INTERNATIONAL
DIGITAL IMAGE CORRELATION
SOCIETY

Monday, November 7, 2022, Full Day Class, 8:30 AM to 5:30 PM (Full Day)

DIC 101: Practical Considerations for Good DIC Measurements – What is in the Good Practices Guide.

COURSE DESCRIPTION

The *Good Practices Guide for Digital Image Correlation* (GPG) defines the knowledge and skills required to conduct DIC measurements in conjunction with mechanical testing of a planar test piece. Furthermore, the GPG defines the knowledge required to obtain Level 1 certification. The GPG is available at https://doi.org/10.32720/idics/gpg.ed1. This course will delve into all the topics covered in the GPG in detail, focusing on practical applications of DIC rather than theory or algorithms. It is designed as training for new practitioners of DIC to supplement vendor-based training, and as a refresher course for those who will be taking the Level 1 certification exam.

Topics covered will include:

- Basic and fundamental 2D and Stereo-DIC concepts
- Design of DIC measurements
- Preparation for DIC measurements
- Camera calibration
- Test execution concepts
- Strain calculations and basic Virtual Strain Gauge size studies
- DIC processing techniques
- DIC reporting requirements

WHO SHOULD ATTEND

DIC users who would like a thorough review of the iDICs *Good Practices Guide for Digital Image Correlation* (GPG). People who will be taking the Level 1 certification exam.

Dr. Elizabeth Jones (Sandia National Laboratories). Dr. Jones received her PhD in Theoretical and Applied Mechanics at the University of Illinois at Urbana-Champaign. She is currently a senior member of technical staff at Sandia National Laboratories in Albuquerque, NM, where she applies DIC to study deformation of various types of materials under complex loading conditions and develops methods to use DIC data for FE model validation.

Dr. Amanda Jones (Sandia National Laboratories) Dr. Jones received her PhD in Theoretical and Applied Mechanics at the University of Illinois at Urbana-Champaign. She is currently a senior member of technical staff at Sandia National Laboratories in Albuquerque, NM, where she applies DIC to material characterization efforts and complex loading conditions/ specimen geometries/ size scales.

INTERNATIONAL DIGITAL IMAGE CORRELATION SOCIETY

Monday, November 7, 2022, Morning Class, 8:30 AM to 12:30 PM (½ Day)

High-Speed DIC Class

COURSE DESCRIPTION

The proliferation of high-speed digital cameras has created the possibility to acquire DIC images at kilohertz and megahertz rates. This opens completely new fields of study for DIC, including high-rate material testing, explosive studies, car crashes, etc. This class will focus on how to successfully apply DIC in these types of testing environments. Details of the camera hardware, lighting and test setup will be discussed. This course will follow the draft HS-DIC Guide that is currently in final revisions.

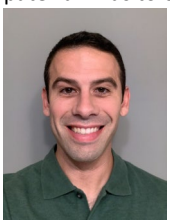
COURSE CONTENT

- High-speed and ultra-high speed camera equipment review
- High-rate DIC experimental design
- Camera synchronization
- Timing and triggering
- Lighting
- Data analysis

WHO SHOULD ATTEND

Engineers and researchers who are interested in high-rate testing.

Dr. Phillip L. Reu is a Distinguished Member of Technical Staff at Sandia National Laboratories. Phillip specializes in developing novel full-field measurement techniques in previously un-measurable regimes often using digital image correlation (DIC). Current research efforts in DIC are focused on uncertainty quantification. Phillip is the author of the “Art and Application of DIC” article series in the journal of Experimental Techniques, chair of the DIC Challenge, president of the International Digital Image Correlation Society (iDICs), and paterfamilias to 6 kids.



Dr. Phillip Jannotti is a research scientist at the U.S. Army Research Laboratory. Phillip specializes in the application of in situ diagnostics, such high-speed DIC, to blast and ballistic testing. Current research efforts in DIC are focused on characterizing material behavior in extreme dynamic environments. Phillip is a member of the International Digital Image Correlation Society (iDICs) board and chair of the high-speed DIC working group.

