

# **correlated**

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# SOLUTIONS

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## **VIC-3D System Overview**

### **About Correlated Solutions, Inc.**

Correlated Solutions, Inc., was founded in 1998 and includes the people who invented Digital Image Correlation. Our goal to commercialize the [Digital Image Correlation](#) technology by providing turn-key systems has been realized with the principals of ease-of-use, reliability, and accuracy in mind. Collectively, we have more than 80 years of experience in this field and we are the world leader in this technology. To our knowledge, we are the only US company that develops and manufactures stereo image correlation photogrammetry software and hardware systems.

### **The VIC-3D Digital Image Correlation Measurement System**



# VIC-3D Digital Image Correlation Software & System Highlights

The **VIC-3D Measurement System** is a turn-key, **non-contact** measurement solution for measuring **full-field** displacements and strains utilizing **Digital Image Correlation** (DIC) with a pair of stereo-mounted digital cameras. The VIC-3D system offers researchers and engineers unmatched speed and accuracy for a wide range of quasi-static and dynamic applications. Please contact [sales@correlatedsolutions.com](mailto:sales@correlatedsolutions.com) to obtain more details on the system or with any questions.

- 1. Coded Calibration Targets:** [Calibration](#) has been streamlined to a nearly automatic process in VIC-3D. The procedure involves moving and imaging a calibration grid in arbitrary positions in the desired field of view. The grid size is then automatically recognized during the procedure, eliminating the chance of incorrectly calibrating the system. Arbitrary movements and automatic grid detection significantly decrease the overall time to calibrate the system, which can be done before and/or after testing.
- 2. Free Calibration Target Generator Software:** Users have the ability to create their own customized calibration grids using our free Calibration Grid Generator software, available for public download from our support portal <http://www.correlatedsolutions.com/support/>.
- 3. Free Speckle Pattern Generator:** Users have the ability to create their own customized speckle pattern using our free software, available for public download from our Downloads page <http://correlatedsolutions.com/software-downloads/>. This is useful anytime an adhesive backed printed pattern needs to be used, which is common for large scale testing.
- 4. VIC Speckle Kit:** The [VIC Speckle Kit](#) enables users to easily apply the ideal pattern to the surface of a specimen, which allows for the highest level of accurate consistent results. The kit virtually eliminates the potential bias that would result from poor sample preparation and is included with every turn-key system.
- 5. Uncertainty Variables:** VIC-3D computes correlation & displacement uncertainty values and represents them as the variable sigma. The closer sigma is to zero, the more statistically likely the value shown is indeed the correct value. High sigma values indicate higher measurement uncertainty, which can result in an increase in noise for shape, displacement, and strain data. Sigma is reported as a standard variable for every test.
- 6. Free Scanning Electron Microscope Drift Correction Module:** VIC-2D includes experimental functionality to correct for both drift and geometric distortions that occur in images taken using Scanning Electron Microscopes. This module is available with every VIC-2D license (which is included with every VIC-3D license) and absolutely free of charge.
- 7. Exclusive Stereo Calibration Models:** VIC-3D 8 includes a new **Hybrid Calibration** feature which utilizes

speckle images to improve the stereo calibration parameters. This new method has shown to increase the accuracy of the system and reduce bias. In addition to the Hybrid calibration feature, a new **Variable Ray Origin (VRO) Calibration** model is now included in VIC-3D 8 that is used to significantly reduce measurement bias caused when imaging through windows or other medium – e.g. measuring a submerged specimen in a water tank.

## VIC-3D System Exclusive Features

While the previously mentioned features make the **VIC-3D System** very user friendly for a wide variety of applications in a wide variety of testing environments, the below features are exclusive to the **VIC-3D System** and make it truly unique. To the best of our knowledge, no other DIC system can provide the following features.

1. **Processing speed:** The VIC-3D analysis code has been recently updated to take advantage of high-end multi-core CPUs (12 or more cores). Up to 250,000 data points/sec can now be processed using the intel i9 2.6GHz 18 core CPU and up 400,000 data points/sec is possible using the AMD Threadripper™ 32 core CPU.

To our knowledge, the **VIC-3D system is more than ten times faster** than any commercially available 3D digital image correlation analysis software. Processing speed is particularly important for long image sequences, such as during high-speed measurements for vibration analysis. Consider a vibration test that is setup to measure operating deflections (ODS) using the VIC-3D HS system and FFT module. A typical test with ~2,000 image pairs containing 50,000 data points will take approximately **5 minutes** to process on a PC equipped with the AMD Threadripper™ CPU. Other DIC software could take up to 1hr or more.

