Integration of Image Quality Inspection Equipment into Production

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Abstract

The benefits of objective image quality analysis are well accepted. The stand-alone image quality analysis systems that are common in R&D labs have been making the migration to production environments. IQ inspection stations are often set up for end of line testing in printer manufacturing lines. However, it is often desirable to incorporate image quality instrumentation into the production line in a more integral fashion. Integration allows for seamless product and data flow, which increases throughput and efficiency. The ability to integrate a system into production requires common communication protocols between the system and controlling software packages, as well as reasonable options for system control via independent external software regardless of platform.

This paper includes a description of several options that are available for the integration of a commercially available image quality inspection system into production lines.

Introduction

Integration of machine vision in today's production lines is quite common. Part tracking and inspection of assemblies is often achieved via machine vision inspection systems. So the concept of integrating vision systems into production is not new. However, the decision to streamline production lines and processes is driving the integration of many instruments that used to be off-line and stand-alone into the manufacturing line--including image quality analysis systems. This transition has brought certain challenges since different instruments have different platforms and cross platform communication has had a reputation for being tricky. It turns out that this is not the case. Appropriate choice of communication protocols and control systems can enable seamless integration of image quality measurement systems into the production flow.

For example, ImageXpert (IX) is a commercially available image quality analysis system with many different hardware configurations. The software is consistent from system to system so identification of interconnectivity options holds true across all of the products in the product line. As it turns out, there are several simple options that cover most of the interconnectivity requirements to enable full integration.

Common Communication Methods

There are several scenarios that can meet most interconnectivity requirements.

Digital I/O

The simplest method of integrating the image analysis system is via digital inputs and outputs. Inputs to the IX system determine which inspection sequence to run and when, and outputs typically include Pass/Fail, On Line, and Inspection Complete. The host can be a PC or a PLC (Programmable Logic Controller).

Simple handshaking provides a measure of reliability: if a single signal is used for pass/fail, the host must wait for Inspection Complete before looking at Pass/Fail. The IX system must clear Pass/Fail and Inspection Complete when a start signal is received.

A disadvantage of such a simple setup is the lack of quantitative results at the host. While the computation of statistics and the detection of trends is available at the ImageXpert system, neither this information nor raw data are transmitted to the host.

Network File Sharing

At a slightly higher level, interconnectivity can be achieved through the placement and retrieval of data or image files to or from shared directories on a network. For example, ImageXpert can be used to evaluate and report on images captured at various points along the production line. Images could be captured online and ported to the IX engine where analysis could take place. Correspondingly, data produced through IX analysis can be sent to other computers on the network for part disposition and performance tracking. In these examples, the IX engine is external to the production process, and all intercommunication takes place through data or image file sharing.[1]

As an example of file sharing, a scanner manufacturer needed to assess the quality of scanned images. The IX system was connected with Ethernet hardware to the PC running the scanner and IX polled the PC for newly scanned images. When a new image was detected it was uploaded to the IX system, the analysis program was run, and the results sent back to the PC.

In the above example, peer-to-peer file sharing was facilitated with a third-party networking application loaded

on the PC. There is also software available for the IX system that does essentially the same thing. In both cases the underlying method of transmission of the data is an industry standard protocol, TCP or IP. Using either configuration, file-sharing connectivity can be established over a Local Area Network, a Wide Area Network, or even over the Internet.
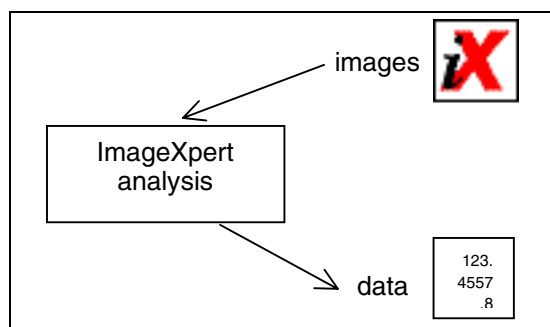

Figure 1. Diagram of file sharing scheme

If a higher level of flexibility and control is desired, there are several common protocols that allow more sophisticated communication between the remote computer and the ImageXpert system. The three that we will cover here are FTP, TCP and LabVIEW (as a specific example of TCP).

FTP

Another option is to use FTP and a set of predefined commands to run IX from a remote computer. Once initialization is achieved, data can be looked for in a specific location on the computer housing ImageXpert and taken by the remote computer to be processed via a macro into whatever format is desired. The computer hosting IX would be transparent to the user.

The set of predefined commands might include, in addition to information about what target or pattern to inspect, a request to retrieve an image, change passwords, print a report or change the destination for saving results.

