ARCHITECTURE OF A FLEXIBLE MANUFACTURING CELL CONTROL APPLICATION

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Abstract - The paper aims to present the architeture of the UO-IMT flexible manufacturing cell control application.

1. The physical elements of the UO-IMT flexible manufacturing cell

The UO-IMT flexible manufacturing system is situated in the multidisciplinary laboratory of the Mechatronics Department of the Faculty of Management and Technological Engineering in Oradea. The location of the components within the UO-IMT flexible manufacturing cell shown in figure 1.1.

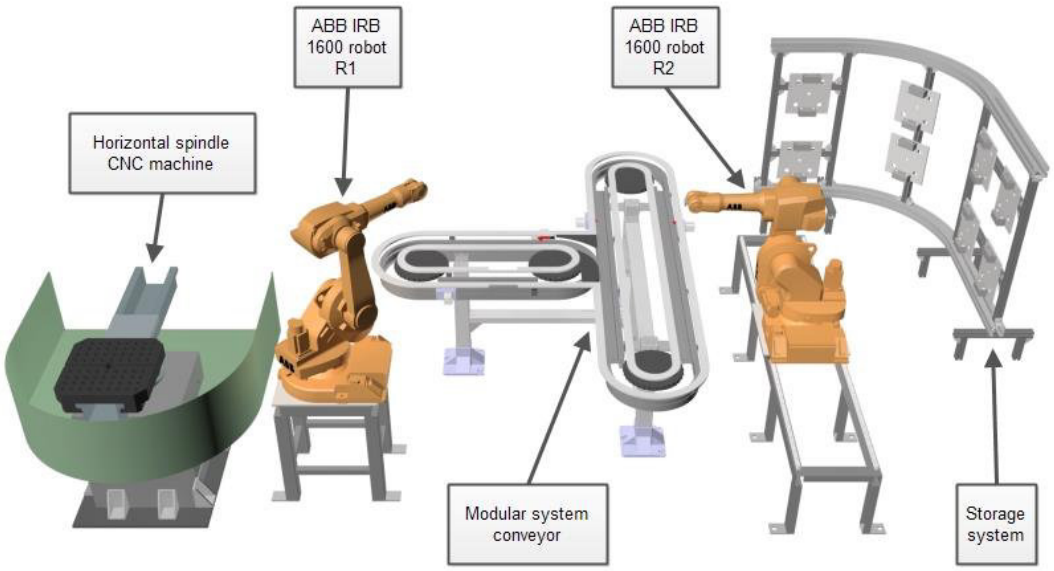

Figure 1. 1. UO-IMT flexible manufacturing cell

1.1 ABB IRC5 Robot controller

The ABB IRC5 robot controller (figure 1.2.) is responsible for the IRB 1600 robot control. This controller is the 5th generation and is based on an Intel Pentium multiprocessor platform with flash memory and USB and PCI interfaces.

The operating system is based on the RAPID programming language which is based on PASCAL and C programming languages.

Figure 1. 2. ABB IRC5 robot controller

1.2 CNC GeFANUC

The control of the machine center UO-IMT (figure 1.3.) is provided by an equipment of two parts, the first is an ordinary PC running Windows XP Embedded which is a human-machine interface with a HSSB (High Speed Serial Bus) interface, and the PMC (Programmable Machine Control) is the "PLC" (Programmable Logic Controller) of a CNC. The two parts are conncted using fiber optic interface (HSSB).

Figure 1. 3. PMC (left) and PC (right)

1.3 RFID system

The RFID system consists of two modules. The first module is the ID-12 RFID reader (figure 1.4.) from the Innovations company. It is very simple to use because of the built in antenna and the serial communication interface.

Figure 1. 4. ID-12 RFID reader

The second mudule is a microprocessor (ATMEGA328 figure 1.5.) with the ability to connect to LAN and communicate via TCP/IP.

Figure 1. 5. ATMEGA328 with LAN shield

The programming language of the microcontroller is called Processing/Wiring and looks very much like C or PHP.

2. The software elements of the control application

Industrial equipment manufacturers deliver their products with libraries compatible with the .NET programming architecture. These libraries can be used with the C# or Visual Basic .NET programming languages. Two of these libraries are from manufacturers ABB and GeFANUC.