INTERNATIONAL DIGITAL IMAGE CORRELATION SOCIETY

Monday, November 7, 2022, Morning Class, 8:30 AM to 12:30 PM (½ Day)

Patterning for DIC

The workshop is led by Mr. Tim Schmidt from Trilion Quality Systems – schmidt@trilion.com

Tim Schmidt, Vice President of Trilion Quality Systems, is one of the most experienced practitioners of 3D image correlation and point tracking photogrammetry in the world, particularly for field tests and high-speed camera applications. Tim has run tests on days, nights and weekends for more than 17 years. He has given Basic, Refresher and Advanced training to hundreds of DIC users, and provides worldwide support for challenging measurements.

COURSE DESCRIPTION

Patterning is an essential part of every digital image correlation test setup. Although most users do avoid the worst-case scenario of "garbage in, garbage out" when it comes to patterning, there still seem to be a lot of non-optimum techniques and results in practice. Many users have concerns about their ability to produce high quality patterns without a lot of struggle, or a degree in Art. However, there are simple guidelines and methods that enable patterning to be a fast, easy and repeatable process, with straightforward quality metrics.

This course will cover everything you need to know to confidently and quickly prepare any specimen for a DIC test and be sure that patterning will not be the limiting factor for obtaining the highest quality data.

COURSE CONTENT

- The Golden Rules of Patterning
- Patterning for the Most Common Test Setups
- Removing Human Factors from Patterning
- Pros and Cons of Spray Paint, Ink, Rubber Stamps, Airbrushes, Markers….
- Masking How's and Whys
- Pre-Test to Check Your Pattern (And Everything Else, Too)
- (System Noise as Opposed to DIC Noise)
- The Ideal Pattern vs The Real World
- What to Do When Larger Dots Are Required
- Evolution of Various Patterning Methodologies
- Small-Scale and Microscale Patterning Techniques
- What About Naturally Occurring Patterns?
- High Temperature and Very High Temperature Patterning
- Some Lighting Techniques – How to Make Your Patterns Look GOOD

And

- Most Common Beginner's Mistakes
- Bad Ways to Do Good Patterns
- Fantastic Examples of Terrible Patterning

WHO SHOULD ATTEND

It is hoped that all current or potential users of DIC would benefit from this course.

INTERNATIONAL DIGITAL IMAGE CORRELATION SOCIETY

Monday, November 7, 2022, Afternoon Class, 1:30 PM to 5:30 PM (½ Day)

DIC 201: Advanced DIC Concepts and Uncertainty Quantification

COURSE DESCRIPTION

The advanced DIC class will cover what is underneath and beyond the Good Practices Guide (GPG). The theme will be to understand where DIC errors come from and work through all the components in DIC that lead to the measurement errors. For example, how to pick a DIC lens and camera (and why), what are the associated errors with various lenses and how do you quantify them. Why does the GPG specify 3-5-pixel speckles? What are the underlying principles? Understanding the camera calibration and the parameters and what makes a good calibration. Where does the matching uncertainty come from?

Concepts of advanced uncertainty quantification on the DIC measurement will also be discussed including a thorough look at the 2D matching error magnitudes. Stereo-DIC errors and advanced virtual strain gauge studies will also be discussed.

COURSE CONTENT

- Uncertainty quantification: What influences my DIC measurement?
- Factors in selecting a DIC lens
- Selecting a DIC camera.
- What makes a good DIC pattern and why.
- Calibration: Understanding the parameters
- Calibration: What makes a good calibration
- 2D and pattern matching uncertainty.
- Stereo-DIC uncertainty quantification
- Understanding the VSG.

WHO SHOULD ATTEND

This course will go beyond the information needed for a Level 1 certification exam and target what is needed for Level 2 certification. All DIC users who would like to learn more about what influences their measurement accuracy.