2. **U.S. Technical Support Team:** All of our digital image correlation systems are designed and built by our team in Columbia, South Carolina. Because we write all the software and assemble these systems ourselves, we are able to provide technical support that is unsurpassed in this industry. All of our systems include unlimited access via phone and email to our experienced support team. Correlated Solutions is the only developer of 3D digital image correlation systems based in the United States.
3. **Flexible Licensing:** The computer provided with the system is equipped with a permanent seat license for the acquisition (for low-speed, high-speed, and ultra-high-speed cameras) and analysis software packages. In addition, each permanent seat license comes with a separate post-processing license on a USB dongle, allowing data analysis and report preparation to be done on any PC. Post-processing licenses can now be provided with network capabilities.
4. **Calibration Disturbance Correction:** The VIC-3D system uses a precise calibration of the camera positions in order to provide the most accurate 3D measurements possible. During normal field and laboratory use, the cameras can occasionally be disturbed by either environmental factors such as wind or ground vibration or by accidental contact.

To preserve data integrity, VIC-3D includes the Calibration Disturbance Correction feature that automatically recalculates the calibration score when a disturbance occurs before or during testing. Because this correction uses previously acquired test images to recalibrate, it does not require any additional calibration images to be acquired. It can be performed from within the VIC-3D software in a single step, even after the test has been completed and the camera system has been disassembled.

5. **Separate calibration for deformed images:** In some cases, it is necessary to dismantle the camera system between the time that the reference images and the deformed images are taken. VIC-3D has a feature that allows a separate calibration to be used between the reference and deformed states.
6. **Full-field Real-time Measurement Processing Speed:** The VIC-3D Real-time Measurement System is capable of measuring over 10,000 data points at 10Hz in real-time using a modern desktop PC with a single Intel i7 processor. Users can freely choose the data density for processing rates between 2-10 Hz. Live data is displayed in an unlimited number of user specified 3D plots, 2D contour image overlays, and extractions via cross-sectional graphs.
7. **Variable Ray Origin (VRO) Measurements:** The VRO calibration feature corrects for changes in the refractive index between the speckle pattern and a stereo camera pair. This is especially useful when viewing a specimen through one or more panes of glass (e.g., a viewport of a heating chamber) and in bio-medical applications, where the sample is oftentimes submerged in a liquid. While a standard calibration procedure cannot remove the bias that leads to significant errors in shape, deformation and strain data, implementing the VRO calibration model leaves data with no discernible bias.
8. **High-Speed Vibration Analysis Measurements:** The VIC-3D FFT system allows for full-field 3D viewing, measurement, and analysis of full-field operational deflection shapes (ODS's) which occur from steady-state or transient vibration events. No other DIC company has the capability to analyze these measurements in their post-processing software. This technology is also more compact and less expensive than laser vibrometer systems.
9. **Accurate 3D Microscope Measurements:** Correlated Solutions has developed and an easy-to-use calibration procedure that corrects for the non-parametric distortion fields of the [stereo microscope](#) and has been proven to completely eliminate shape and strain bias from the measurements. This is most useful when 3D data is needed on samples ranging in size from 0.7mm to 7mm.
10. **Accurate 2D SEM Drift Correction:** In applications where a scanning electron microscope is used to collect images, it is necessary to correct both drift and geometric distortions in order to achieve non-biased deformation and strain measurements. Correlated Solutions, Inc. has a unique drift and distortion correction calibration feature which calculates accurate deformation and strain results. Without this procedure in place, deformation measurements obtained using traditional digital image correlation methods would be inaccurate.
11. **Integrated Discrete Marker Tracking:** VIC-3D includes the ability to track discrete markers (circular or bow-tie format) in three dimensions at no additional charge. Markers can also be used for precise

coordinate system alignment with external frames of reference in CAD models or FE models.

## **VIC- Snap Image Acquisition Software Exclusive Features**

**VIC-Snap** is Correlated Solutions' camera control and image acquisition software designed specifically for tests to be measured with DIC. Multiple low speed, high-speed, ultra-high-speed, and IR cameras can be controlled simultaneously: for example, electronic exposure, capture rate, and capture method can be adjusted for each individual camera or all cameras at the same time. Other features include crosshair toggling, click to pan, scroll to zoom, and simple black referencing for high-speed cameras. The below features highlight some of VIC-Snap's additional features, functions, and versatility:

