

## **NI LabVIEW™ and Vision Products Monitor Pharmaceutical Processes**

by Bengt Lagerholm, Senior Engineer, Jonas Johansson, PhD, Staffan Folestad; Professor;  
Analytical Development, Pharmaceutical Analytical R&D; AstraZeneca R&D,  
Mölndal, Sweden

### **Products Used:**

LabVIEW  
IMAQ™ Vision Builder  
IMAQ Vision  
NI-IMAQ™  
Measurement & Automation Explorer  
IMAQ PCI-1408 Image Acquisition Board

**The Challenge:** Developing a system that continuously monitors homogeneity in blending processes, with the option to act as an OPC server.

**The Solution:** Illuminating the blending process with Infrared (IR) light, acquiring images with a Near Infrared (NIR) camera, and visualizing the process evolution in a trend plot to define the process end point.

### **Controlling Homogeneity**

In pharmaceutical formulations, such as tablets and capsules, the lack of homogeneity and content uniformity (the same amount of active substance in each unit produced in a batch) leads to rejection of the entire batch. To prevent this, we must carefully control homogeneity in our blending processes. We developed a system for taking continuous homogeneity measurements. This control system monitors physical processing in the manufacturing of solid dosage forms in order to assess homogeneity. Our work focused on NIR as a spectroscopic tool for visualization of chemical content by imaging in the reflectance mode. We developed a simple and cost-effective method for doing this using National Instruments LabVIEW graphical development environment, IMAQ Vision products, and a NIR CCD camera.

The interaction of most organic components in pharmaceutical blends/formulations with NIR light depends, to some extent, on their chemical/physical properties. By illuminating a specific area in the process vessel with a source containing light in the NIR region and regularly acquiring images, we accomplished visualization of the chemical content.

To achieve this visualization, we used a NIR CCD camera with a spectral sensitivity of 900 nm to 1700 nm. With this camera, we increased the selectivity to the analyte(s) of interest by using a band-pass optical filter in the imaging side, in front of the lens of the camera. We illuminated the sample area of interest with a regulated 55 W tungsten lamp. We then collected images using a National Instruments high-resolution IMAQ image acquisition board, an 8-bit monochrome frame

grabber. Before the image acquisition session started, we defined the onboard region of interest (ROI) using National Instruments Measurement & Automation Explorer to image the proper area of the process sample.

### **Easily Acquiring Images**

We chose LabVIEW to build the system software because of its intuitive and straightforward way to solve automation of analytical measurements. In particular, handling large vectors and matrices is easy and fast using LabVIEW. Using NI Vision Builder and Vision software, we can acquire pictures in three ways:

1. Manually – images are acquired each time the operator clicks a button
2. Time based – images are acquired continuously at an interval set by the operator (default)
3. Trigger based – an external trigger signal from the blender or a control system initiates acquisition

### **Summarizing Chemical Information**

A problem when collecting and processing images continuously is the large amount of data forced through the system during a limited amount of time. Depending on the dynamics of the process involved, we can acquire images on the scale of seconds or faster. We used NI Vision software to correlate each pixel value in the picture to NIR reflectance of the substances involved and to summarize chemical information in the image using a histogram. The software automatically saves time-stamped histograms in a matrix file.

To extract blending process information from the data matrix, we use principal component analysis (PCA). PCA is a multivariate projection method that extracts and highlights systematic variation in a data matrix to give us an overview of dominant patterns and major trends in the data. PCA treats each of the 256 bit levels in the histogram as a variable; therefore, we can think of the histogram as a point in a 256 dimensional variable space. For each new histogram of gray levels, a new point in the variable space is added. For each point added to the swarm, a line in the variable space is calculated that best approximates the data in a least squares sense. This is a principal component, PC, in this case the first principal component, PC1. We can calculate additional components, PC2, PC3, etc, orthogonal to the first component explaining more of the variation in the data. LabVIEW then projects each point on this line, giving a new value called score. A graphical presentation of this is shown in Figure 1. A LabVIEW solution for the PCA is given in Figure 2.