2.1 ABB PC SDK

The ABB PC SDK libraries (figure 2.1.) (Software Development Kit) allows developers to create applications that can communicate with the IRC5 controllers. These libraries are provided along with the RobotStudio.

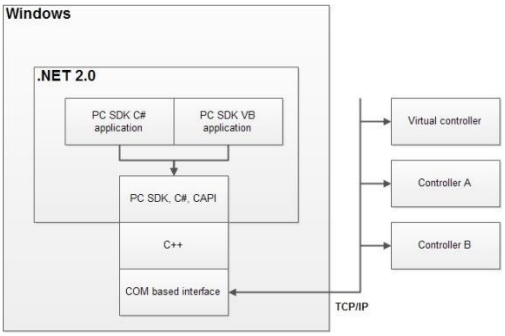

Figure 2. 1. ABB PC SDK

To create applications using the PC SDK libraries requires the Visual Studio 2005-2010 development environment.

2.2 GeFANUC .NET FOCAS

The FOCAS interface provides a robust and documented access to CNC and process data. Using the libraries and drivers a programmer can create applications that have access to information such as current status or error messages. Reading and writing routines allow modification of data elements in CNC or PMC.

3. Architecture of the flexible manufacturing cell control application

The general scheme of the control application is presented in figure 3.1. and the interface is visible on figure 3.2.

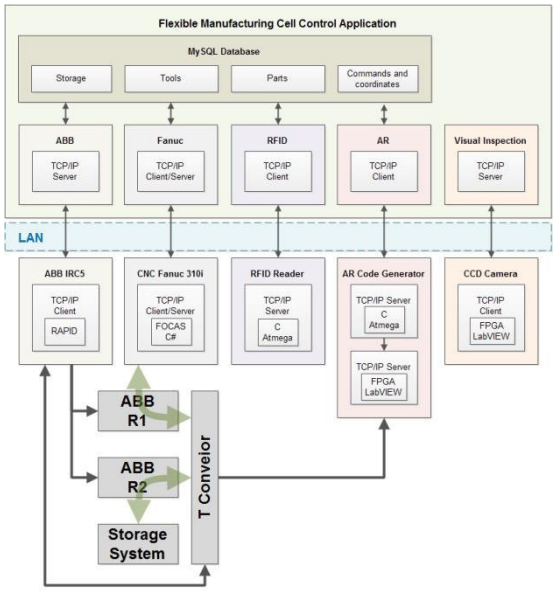

Figure 3. 1. General scheme of the control application

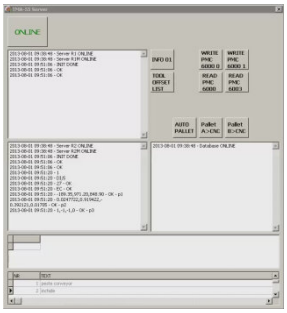

Figure 3. 2. Control application interface

3.1 ABB module

The ABB module consists of two parts:

- ABB-PC running in the control application
- ABB-IRC5 running in the IRC5 robot controller

The two modules communicate via TCP/IP client and server synchronous socket components.

3.2 CNC GeFANUC module

The CNC GeFANUC module is also composed of two parts, a PC module and a module running on the CNC, and is written in the C# programming language (figure 3.3.). The PC module is constructed using the same non-visual TCP/IP components like the ABB-PC module where the PC module is the client and the CNC one is the server.

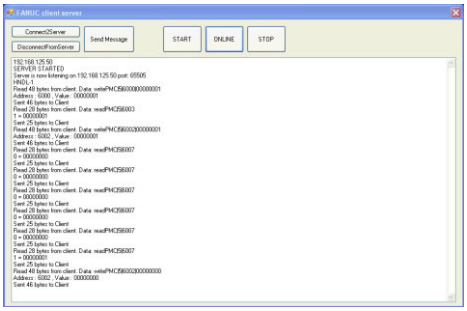

Figure 3. 3. C# application running on the GeFANUC CNC

3.3 Conveyor module

The conveyor module is integrated with the ABB module (see figure 3.4.). This module is a collection of procedures defined in the ABB-IRC5 module. The procedures are responsible for controlling the solenoids and the pneumatic conmponents.