Sample Code

The following is a very simple example of interconnectivity via ftp in Visual Basic. It shows how you can connect, log in, list the contents of a directory and log out. In real life, this code would be associated with a "form" - which is the name for the VB interface window.

```
Private Sub cmdConnect_Click()
Winsock1.Connect "xx.x.x.xxx", 21
End Sub

Private Sub cmdLogin_Click()

Winsock1.SendData "USER ix customer" & vbCrLf
Winsock1.SendData "PASS sensible" & vbCrLf
End Sub
```

```
Private Sub cmdLogout_Click()
Winsock1.SendData "QUIT" & vbCrLf
End Sub

Private Sub cmdList_Click()
Winsock1.SendData "LIST" & vbCrLf
End Sub

Private Sub cmdClearText_Click()
Text1.Text = ""
End Sub

Private Sub Winsock1_DataArrival(ByVal bytesTotal
As Long)
Dim strData As String
Winsock1.GetData strData
Text1.Text = Text1.Text & strData

End Sub
```
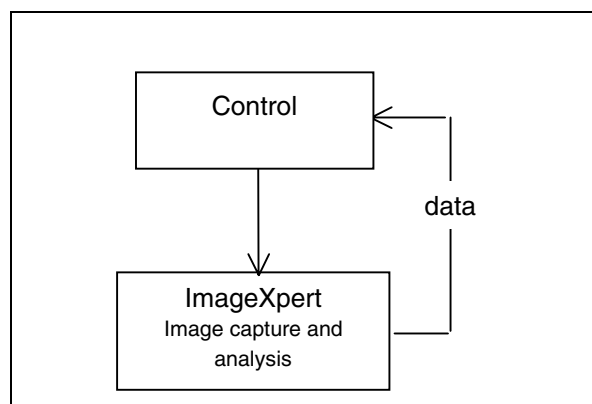

Figure 2. Diagram of FTP options

TCP

TCP (Transmission Control Protocol) is a reliable two-way communications method that supports error detection and guaranteed delivery of messages. TCP can be used to run IX from a remote computer, and to return data from IX to the remote station either as a file or as single strings. In this way, the data can be processed using a custom spreadsheet or a statistics software package. IX can perform analysis but custom analysis can be performed on the raw or processed data on the remote computer if the user prefers. The computer hosting IX is "transparent" to the user in this scenario as well. This is one of the fullest functioning options since ImageXpert can be run from a remote server.

Using TCP allows the IX system to send data to the remote server once analysis is complete. This is useful for inclusion in databases and off-line tracking. However, TCP options can also include sending just the measurement results or the raw data as they are computed so that control charts can be updated in near real-time.
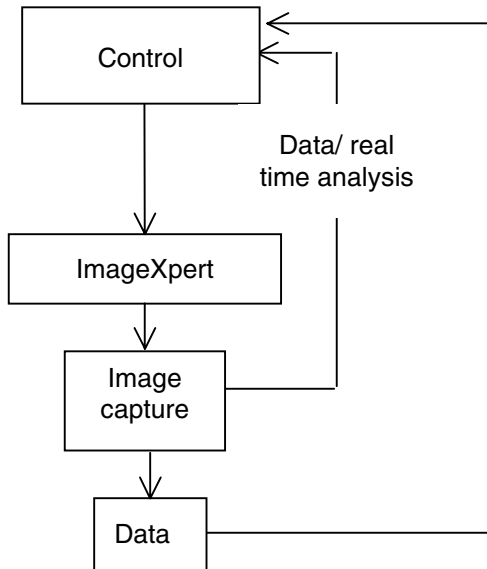
Figure 3. FTP option diagram

LabVIEW

LabVIEW is a well-known software package that assists in automation control, instrument control and control over data flow. It is a staple in many production environments. Several of our customers have successfully integrated IX into their production lines via LabVIEW. [1,2]

LabVIEW contains the built-in commands necessary for TCP networking, just as IX does, including VIs (Virtual Instruments) to perform functions such as

TCP Open Connection
TCP Write
TCP Read
TCP Close Connection

The LabVIEW software can be running on the same platform as IX or on a different one. Again, this allows the user of the system to design the scheme that makes the most sense to their production process and data control requirements.

Conclusion

The migration of stand-alone image quality analysis systems into the production line has prompted an examination of the available options. The goal of seamless integration is clearly an important factor driving purchasing decisions for production equipment. ImageXpert systems have been successfully integrated into several production lines via common communication protocols between the system and controlling software packages. Many reasonable and familiar options for system control via independent external software exist. Incorporation of image quality instrumentation into the production line in a more integral fashion allows for seamless product and data flow, which results in an increase in throughput and production efficiency. An additional benefit of being able to transition measurement equipment and test methods from R&D to production allows for continuity in performance tracking and aids in internal communication.

References

1. Randy Dumas, et al., *Image Quality Testing on the Production Line,* IS&Ts PICS: 2000 pp. 114-116
2. Mark Klino, *Automated Inkjet Print-head Quality Analysis,* IS&Ts NIP 16: 2000 pp. 400-402

Biography

Scott Cole is a Senior Software Specialist at ImageXpert in Nashua, NH. He worked for 11 years as a machine vision engineer at RVSI Acuity. Before that he wrote factory automation software at Texas Instruments in Austin. He has a Master of Science degree in physics.

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