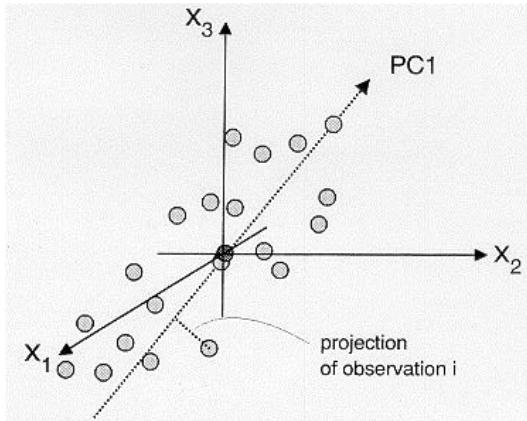


Figure1: Point Swarm with Its First Principal Component, PC1, Drawn

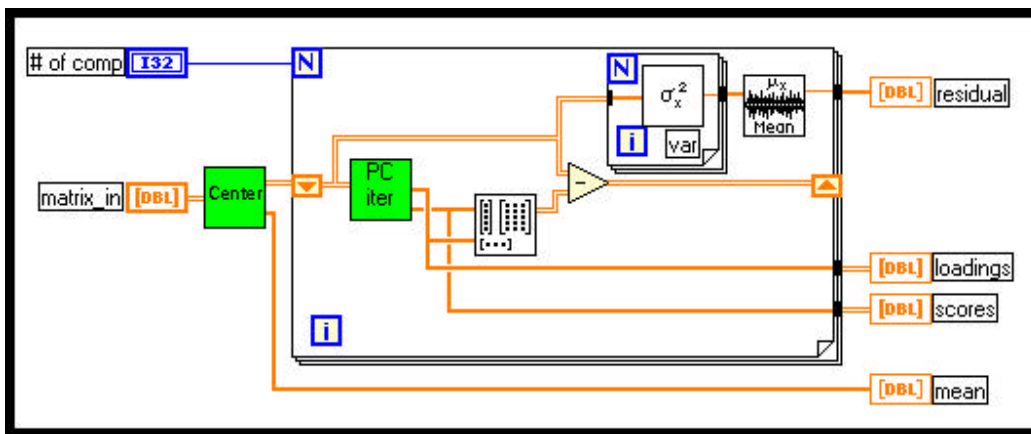


Figure 2: Calculation of PC – in subVI Center, variables are centered round its mean-value. SubVI PC-iter is an iteration process calculating the best fit for PC vectors.

LabVIEW displays the blending process scores in different ways:

- Score plotted versus number of observation gives us a trendplot with information about how the process evolves and major trends and dynamics in the data. We can follow the blending process and decide when the end-point is reached. (See Figure 3.)

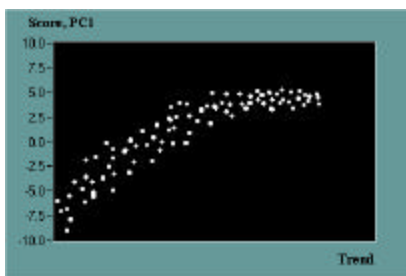


Figure 3: PC1 Versus Observation – Giving a Trend-Plot

- PC2 forms a plane in the multidimensional variable space. Plotting the observations into that plane gives us a two-dimensional window into the variable space. Two observations with similar properties tend to lie close to each other. Plotting PC1 versus PC2 shows us views of the process

starting at a point in the diagram and as the process evolves, creeping into a smaller area of variation. This area is the process end point. We can define the size of this area. (See Figure 4.)

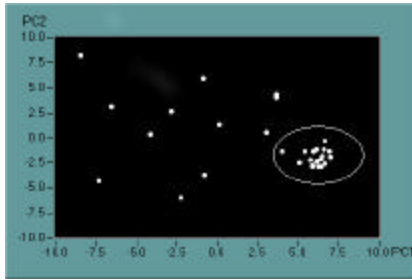


Figure 4: PC1 Versus PC2 – Forming an End-Point Area

- Another approach to presenting scores and giving more spatial information is dividing the image in smaller areas and calculating PC for each area. Plotting all PC in a trend plot gives extended information about process dynamics, and the end point can be more easily estimated. (See Figure 5.)

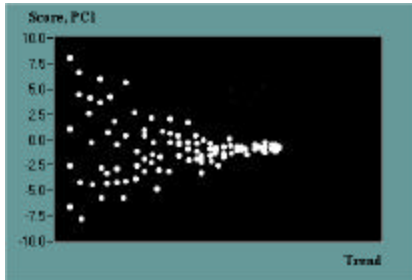


Figure 5, Trend Plot of PC – Image Divided into Four Areas.

LabVIEW, IMAQ Vision software, and NI imaging hardware facilitated rapid prototyping and implementation of a new and advanced measurement application for chemical analysis using vision analysis. Using LabVIEW and IMAQ, we easily developed a visualization system to monitor and control our pharmaceutical homogeneity processes.

Bengt Lagerholm, Astra Zeneca PLC, S-43183 Molndal, Sweden, Tel 46 31 7761000, Fax 46 31 7763813, e-mail [bengt.lagerholm@astrazeneca.com](mailto:bengt.lagerholm@astrazeneca.com)