CONTRIBUTION TO GAS DISTRIBUTION AUTOMATION

DOCTORAL THESIS SUMMARY

PhD Candidate:

Lecturer eng. **Traian Turc**

Scientific coordinator:

Professor eng. **Gavril Toderean,** PhD

-2005-

INITIAL STAGE IN GAS DISTRIBUTION

The main purpose of gas compression stations is to raise gas pressure from the production tubing in order to transport gas trough long pipes to consumers.

The gas compression stations are made using many compressions aggregates.

The most used compressions aggregates are electrical compressors and gas compressors.

Without remote monitoring and control systems, gas producers are forced to incur the high costs associated with many services activities.

To improve gas compression station reliability and safety it is strongly necessary to add control function and real time remote monitoring.

This thesis presents a microprogramming system for industrial process flexible enough to be moved from different types of gas compressors.

The system presented below provides accurate and real time remote monitoring and control function.

The transfer of acquisitioned data is made through local networks, through private networks INTRANET or through global network INTERNET.

The complexity of gas compression stations needs a sophisticated system for control and data acquisition. The cabled systems can't keep up with tremendous evolution of industrial systems. Only micro programmed system can adapt fast and continuously with evolution of industrial process.

"DASYS" MICRO PROGRAMMED SYSTEM MADE FOR INDUSTRIAL PROCESS CONTROL

Process controller DASYS makes data acquisition, leads industrial process according to the algorithm written in micro program, signals different events using flesh light, displays acquisitioned data using alphanumeric display, sends data to computer and receives data and orders from remote computer.

DASYS has a modular structure that allows users to attach the desired number of input or output channels, digital or analogical.

DASYS is based on ATMEL AT89C52 micro controller. The application program is written in flash memory. The program codifies the algorithm of industrial process function. DASYS is a universal system for process control because has a modular structure and can be programmed for different industrial process.

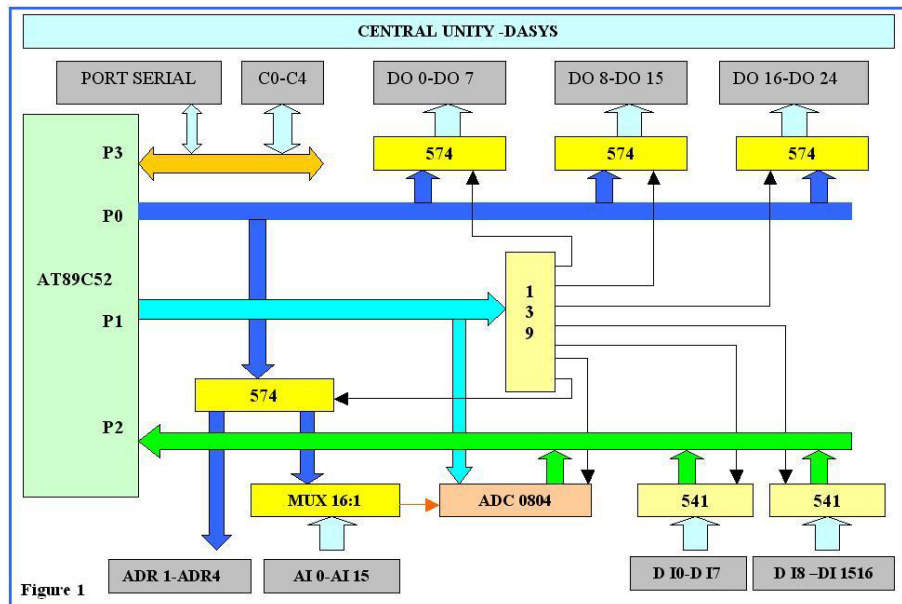The "DASYS" micro programmed system has a lot of advantages such as:

- it contains a nucleus of programs called micro operating system that handles the hard resource of the system. To implement a new application one must write only specific application program and the nucleus remains unchanged;

-it can be upgraded with any number of channels of any type (input, output, analogical, digital);

- it has a serial interface for communicating with remote computer ;

- it has a programmable number of led soft functions to indicate the status of industrial process and alphanumeric display for local display of different value parameters.

