Automated Verification of Focal Plane Arrays

by
Quintin Stotts
Consultant
Data Science Automation, Inc.
USA

Category:
Prototype/Validation Test

Products Used:
NI LabVIEW 8.5
NI Report Generation Toolkit
NI LabVIEW Vision Module

The Challenge:
Automate a large number of independent code modules that were being run manually to conduct verification tests for Focal Plane Arrays (FPAs) and efficiently manage the acquired test data.

The Solution:
Data Science Automation was designed and developed a flexible, scalable, maintainable architecture to automate the client's existing test modules while allowing for future expansion to include new verification tests as well as new FPA types.

Abstract:
A robust application was required to provide the ability to test multiple types of Focal Plane Arrays (FPAs), which are the sensing component in infrared cameras. LabVIEW was chosen to provide a flexible, maintainable, and scalable software application that incorporated various data analysis routines, presented the analysis results , and generated reports. The client needed to consolidate the piecemeal modules into a comprehensive unifying application that would satisfy all their testing needs for all their product types, for the present and the future.

Overview:
The client is a leader in the design and fabrication of FPAs and implements them into various types of detectors and camera applications. A FPA are 2-D arrays of light-sensing pixels, typically used for detecting the infrared spectrum (Figure 1).

Figure 1. Typical Infrared Image Application.

Each pixel in the FPA generates a voltage or charge that represents the infrared intensity observed by the FPA. The voltages for each pixel can then be digitized and constructed into an image for display and or analysis purposes. Different FPAs are manufactured for different wavelength ranges in the infrared spectrum.

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Each FPA that is manufactured needs to be tested and verified for proper operation and is generally tested in an actual infrared camera test bed. This allows for acquisition of real image data and the capability to perform a variety of tests from analyzing each pixel acquired to extracting quantitative information based on the entire image frame, assuming the camera digitizer and acquisition hardware are previously tested and verified. Some analyses require multiple images from the same FPA and camera test bed to perform a comparison. Some analyses can be conducted from a single image. Generally the acquisition is performed while the camera lens is directed at a controlled "black body" instrument which emits infrared radiation at a specified set point. Based on the known set points of the blackbody field, calculations can be conducted on the acquired images to characterize and/or verify the FPA. Typically analyses are bad pixel analysis, responsivity, gain and offset calculation for image correction scaling, noise-equivalent delta-T (NEdT), noise-equivalent irradiance (NEI), and others. Bad Pixel analysis is show in Figure 2.

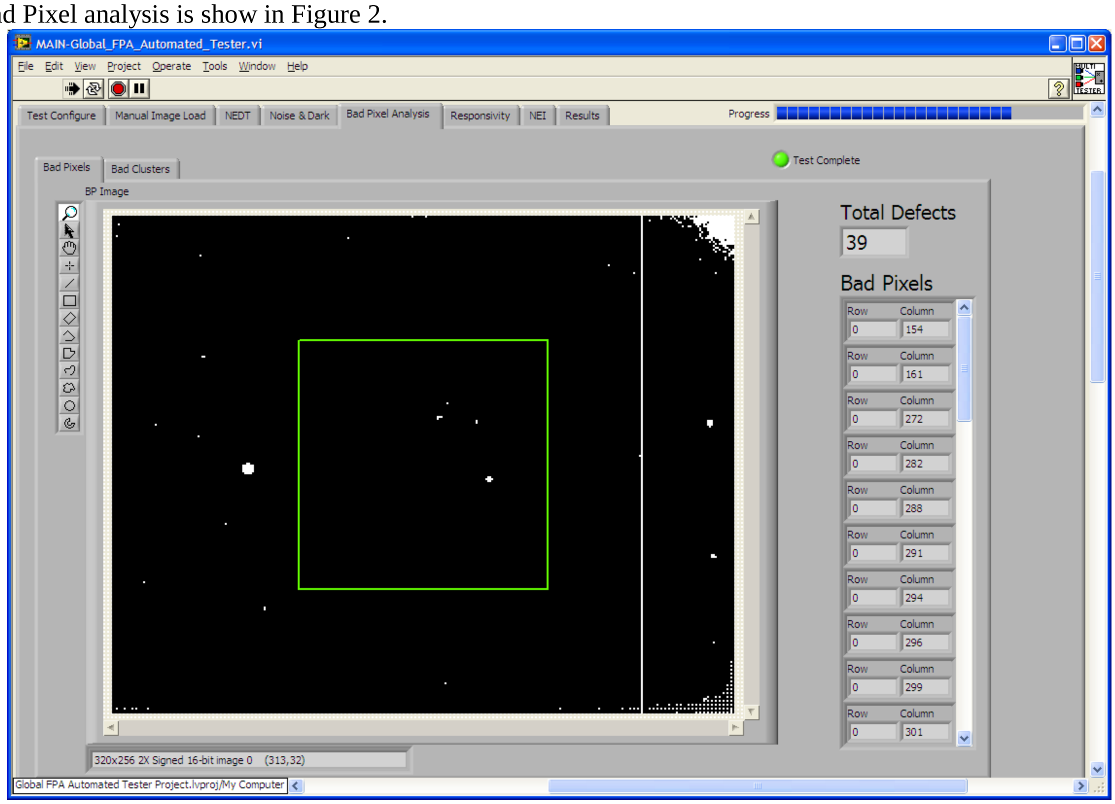

Figure 2 - Bad Pixel Mapping

The bad pixels are displayed as the white pixels based on the criteria set for the test. Once image correction gains and offsets are calculated using a two point correction algorithm (basically acquiring images of "high" and "low" temperature sources and comparing) bad pixels would be defined based on tolerances of their individual scaling and offset values.

Prior to this project, the client had many independent LabVIEW code modules that were being used one at a time to conduct the tests and analyses. Each module had the capability to load an acquired image file, perform its analysis and generate a report. To improve the productivity by reducing the manual interaction, a single user interface was developed to display the multiple test results based on the FPA and camera test bed being tested. The operator would be presented with the default tests that apply to the selected FPA/camera test bed, but had the option customize the run by disabling some tests. Once the tests were configured, the operator would press the Start Test button and all the tests would be conducted and results displayed. This freed the operator of the responsibility of managing the test process. The new application also gave the operator easier access to all the test results on the user interface enabling a quick, comprehensive review of results. Once the results were examined they were able to generate and print out reports for all tests with the click of a button.

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The improved application included the additional ability to save and restore test analysis results for later investigation and report re-generation. Due to the complexity and large volume of data coming from each analysis, the TDMS file type was selected due to its capability to store large amounts of data efficiently along with the power to organize data within the file itself.

Conclusion:
Thanks to LabVIEW's ease of use, a flexible, scalable, maintainable application was developed to consolidate the client's testing efforts. This consolidation greatly improved their test process management as well as test data management. The architecture of the application allows the client to easily add new FPA types for testing as well as new analysis tests for future expansion in R&D and product testing.

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