Dr. Phillip L. Reu is a Distinguished Member of Technical Staff at Sandia National Laboratories. Phillip specializes in developing novel full-field measurement techniques in previously un-measurable regimes often using digital image correlation (DIC). Current research efforts in DIC are focused on uncertainty quantification. Phillip is the author of the “Art and Application of DIC” article series in the journal of Experimental Techniques, chair of the DIC Challenge, president of the International Digital Image Correlation Society (iDICs), and paterfamilias to 6 kids.

Dr. Mark A. Iadicola is a Staff Scientist at the National Institute of Standards and Technology. Mark 's research interests include advanced experimental methods in solid mechanics as applied to multi-axial plastic deformation and stress induced phase transformation, with special emphasis on sheet metal forming and shape memory alloys (e.g. Nitinol). Mark is vice president of the International Digital Image Correlation Society (iDICs), a USA/ANSI Delegate to various subcommittees of the ISO TC164 Mechanical Testing Committee, and an active Member of Committee E28 on Mechanical Testing in ASTM International.

INTERNATIONAL DIGITAL IMAGE CORRELATION SOCIETY

Monday, November 7, 2022, Afternoon Class, 1:30 PM to 5:30 PM

Modal Testing Using DIC

COURSE DESCRIPTION

Modal testing is the practice of dynamically characterizing a test article in terms of natural frequencies, mode shapes, and damping values. These tests require careful measurement of input forces and output vibration responses to develop transfer functions from which modal properties are extracted. High-speed stereo Digital Image Correlation (DIC) offers modal testing practitioners the ability to measure dense- to full-field response measurements without the need for physical sensors such as accelerometers. There are, however, practical considerations and limitations to this method that must be addressed to ensure a successful modal test is conducted. While several commercial and open-source DIC software options exist, it is still generally necessary to develop supplementary customized tool sets to complete the modal workflow. In addition, phase-based motion magnification is an advanced technique with applications in modal test and analysis including visualization, noise reduction pre-processing, and image-based expansion.

This course will provide an overview of the practical aspects that must be considered to successfully plan, set up, and conduct a modal DIC test. We will also address common issues that may be encountered in the process and techniques to prevent or mitigate their effects. Finally, an introduction to phase-based motion magnification and its modal applications will be presented.

COURSE CONTENT

- **Basic Modal Testing**
- Equipment selection
- Excitation strategies
- Evaluating test feasibility
- Camera mounts & lighting
- Part preparation
- System synchronization
- Data acquisition
- Averaging images
- Data manipulation
- Coordinate transformations
- Subset data quality assessment
- Combining subsets and accelerometers
- Frequency response functions
- Time delay phase corrections
- Noise mitigation strategies
- Modal extraction

- **Phase-based motion magnification**
- Magnifying 1D signals
- Analogy to FFT Shift Theorem
- Construction of complex filters
- Filtering and reconstruction
- Magnifying 2D signals
- Modal applications

WHO SHOULD ATTEND

DIC practitioners who would like to learn about conducting dynamic characterization testing. A basic knowledge of modal testing and analysis is assumed, but not strictly necessary to benefit from the course.

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Dr. Daniel Rohe is a Principal Member of the Technical Staff at Sandia National Laboratories. Dan works in the Experimental Structural Dynamics department where he specializes in dynamic characterization testing using non-contact diagnostics. Dan's current research focus is to leverage X-ray imaging of structural dynamics tests to extract responses not only from the exterior of the test article, but also from motions of internal components and subsystems. His interests also include using synthetic imaging and motion magnification to improve optical testing techniques.

Mr. Bryan Witt is a Principal Member of the Technical Staff at Sandia National Laboratories (NM). As part of the Experimental Structural Dynamics group, he specializes in dynamic characterization testing of complex aerospace structures and the use of non-contact diagnostics. His current focus is on the development of DIC as a modal testing capability, with emphasis on test planning and feasibility evaluations to improve robustness.