The Research and Industrialization of an Accelerator Control System for Large Container on-line Inspection

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Abstract

An economical and practical design of the accelerator control system for large container on-line inspection system is presented in this paper. The system consists of one Pentium computer and one PLC, which are connected by an RS-232C cable and forward a simple distributed system. CSMA/CD protocols are adopted to prevent data collisions in communication, and Windows95 is employed as developing platform. In order to improve the response speed of the system, several analogue modulators are used.

1 Introduction

A large container inspection system THSCAN used mainly for customs has been developed by Tsinghua University in the Eighth Five Year of Science & Technology. It's high time to industrialize this technology. As one of the most important parts of the system, the linac has to be controlled safely, efficiently and easily.

The THL-9 linac consists of the following subsystems: a 9MeV traveling wave accelerator tube, a beam transport system which includes an electron gun, focusing and steering coils and magnetic quadrupole lenses, a microwave power source and a transmission system, a vacuum system, a cooling water and pressing gas system. After simplification about 86 digital signal channels and 22 analogue signal channels needing control.

2 Control system overview

In this system, the number of digital signal channels is much larger than that of analogue signal channels. Output information is less than input information. So we employed a control architecture as shown in Fig. 1.

The Programmable Controller is applied as local controller. In this system, we chose CQM1 of OMRON Co., Japan. This kind of machine supports Host Links and PC Links, executes instructions quite quickly (basic executing time 0.5 mS), and has a large capacity for programming (7.2K). Above all, it's very reliable, beautiful and small. A Pentium computer is used as the inspection station. Both are connected by an RS-232C cable and form a simple distributed system. The transmission rate between them can be adjusted from 1200bps to 19200bps.

The process controller fulfills real time control of the linac, which is the main task of the setup, and it has several functions:

- Scanning: Sample the field data, achieve the programmed control, coordinate start, stop and breakdown detection of the machine.
- Communication: Transmit required data to the inspection station and receive the command from the upper supervisor.
- Alarm: Identify the status of the machine and output an alarm when necessary.

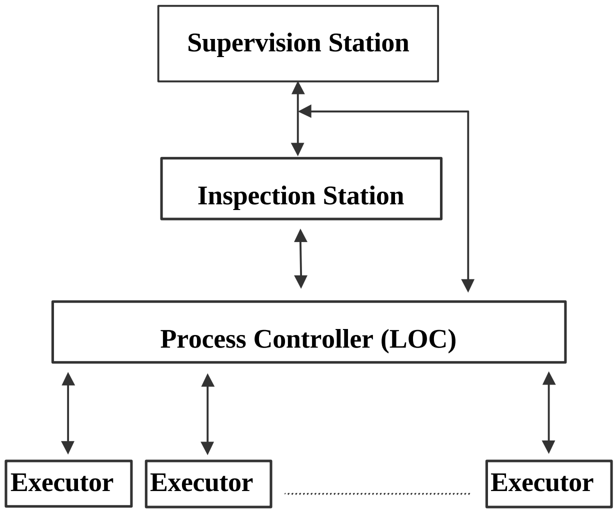

Fig1. THL-9 Control System Architecture

The Inspection Station is comprised of a Pentium computer, an industrial TV and a stethoscope; Windows95 is selected as developing platform and VB4.0 Enterprise and VC++4.2 as tools. The operator can inspect the machine from the CRT screen, and debug the machine dynamically by employing the engineer's keyboard. It has functions as follows:

- Real time database management: Analyze the data sent from the local controller, obtain relative information and respond quickly.
- Graphical display: Display the status of the machine and of some crucial parameters.
- Dynamic debugging: an engineer can debug the system dynamically using the keyboard: change the baud rate, the sampling interval, and RS-232C port time; debug the subsystem one after another; adjust parameters on line; detect the breakdown.
- Storing Breakdown Information: Analyze the breakdown code, display and store the breakdown Id and time.

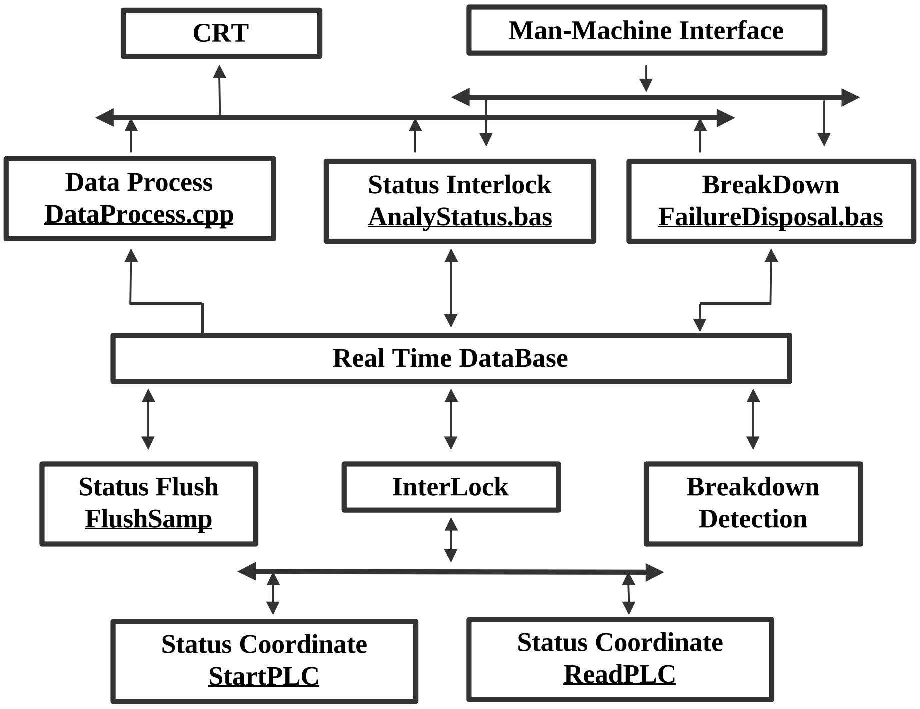

Fig2 Software Architecture of the Control System

- Communication: Realize two_direction data flow.

In order to keep the influence of breakdown as small as possible, the local controller can run independently.

3 Software architecture

In this course of optimization, we improved the software as well. The improved software structure is shown in figure2. The data of all the subsystems of the machine are scanned and sampled by FlushSamp which runs on the PC, and the inspection station flushes the data into the real time database. DataProcess.cpp operates the data and displays them on the screen. The operator can type a command at any time. The control functions are executed mainly by StartPLC and ReadyPLC.

The real-time database architecture can be described as follows:

```
Structure Control_DB
{
        Private:
                Char *Channel_Name;
                Char *Scan_Time;
                DataType Channel_Status;
                FieldType Field_Name;
                Char *SubSystem_Name;
        Public:
                void Field_Operator(FieldType *Fin);
                void Alarm_Detection()
                DataOutType Local_OutPut_Document(*);
}
```

To prevent data collisions in communication, we employed the simplified CSMA/CD protocols to coordinate the two members of the system. It proved worthwhile. At the same time, we applied some new technologies, such as self-protection and combined detection, in the programming of the PLC, which improved the reliability of the system.

4 Conclusions

Today, this system has been tested in field operation. We find that the man-machine interface was improved significantly and the machine is more reliable and easier to operate. We still need improvement in the next thorough trial.

Finally, we have to mention the integration of the control system. From the very beginning, one of the major goals of this optimization was to achieve miniaturization of the control system. We managed to integrate the control system in a cabinet, which is as large as three drawers. Above all, the cost of the system has been reduced dramatically.

References

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