

PXI BASED PLATFORM FOR FOOD PROCESSING APPLICATIONS

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Abstract: There has been a huge demand for instrumentation and control platforms for food processing applications. Such platforms with novel techniques and virtual instrumentation provide not only control but offer re-configuration of logic in real-time; modularity and better human interface etc. Prime design concerns are its mechanical, electrical design and the controlling part. The controller NI PXI-8106, a Field Programmable Gate Array (FPGA) based controller, consists of a Core 2 Duo™ processor with real time embedded software, integrated I/Os, which offer both data acquisition as well as controlling mechanism. The control logic can be designed using LabVIEW™ and then complete VI can be downloaded in to the FPGA of PXI controller; after processing these field inputs, controller will yield controlled signal. In the present work, one host computer and other remote target machine are interfaced and logic was developed at host computer which can be downloaded into the remote target in the form of a bit-stream file to program FPGA's Configurable Logic Block(CLB). Multi-tasking can be done for various processes by deciding the hierarchy of the operation and respective Core of the processor. In this application, virtual instrumentation plays an important role and user friendly- HMI (Human Machine Interface) can be done by Front Panel of LabVIEW™- VI. This paper also discusses design aspects, problems and issues related to the monitoring & controlling of various processes involved in food processing applications.

Keywords: PXI, CLB, FPGA, Virtual Instrumentation, HMI, Multi-tasking

1. INTRODUCTION

Although, there have been various types of food machines available in the market from different manufacturers, these are huge in size, costly and unable to prepare the traditional Indian food items. Hence, there has been a great deal of requirement for food machines capable of producing traditional Indian foods with low cost and small in size. Automation/ instrumentation of such machines emerges a new category of processors/ controllers. When requirement is modular, reconfigurable and more flexible, PXI controllers are the best options. PXI platform is a combination of modular hardware and flexible software which can work together to meet the application of data acquisition and control without any constraints.

Automation of proposed modular machine comprises of various modules such as temperature control unit, motion control unit, image acquisition and image processing and many more to control the process and monitor for uniform quality throughput. The proposed system consists of an inlet unit for feeding ingredients into the machine. This inlet unit comprises of a hopper and sensors & actuators to control the ingredients. Once ingredients are fed into the hopper, these can be mixed by means of a blender and mixture will be ready. Small pieces can be cut from the mixture and passed over on the moving conveyer belt. These raw pieces can be passed over to the next conveyer belt while baking can be done by heating these pieces beneath the rolling conveyers. Then next to this, some storage

can be provided to collect the throughput.

Though the mechanism appears simple, a lot of automation will be needed for the preparation of mixture, cutting it into small pieces, baking and storage. Starting from hopper end, measured quantities of ingredients can be fed into the hopper, so that composition remains same. To do this, say, a load cell will be needed to weigh the actual mass of the flour being fed to the machine. To control the cutting, pneumatic sensors will be needed. To control the baking of pieces, temperature control is necessary. Thus, this machine offers a good mechanical design along with a complete automated system to control its operation.

In addition to the above, a good Human Machine Interface (HMI) will be required so that we can provide a better user friendly machine to its users. For this, we can use either a touch panel computer (TPC) or PC based control so that we can monitor the real time conditions of the machine and to do necessary changes in process parameters and to maintain the uniform quality of throughput.

It must have some provision for up-gradation and further betterment of this food machine and compatibility with other machines, say for data acquisition or process control.

2. AUTOMATION

The system is designed in such a way that it can work automatically or semi-automatically. In this system, mechanical design with compatible

automation is required for better control over the machine. To achieve this, different types of sensors can be installed on the machine at different locations and then data from these sensors can be gathered by NI-PXI 8106. Then after processing this data and applying control logic by means of PXI dual core controller, process can be controlled by actuating appropriate actuators installed at various locations on the machine.

Being an automated system, it must have some kind of embedded processing, which requires data acquisition, data processing, control and to display real time machine conditions.

Automation of this food machine requires some sensory signals to be fed into the control unit of the machine, i.e. controller, where all necessary signal processing is done after applying necessary signal conditioning on the acquired signal. These sensors may be of different working principle and generating different output.