The central unity UC (see figure 1) is based on ATMEL AT89C52 micro-controller compatible with INTEL C51 micro-controller family.
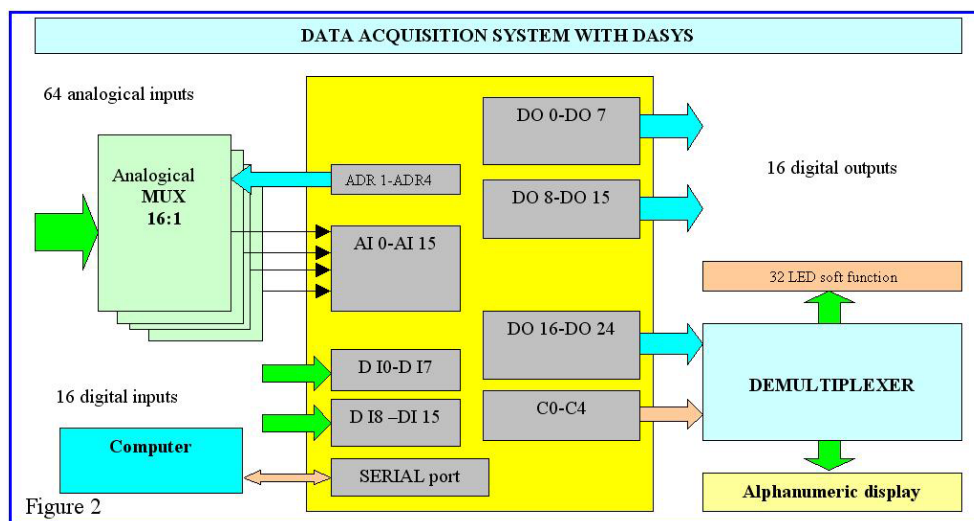

Figure 1

The AT89C52 micro controller has no analogue numeric converter (CAN). For that reason the UC has 8 bits CAN and 16 input analogical multiplexes.

The digital inputs and outputs are buffered and a serial port is buffered with a special driver RS232 that allows connection with PC computer.

For future extension, UC provides the following external addresses (ADR1-ADR4) for addressing other modules that increase the number of input or outputs.

The extension of inputs and outputs using new module, the connection with alphanumeric display, with flesh light and with the computer is showed in figure 2.
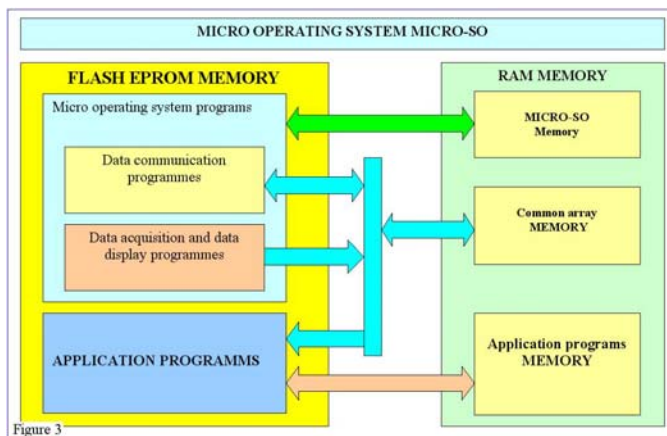

Figure 2

The micro operating system manages the entire hardware resources of the controller and solves data transfer request. The application program use micro operating system in order to access hardware resources and to receive or to send data.

The flexibility of DASYS process control is given by micro programming facility. The hard configuration possibility is important, but the programming facilities are more important. The micro operating system is the same in every application. Only the application program code is adapted to the new application.

The micro operating system manages the hard resources and is necessary in every application.

DASYS micro operating system runs three major tasks named threads:

Figure 3

Thread 1: Data acquisition, data display on alphanumeric display, flesh light signal, refreshes output digital data

Thread 2: Computer data communication –transfers data from and to a remote computer

Thread 3: Application program-the main program

The specific data of industrial process are being sent through serial interface on the remote master computer demand.

Using a WEB sever the acquisitioned data can be sent to a large number of users, in WEB pages format.

The WEB server collects data and generates the WEB page in a standard format or in a client's requested format.

