CONTROL OF INDUSTRIAL EQUIPMENTS USING EMBEDDED APPLICATIONS

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Abstract: This paper presents a flexible implementation for an embedded application capable to acquisition data and to control an industrial process. The paper is structured into several parts. First, there is presented the goal of the work and how this purpose will be achieved taking into account to actual trends. The second part describes design specifications and technologies used to this application. Thus, it makes a functional presentation of the implemented application. Next part shows the implementation of the application. The paper concludes with some significant results and some considerations about this embedded application; also, is presented some future research.

Keywords: embedded application, PID control, bi-positional control, development board, controller

1. INTRODUCTION

The purpose of this work is to design and implement of a main interface capable to acquisition data and to control an industrial process using additional dedicated boards.In order to these there will be used two boards made from Weeder Technologies – WTADC [2] and WTDAC [3]; the modules are connected through serial interface at the main interface and they assure analog-digital and digital-analog conversions. These boards allow to measure voltage between 0 and 4095 mV received by the industrial sensors like temperature sensors, pressure sensors, pH sensors, level sensors etc. The sensors must give voltage electrical signal or a signal convertible into voltage signal. A classical example used in industry it is the unified signal between 4 and 20 mA.

The conversion from voltage to value measured by the sensors is made using second degree polynomial formulas.

The main interface offers the possibility to acquisition and control on four channels configurable into independent ways by the boards and by the software application. Any channel can acquisition data and control a process in the same time; the control may be PID or bi-positional. Independent of the acquisition/control, each channel has attached an alarm.

Into industrial domain, the automat control of the processes are using for many years. There are certain concepts used by the embedded applications like the followings.

Master-Slave systems consist of the systems in which a least one of the embedded boards coordinates the communication on the bus and the others have reactive functions. In this project, the main board has a double role: it is Slave for the computer and it is Master for the additional boards. Data Acquisition systems are devices

used to receive significant data from an industrial process directly or through additional board, in order to monitor the good function of the process. For this project the WTADC is a data acquisition board.
Industrial Process Control systems, in addition to the systems above, have control functions in order to maintain the industrial function parameters between certain secure limits. In case of present project the control will be made by the WTDAC board.

2. GENERAL AND FUNCTIONAL DESCRIPTION

In the figure 1 it is presented bloc diagram of the embedded acquisition/control application.