- 1. Real-Time Calibration Preview:** Calibration images are immediately analyzed and the overall calibration score shown in real-time, which greatly increases the speed and efficiency of the calibration procedure. The user receives real-time feedback of calibration target marker extractions and the final calibration score.
- 2. Automatic Real-Time Image Saturation Feedback:** When parts of the speckle pattern become overexposed due to a reflective surface, a change in lighting conditions, or deformations of the sample, data can be difficult to obtain. To alert the user that light saturation is occurring on the image, VIC-Snap automatically shows all parts of the live image above the pixels' maximum threshold value as red so necessary adjustments can be made accordingly. This feature is also a great tool for focusing.
- 3. Remote Acquisition:** The VIC-Snap remote app allows users to view and acquire live images while calibrating the camera system and during testing. Pinch to zoom for focus adjustments, toggle crosshairs, and exposure control are just a few features of the remote, which can be downloaded on any Android or iOS device for free.
- 4. Flex Capture Mode:** This feature allows the user to pre-program the number of images taken at pre-defined periods of the test. For example, 1 image per minute for the first 10 minutes and then 10 images per second for 10 seconds can be defined. This is especially useful when the image capture rate needs to be increased before a crack occurs to obtain more highly sampled strain and deformation data. The framerate and acquisition duration can be altered at any point during the test.
- 5. Additional Software and Hardware Trigger Mode Options:** VIC-Snap provides the user with the ability to initiate image acquisition via several types of trigger modes. Images can be taken via software synchronization either at the user's discretion or at a predefined time interval and for a set duration of time. Alternately, a hardware signal (e.g., a TTL signal 0 - 5V pulse) can be used to either 1) trigger cameras at regular intervals, or 2) initiate the acquisition at a predefined rate. The 2<sup>nd</sup> option is especially useful if the test needs to be initiated by external hardware, such as a voltage signal from a test frame or a sensor.
- 6. External Data Synchronization:** All VIC-2D and VIC-3D turn-key systems include a USB DAQ system up to 32 channels. The DAQ system is useful when data from external sensors or measurement devices needs

to be synchronized with DIC displacement and strain data. For example, if the user requires data from a load cell and thermocouple to be synchronized to the DIC data, this is simply done by outputting the load and temperature data via a +/-10V analog signal to the DAQ system using a BNC connection. The load cell and thermocouple each output a voltage signal that is proportional to their readings, which are confirmed in VIC-Snap. They can then be scaled and/or offset as needed. The analog data can then be graphed/plotted against the DIC strain data in VIC-2D and VIC-3D.

7. **Live Speckle Pattern Uncertainty:** The option to toggle full-field contour plots of correlation confidence (Sigma) and histograms (grey value vs. pixel count) for focusing assistance is only two clicks away and visible in **real-time**. These tools simplify and speed up the initial setup process for each DIC test by giving the user a live preview of the quality of the speckle pattern.
8. **Multi-Camera Clipping and Binning:** Clipping and binning can have a huge impact on the cameras' frame rate, image size, and final project size. Having the ability to control all DIC cameras at once or individually to obtain the extra speed and smaller file size may be necessary for some applications and satisfies even the most complex and demanding test setups. Toggling each feature simplifies and accelerates the image capture process and is only two clicks away.
9. **Fully Integrated Thermal Camera Control:** VIC-Snap IR controls all monochrome and select IR cameras within a single instance of the acquisition software. This is especially useful because it allows triggering of all cameras via previously mentioned software trigger options. Calibration and testing images can all be acquired at the same time for all cameras in VIC-Snap IR. The IR camera is also calibrated which allows temperature data to be displayed in the same coordinate system.
10. **Fully Integrated High-Speed (HS) Camera Control (Photron, Phantom, NAC\*):** VIC-Snap HS has the inherent capability to display and control multiple high-speed cameras in a single instance of the acquisition software. The capability to properly name & acquire both single image sequences for calibration and a series of images for testing can reduce lab time by hours. Simultaneous control multiple high-speed cameras' resolutions, framerates, and exposure times also serves to greatly decrease the amount of time taken for the system setup and calibration procedure. Additionally, an integrated data acquisition system is included with each turn-key system that provides the option to record an external analog signal (+/-10V). For example, VIC-Snap HS can display and record load data from a test frame which can be imported into VIC-3D. This is useful if the user would like to display load vs. strain data in VIC-3D. *\*Not all models are supported*
11. **Fully Integrated Ultra-High-Speed (UHS) Camera Control:** VIC-Snap UHS has the inherent capability to display and control multiple ultra-high-speed cameras in a single instance of the acquisition software. The capability to properly name & acquire both single image sequences for calibration and a series of images for testing can reduce lab time by hours. Simultaneous control multiple ultra-high-speed cameras' resolutions, framerates, and exposure times also serves to greatly decrease the amount of time taken for the system setup and calibration procedure. Additionally, an integrated data acquisition system is included with each turn-key system that provides the option to record an external analog signal (+/-10V). For example, VIC-Snap UHS can display and record load data from a test frame which

can be imported into VIC-3D. This is useful if the user would like to display load vs. strain data in VIC-3D.