Data are acquisitioned using a data acquisition server that is in charge also of data transfer through Internet. The server is both a data acquisition server and a WEB server. The purpose of the WEB server is preparing data in HTML format or DBF format and then using MIIS to send data to client's request.
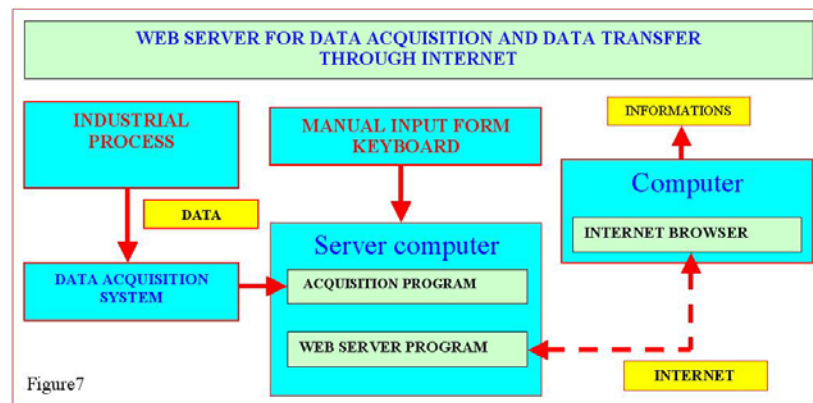
The clients using a browser for WEB pages can display data.

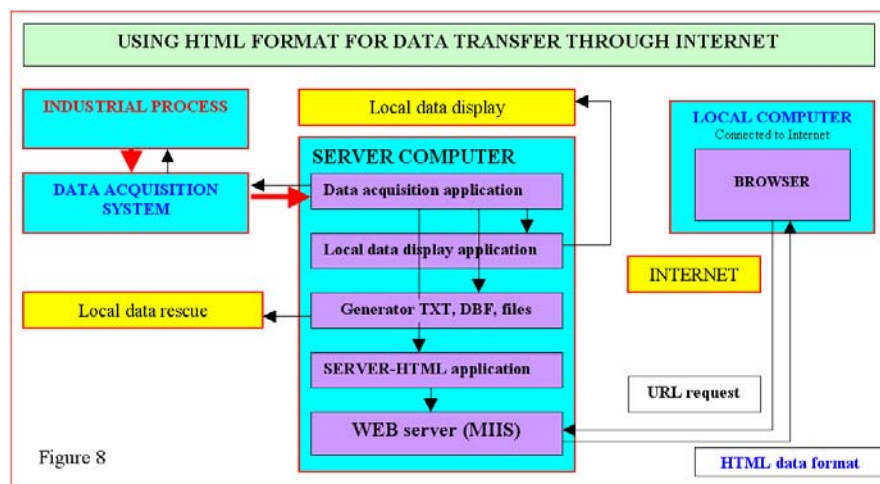## Data Acquisition and Transfer Through Internet

For sending acquisitioned data to long distance to a large number of users at low costs it is better to use the public network Internet.

Using this network means a major advantage: the possibility of displaying data using any computer connected to the Internet using any kind of Internet browser.

The users don't need expansive and sophisticated programs for data acquisition and data displaying. (See figure 7)

Figure7

Data transfer and display can be done using different methods. A simple way is using data files in HTML (Hyper Text Mark up Language) format used in the documents' transfer through Internet (see figure 8).

Figure 8

The local computer connected to the data acquisition system, takes data and after data' processing makes data display. Acquisitioned data are saved in different formats from time to time to the local disks for future using.

For data transfer there is generated another special file in HTML format with acquisitioned data and even with data briefing from the previous period. The program, which prepares data in HTML file, is called SERVER HTML application.

The WEB server performs the HTML file transfer to the client's URL request.

Users can display data on the local computer connected to the Internet using any available Internet browser simply addressing the server that contains the HTML file with acquisitioned data.

The Internet address contains the URL (Universal Resource Locator) of the resource, in other words the name of the server and the name of HTML document.

The content of the resource is permanently changing. Any display of this resource means displaying new data.

The HTML file generated by the HTML server can contain data and other TAG-s that allow users to request specific data.

If the browser displays repetitively the HTML file we have a real time displaying.

The method described previously is very simple, the data access is very fast, and the users number simultaneously connected depend only on WEB server performances.

The users don't access directly the acquisition server and they can't break down the data acquisition by a large number of requests.

The disadvantage of this method: the users can't make a particular request, they can only display data prepared by HTML server.

To solve this problem there have to be used a client server application when the client makes some requests and the server provides only requested data.

Gas Compression Stations Remote Monitoring and Control Function

Every compressor is equipped with "DASYS" in order to make control function and real time remote monitoring.