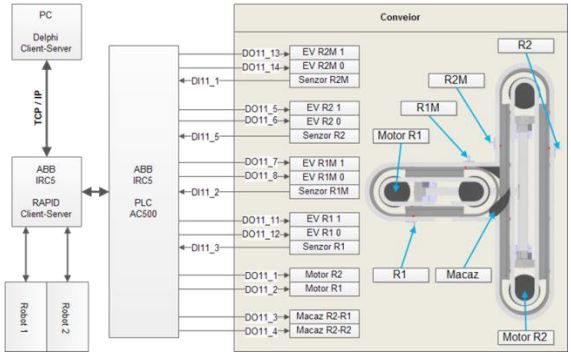

Figure 3. 4. Communication between the conveyor and the ABB IRC5 controller

3.4 Visual inspection module

The visual inspection module is still in development. The module is divided into two parts: one that runs in the control application and one running in the NI-1722 monochrome CCD camera (see figure 3.5.).

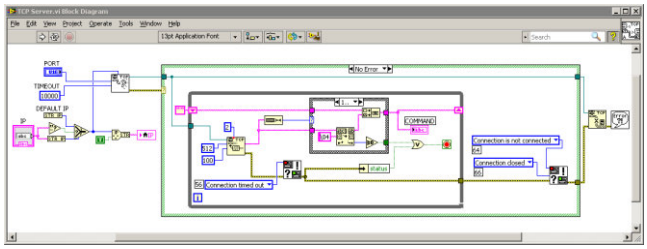

Figure 3. 5. LabVIEW application responsible for TCP/IP communication

3.5 RFID module

The RFID tracking module (see figure 3.6.) is divided in two parts:

- RFID-PC running in the control application
- RFID ID-12 which is mounted on the conveyor (4 RFID readers and an ATMEGA328 microcontroller which connects to the RFID-PC module via TCP/IP)

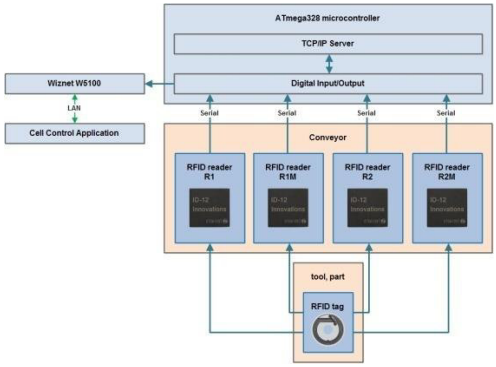

Figure 3. 6. RFID system structure

3.6 AR module

The AR module is divided in four parts:

- The web module is responsible for displaying the documentation for error codes and other informations
- The application control module is responsible for the collection of error messages and other informations
- Modules running on the equipments like the ABB IRC5 controller or the GeFANUC CNC
- AR application running on the mobile device equipped with a camera

The interaction between the modules is shown in figure 3.7.

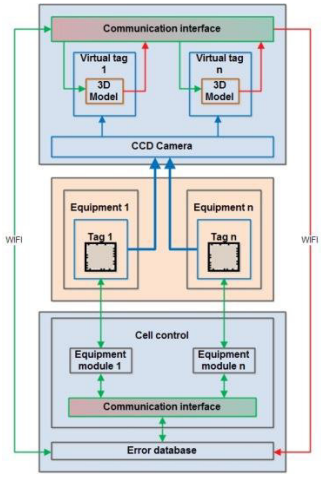

Figure 3. 7. Interaction between AR modules.

In the figure 3.8. is presented a page of the ABB IRB 1600 robot documentation to solve the error if the battery that powers the robot`s memory is depleted, it must be replaced and the robot must be recalibrated.

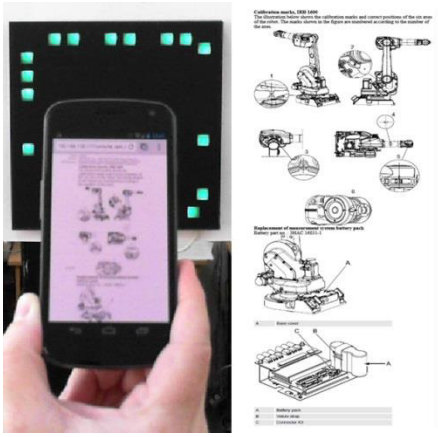

Figure 3. 8. Documentation on the mobile device

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