consists of following components:

- **Application and Database Server.** Application software allows receiving information from middleware and to assign an actual NC program from SQL database to this information. Subsequently, a file with a given NC program is passed to CNC Machine tool control system**.**
- **Middleware** presents a cornerstone for non-trivial RFID deployments**.** It is a platform that manages and routes data between tag readers or other automatic identification devices and enterprise systems. In our case it selects and transforms data from the RFID reader to Application software.
- **Computer PC_{NX}** contains installed NX software along with a predefined template for submission NC programs to the SQL database.

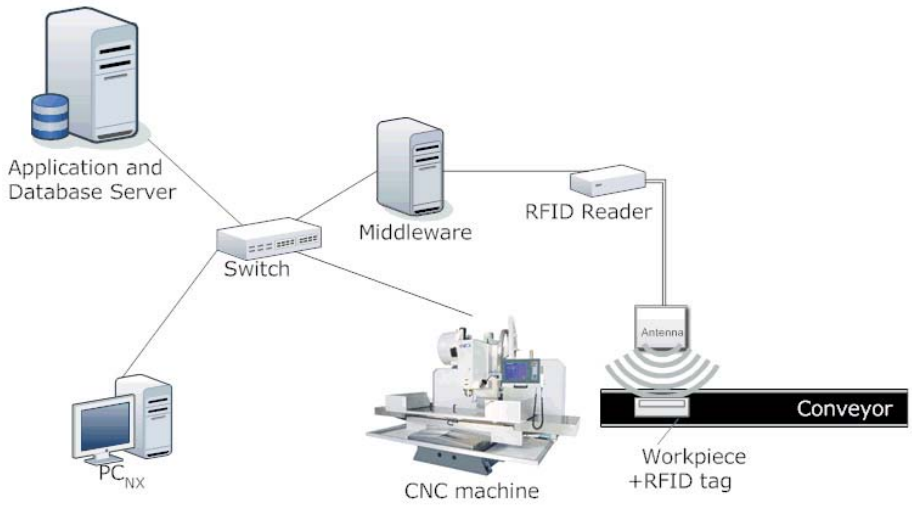

Figure 2. Design of integration of RFID technology with NX system

Summary of conceptual model functioning:

- Engineering draw designer uses NX software on PC_{NX} for the design of objects (3D virtual model of a part) and assigns needed tools, operations and methods of machining to a file of part in the CAM environment of CAD/CAM system. Subsequently, he chooses a type of NC machine tool from a predefined library of machines. Then he starts module Shop floor documentation for creation of NC program for PLC and other digital outputs that are sent to SQL database.

- RFID Reader processes the input signal from antenna to a Middleware data understandable for software application. The workpiece is located on the step to step conveyor. The Item with embedded RFID tag is read before it is placed into CNC machine. Middleware receives data from the RFID reader and subsequently after their processing they are passed to the application software. NC program after its selecting from SQL database is sent to the Controller of CNC machine tool.

5. Conclusion

In spite of mentioned advantages of RFID technology, there are still skeptic views on its exploitation due to certain limits and disadvantages, which weren't the issue of this article. On the other hand offers uncovered potential of practical applications to increase efficiency of many of activities in manufacturing. Described concept with use of RFID technology in manufacturing processes linked with CAD/CAM system that uses NX system after its verifying it should contribute to increase a level of automation in specified functions. Moreover, presented solution creates conditions for full automation of machine toll workstations without human operators. Target of a subsequent research, before its implementation to the real manufacturing process, is to investigate the viability of model for specification of HW/SW tools.

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