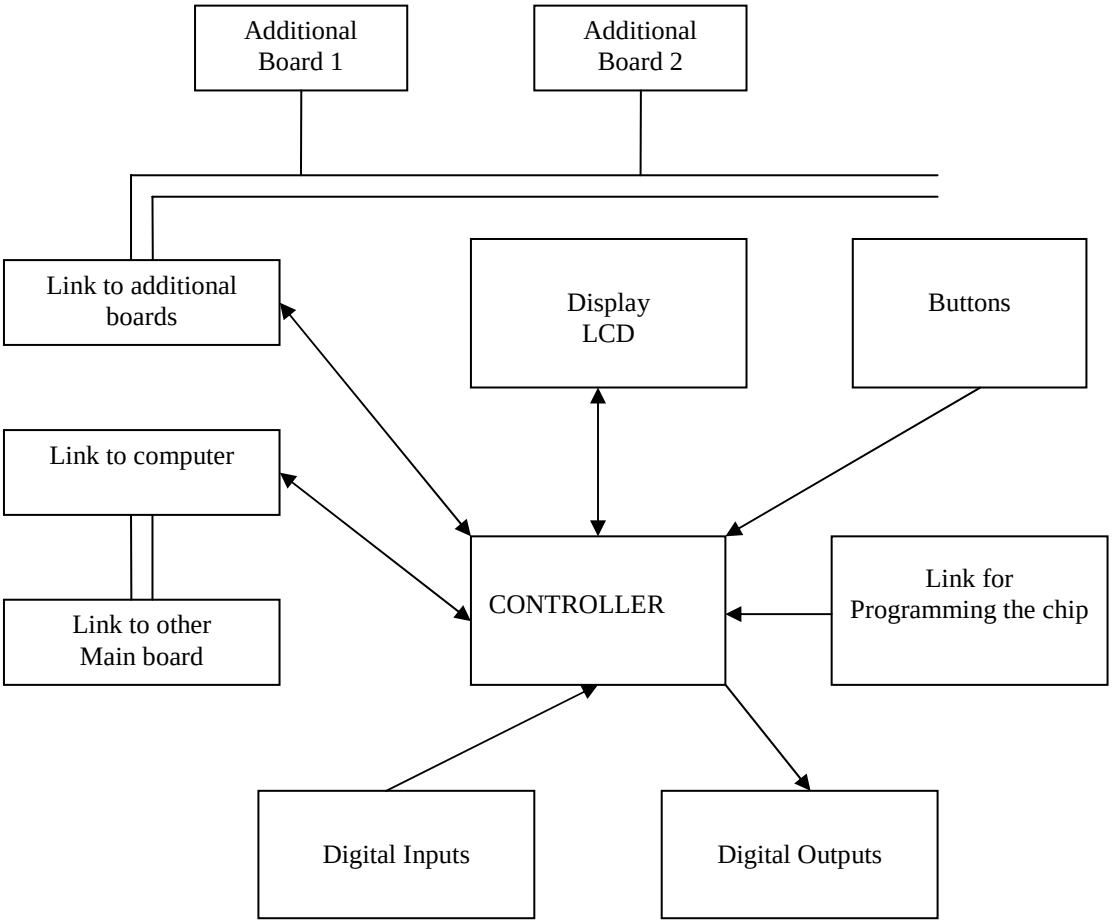


Figure 1. Bloc Diagram of the application

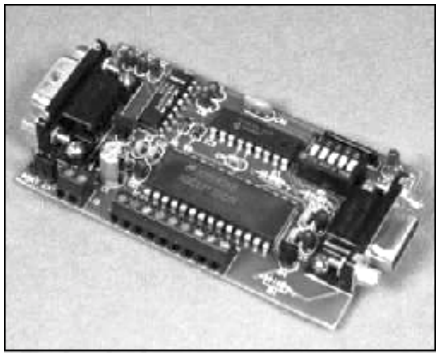
The additional boards 1 and 2 are represented by WTADC and WTDAC used for a control on four chanells. The link to additional boards is provided by MAX232 chip [4] and one DB9 standard connector. The link to computer is also provided by MAX232 chip and the link is opticaly separated with 6N138 optocouplors. The link with other main boards is provided directly by TX and RX signals or by an USB-serial connector. LCD has 2 rows and 16 columns. Controller can be programmed directly on board or serial by a DB9 standard connector. There are four digital inputs for acquisition data and four digital outputs for control the industrial process. Processor coordinates whole function of the embedded application.

2.1. Main development board

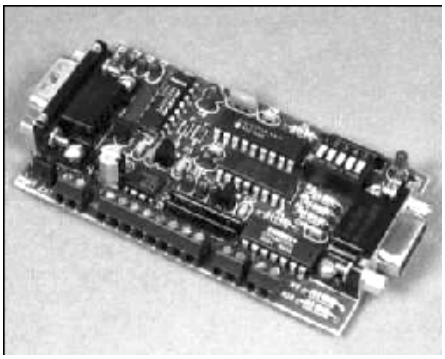
This board represents the central core of the project. The kernel of the board is the AVR microcontroller ATmega162 from ATMEL [1]. The chip program was written in C cod using CodeVision tools by HP Infotech and the chip was programmed by serial interface using PonyProg application free on address http://www.lancos.com/prog.html. For simulate the program was using AVRStudio free by Atmel.

2.2 Additional boards

The boards are from Weeder Technologies.and are shown bellow:



WTADC board



WTDAC board

Figure 2. Additional boards

WTADC makes the analog – digital conversion (voltage input is 0 to 4095mV range). It has a 12 bits resolution and 8 chanells (4 chanells for simple acquisition or 8 chanells for diferential acquisition). A switch selects its address. WTDAC makes the digital – analog conversion (voltage output is -10 to 10 V range). It has also a 12 bits resolution and a switch selects the address. The both boards have DB9 standard connectors for input and output, a LED for communication and some other inputs for control and supplies signals.

2.3 Computer user application.

The user application was written in Microsoft Visual Studio.NET 2003 tool. It uses a MFC (Microsoft Foundation Classes) graphical interface.

