

Gee, Measuring Cockpit G's with G

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Category:

Aerospace/Defense

Products Used:

LabVIEW 8.5
Vision Toolkit

The Challenge:

The *g*-meter on an aircraft's instrument panel displays the acceleration forces on the aircraft in analog and digital form. A test system is needed to verify that the two displays are returning the same information. This system must also document the flight by recording the data.

The Solution:

Data Science Automation (DSA) created a LabVIEW application utilizing National Instruments' vision tools to capture an image of the *g*-meter and then analyze the image to read the information that the meter is presenting. Finally, the system archives the results to a log file.

Abstract:

A military research facility needed to verify the accuracy of a cockpit *g*-meter containing an analog and digital reading display. It was suspected that under certain situations the analog and digital readings would not agree. The raw data consists of video of the meter recorded during a flight test. To avoid the tedium, time and error inherent in analyzing this video manually, DSA developed an automated application to analyze the video and log the data to a file – thus doing in a matter of seconds what would have taken hours manually.

g-Force

As soon as an aircraft starts moving it is subjected to acceleration forces, or *g*-forces. While it is always important for designers to understand the *g*-forces being exerted on an airframe (and the people inside it!), the matter become especially critical for military aircraft that are expected to routinely press the edges of their performance envelope.

For this reason certain military aircraft incorporate a meter for measuring *g*-forces during flight. It is located on the aircraft's instrument panel so the pilot can monitor how much force he is putting on himself and the aircraft during aggressive flight maneuvers. The meter presents both digital and pseudo-analog readouts. The digital display offers one decimal of precision and is located in the center of the display. The tick marks that form the pseudo-analog display appear around the inside of the meter's outer ring. Each tick mark represents 0.2*g* units. This portion of the display also keeps track of the maximum and minimum values using an additional pair of tick marks. The notch marks can be seen in Figure 1 inside the green regions of interest.

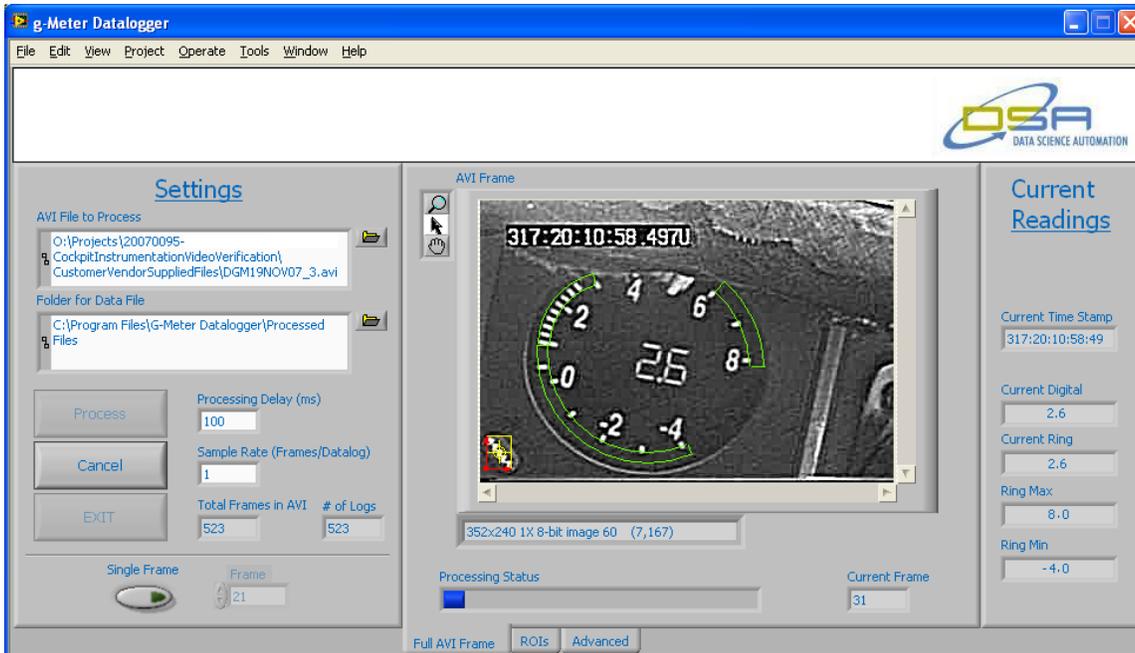


Figure 1 - User interface of the application displaying an .AVI file being processed.

Another kind of G-force

To insure its accuracy, this meter needed to be verified and its readings saved for record keeping purposes. To accomplish the basic data collection, a video camera was mounted inside the cockpit and positioned to view the meter. The video would then be played back after the test flight to determine the values that were observed during the flight. Manually, this play-back and data transcription process was very time consuming and error prone. The solution to this problem lay in another kind of “G-force”. In this case the “G” refers not to gravitational forces, but to the programming language that LabVIEW implements. LabVIEW’s graphical programming environment teamed with the add-on Vision Toolkit was the perfect solution for automating the process of analyzing the cockpit video.