The revolution of compressor is permanently controlled by "DASYS" according to the feedback control system showed in figure below (figure9).

The purpose of the feedback control system is to guarantee output y (compressor revolution) near set point (300 rpm), despite the system parameters disturbances.
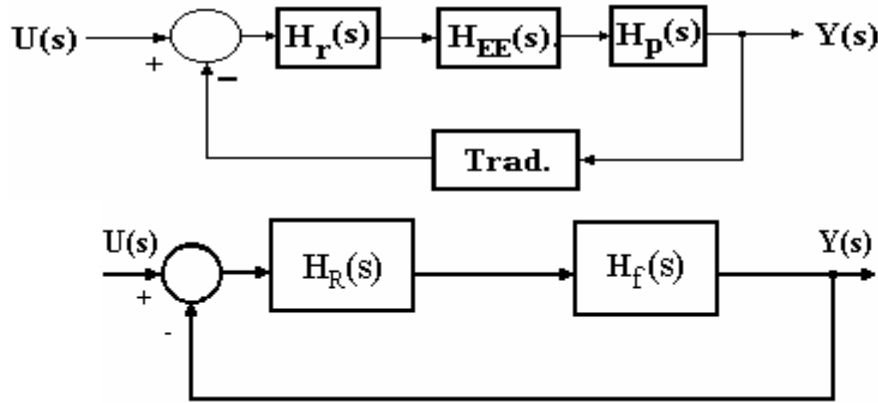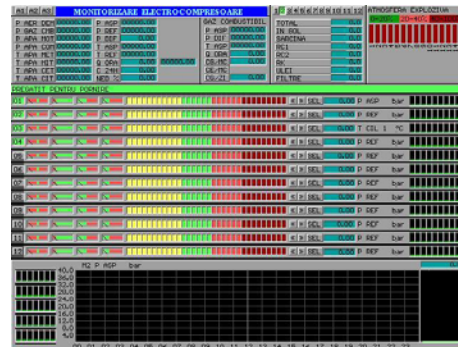

Figure 9 - a basic feedback control system

With $H_F(s) = k_T \cdot \dfrac{k_{EE}}{T_{EE}s+1} \cdot \dfrac{k_p}{T_p s+1}$ and $H_R(s) = K_R\left(1+\dfrac{1}{T_i s}\right) = \dfrac{K_R}{T_i s}(T_i s+1)$ is found the

relation needed to implement the regulatory algorithm in "DASYS" controller:
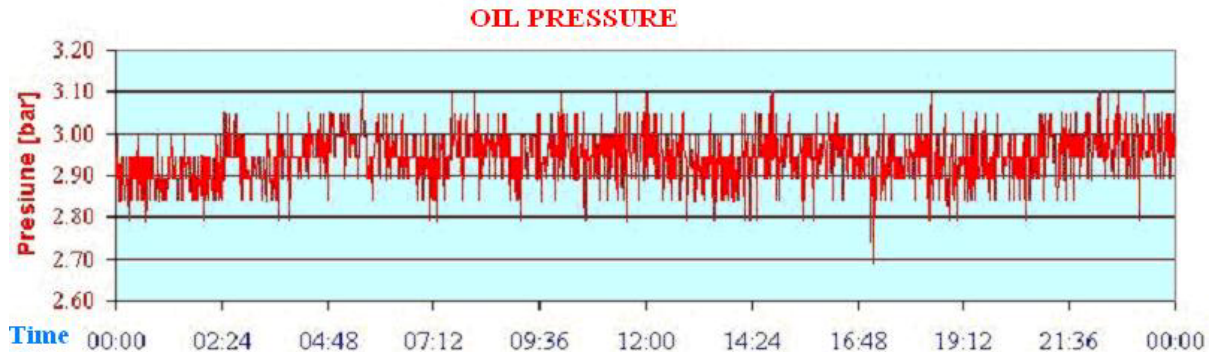
$$r_k = 3,5(u_k - y_k) - 3,44(u_{k-1} - y_{k-1}) - r_{k-1}$$

Data sends from every compressor are centralized and displayed at station office.

The central computer from station office collects data from compressors and sends orders to every compressor.

Human Machine Interface (HMI) includes an overview screen list and diagrams for example: oil pressure (see chart below).

Acquisitioned data from gas compress systems can be also exported in different formats (for example in Excel format) or sent thought Internet and displayed using any Internet browser.