3. IMPLEMENTATION AND RESULTS

3.1. Main board implementation

The board is shown in the following figure:

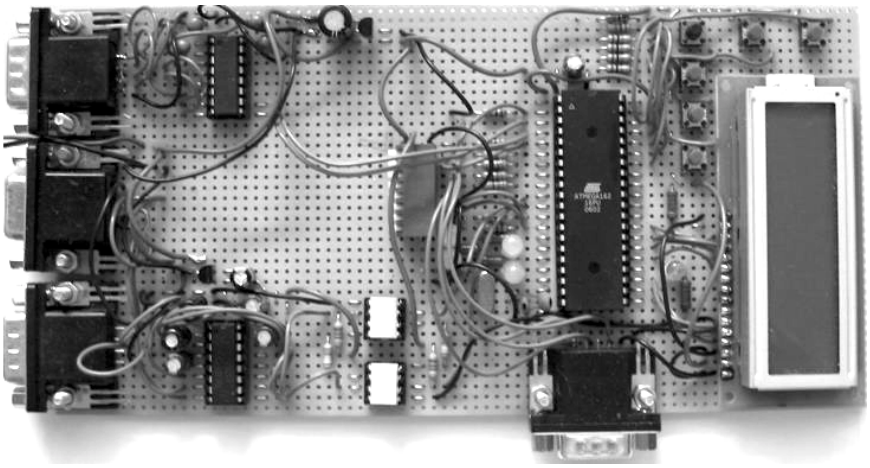


Figure 3. Main board implementation

Microcontroller chip program is written in C inside EEPROM and it consists in a module for board management and processing and in a module for computer serial communication.

3.2. User program implementation

High level computer application is split in several modules written in C# under Microsoft.NET. There are modules for board configuration, for abstracting data acquisitions, for setting the control type (simple, PID or Bi-positional) and for a 2D graphical acquisition window.
Dependence between modules is presented in the figure 4.

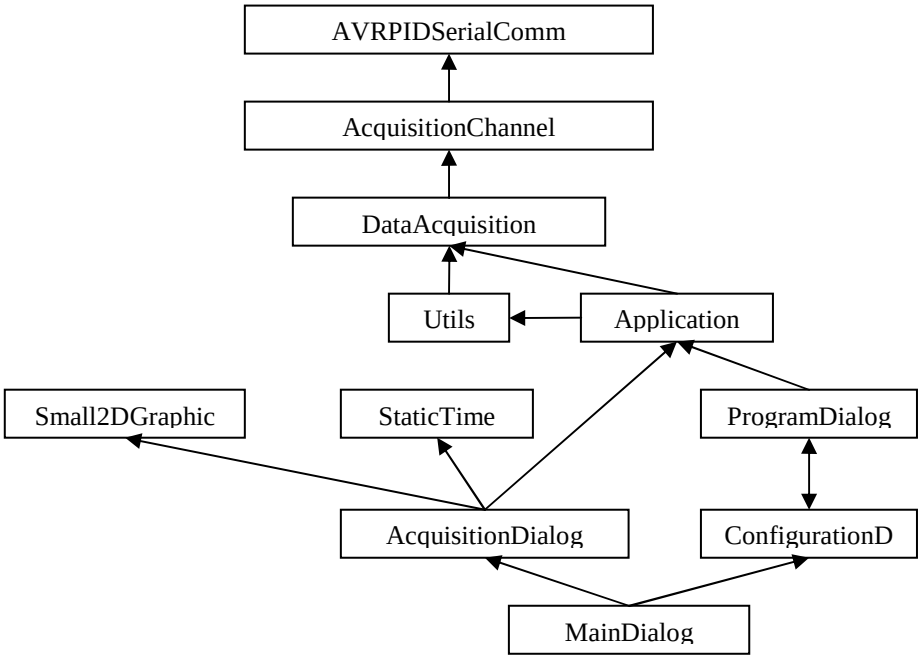


Figure 4. User program dependencies

4. CONCLUSIONS

This application is very flexible and makes data acquisition from an industrial process and controls the process parameters at a good precision and at a low price.

The embedded system designed can acquisition data from four channels but in the same time can control the industrial processes and all are making in real-time.

The results are very encouraging and on the future they wish to extend the interface capabilities by attaching of a supplementary conversion circuit by RS232 into RS485 and thus they are growing the range of the interfaces which the system can communicate with.

5. REFERENCES

[1] ***, *8 Bit AVR Microcontroller with 16 Kbytes In –System Programmable Flash – Atmega162,* ATMEL, 2513H-AVR-04/2006.
[2] ***, *WTADC-Module Specifications,* Weeder Technologies, 200-2006.
[3] ***, *WTDAC-Module Specifications,* Weeder Technologies, 200-2006
[4] ***, *+5V-Powered, Multichannels RS-232 Drivers/Receivers MAX220-MAX249 Features,* MAXIM Integrated Products, 19-4323; Rev 10; 8/2001.