The heart of the system is the data acquisition and process control which can be done by installing various sensors at desired locations. NI's PXI-8106 primarily consists of Chassis on which various data acquisition modules are attached through USB 2.0 and these modules can also be connected to a PC so that it can also be used as PC based instrumentation for process control application. This PXI system offers fast data acquisition system with 1GB/s bandwidth so that more sensors can be connected to it. It has connectivity with GPIB (IEEE 488), RS232 serial port, and IEEE 1284 ECP/EPP parallel port. It works with Real Time and Windows operating system.

Now, the actual data acquisition is the key factor to control the whole operation. NI-PXI 8106 can be installed on the actual machine and only this system is sufficient to acquire sensor's data and control the process. Data acquisition can be done by using various available techniques, say using NI-DAQ cards or any other data acquisition cards. But it would be better if data acquisition and control can be done by the same system, then NI-PXI is the perfect solution to this problem.

PXI based process control platform bring monitoring and control activities in same frame so it provides easy to understand and control interface.

3. DISCUSSION

This automation design platform offers control for various field processes in a convenient manner. An extra sensor node can be connected to the SCB (Shielded connector block) of the system regardless of their nature, i.e., sensor is yielding analog or digital output. Data acquisition and processing can

be done on respective FPGA target, here NI's PXI 7831R. These are separate targets and can be programmed remotely by means of Host-Remote configuration system.

The front panel (Fig.1)consists of monitoring and control for temperature and motion. Signal acquisition and display is provided on it along with control and selection to various sensors/ actuators. One such platform has been designed using LabVIEW™ graphical programming environment for temperature and motion control(Fig.2).

This platform is purposely designed to monitor and control processes of Automatic Chapati Machine. This machine could be automated for temperature, motion and uniform quality production. Being modular it can be further extended to Automatic Poory Fryer Machine by adding few extra modules.

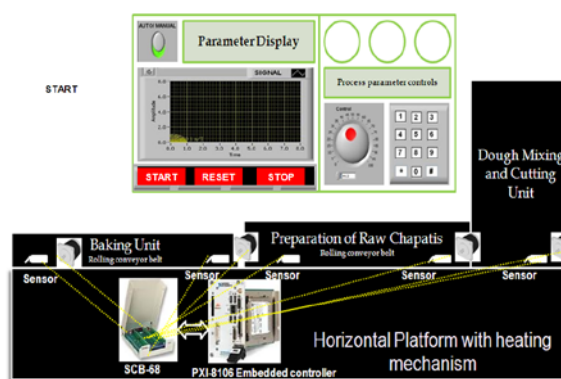


Fig. 1 Front panel

PXI system offers control in two manners: Windows based control and Real-time control. In the first kind, all control logic developed in the host computer and it is almost like PC based instrumentation but differs in a manner because these codes are deployed on a FPGA target. In the second kind PXI works as a remote target and control logic develop in Host computer. A bit file generated in Host computer from HDL codes extracted from NI FPGA compile server, is then downloaded to the respective FPGA target remotely located. In this condition , PXI works like an embedded controller but Real time re-configurability, i.e., control logic can be changed any time without actually stopping the process.

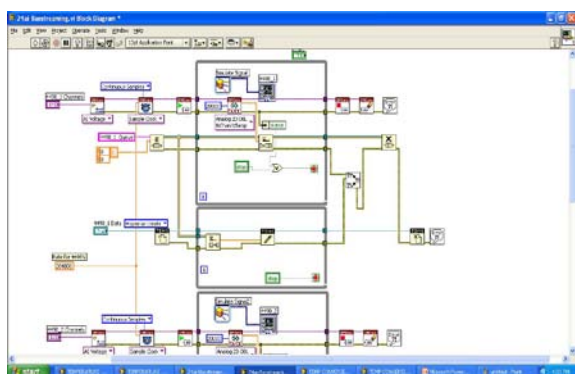


Fig. 2 Block Diagram

Quality monitoring, hence control, can be done at the output end by installing appropriate sensory and vision sensors. Data from these sensory and vision system can be helpful to evaluate and grade the throughput.

4. CONCLUSION

This design platform supports a number of sensors/ actuators with different ranges of output/ input. The main advantage of this proposed system is that the machine can be reconfigured as per the requirement. Complete automation can control the quality and maintain uniformity of throughput. Further, with complete automation and user friendly-HMI, it will be able to provide monitoring and control at a low cost and power.

5. ACKNOWLEDGEMENTS

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