The Vision toolkit contained built-in functionality to read the video files (in this case .avi files) and analyze the video frame-by-frame. While, LabVIEW’s ability to integrate and accomplish a variety of tasks in a single, user friendly, aesthetic application made it the natural choice for creating the overall program architecture.

For the most part, the Vision Toolkit VIs made developing code to extract a given frame from the video file for analysis simple. The challenging aspect of the process was analyzing the analog and digital readings. To begin with, because the video was being filmed in aircraft undergoing aggressive maneuvering, the position of the meter in the video field of view would vary slightly from frame to frame. Hence, the regions of interest (ROIs) for inspection of the digital and analog readings also varied from one frame to the next.

DSA therefore implemented a coordinate system so that when the meter shifted in the video field of view, the ROIs would move with it. To make this technique work a reference or benchmark was needed that would always be visible in the frame and which had a fixed relationship to the meter. To fulfill this requirement DSA chose a visually prominent push button that was part of the meter display and so was always in the frame. Using this push button as a reference point meant that as the software tracked the movement of the button in the image, it could move the ROIs to keep them located properly.

In terms of the vision algorithms required to analyze the image frames and determine the analog and digital meter values, NI Vision Assistant and the OCR Training utility were key contributors. Vision Assistant was the perfect prototyping tool in that it provided a quick and convenient process for developing the required vision algorithms (Figure 2). Moreover, its ability to generate LabVIEW code significantly reduced overall application development time. Likewise, the OCR Training utility contributed significantly to the robustness and reliability of the code that was responsible for reading the digital readout and timestamp from the video.

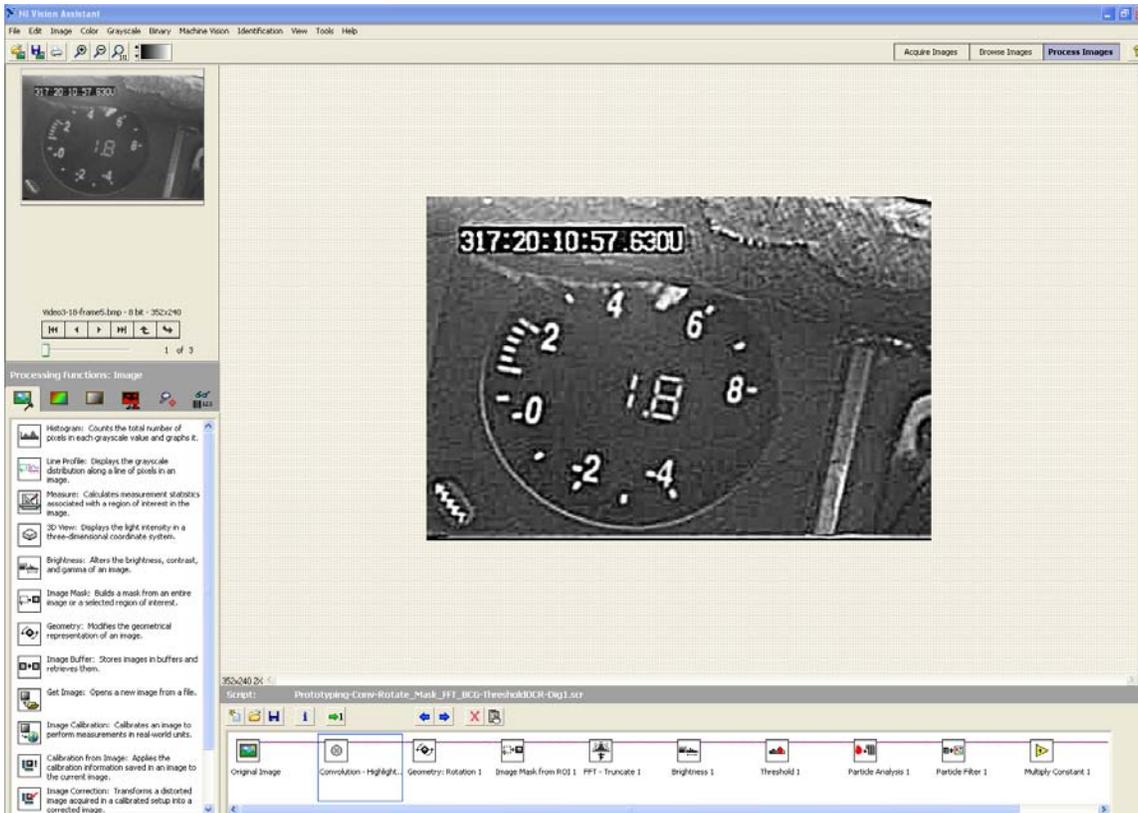


Figure 2 - NI Vision Assistant was extremely useful in prototyping the needed vision algorithms.

Results Fast

Thanks to the comprehensive functionality of the modules of the National Instruments Vision Toolkit, this project was able to accomplish all of its requirements while at the same time minimizing development time. Military personnel were able to accomplish many other tasks now that processing of hour long flight videos could now be completed in seconds.