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Update on the 2D-DIC Challenge: Results and Conclusions

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Abstract

The 2D-DIC Challenge is organized by an international committee working to understand the accuracy of digital image correlation (DIC) through standardized image sets. The DIC Challenge is run under the auspices of the Society for Experimental Mechanics (SEM) and the International DIC Society (iDICs). The 2D-Challenge incorporates 19 image sets that can be used in evaluating 2D-DIC algorithms. The full results of the study and description of the image sets may be found in [1]. A new round of the 2D Challenge is being launched at SEM 2018 and will seek to probe the concept of spatial resolution.

Introduction

The 2D-DIC challenge seeks to provide images that may be used for comparing DIC algorithms and determining the ultimate resolution of DIC. To this end, 19 image sets were developed that challenge various aspects of DIC including contrast change, image noise, image rotation, etc. The images listed in Table 1 are all freely available at the SEM website, and researchers are encouraged to use these images in publications, particularly when improvements in DIC algorithms are claimed. The images include synthetically generated images with known answers that can be used for DIC code verification, i.e. ensuring that the DIC code is correctly implemented and for probing the ultimate error regime of DIC. Experimental images with known displacements are also available and can be used for code validation (Sample 16) or for comparing different DIC implementations (Sample 12, 13, and 17). These images have been widely vetted and a detailed discussion of their generation and use are described in [1].

Table 1. Sample image set numbering and information. Image sets are available at: https://sem.org/dic-challenge/.

Description	Set Name	Method [2, 3]	Contrast	Noise σ (GL)	Shift (pixels)	# Images
TexGen Shift X,Y	Sample1	TexGen	Varying	1.5	X=Y=0.05	20
TexGen Shift X,Y	Sample2	TexGen	0 to 50	8	X=Y=0.05	20
FFT Shift X,Y	Sample3	FFT Shift	0 to 200	1.5	X=Y=0.1	10
FFT Step Shift	Sample3b	FFT Shift	0 to 200	1.5	0.05 to 0.5	5
FFT Shift X,Y	Sample4	FFT Shift	0 to 50	8	X=Y=0.1	10
FFT Shift X,Y	Sample5	FFT Shift	Varying	1.5	X=Y=0.1	10
Prosilica Bin	Sample6	Binning	0 to 200	0.26	X=Y=0.1	10
Prosilica Bin	Sample7	Binning	0 to 50	0.66	X=Y=0.1	10
Rotation TexGen	Sample8	TexGen	0 to 100	2	Θ by 1	10
Rotation FFT	Sample9	FFT	0 to 100	2	Θ by 1	10
Strain Gradient	Sample10	TexGen	0 to 200	2	Sinusoid	10
Strain Gradient	Sample11	TexGen	60 to 130	2	Sinusoid	10
Strain Gradient	Sample11b	FFT	0 to 200	1.5	Tri. .01 to 1	6
Ex1 – Plate Hole	Sample12	Exper.	Good	Low	N/A	12
Ex2 – Weld	Sample13	Exper.	Poor	Low	N/A	52
Varying Strain	Sample 14	FFT	0 to 200	5	N/A	4
Varying Strain	Sample 15	TexGen	80 to 180	2	N/A	9
Rigid Motion	Sample 16	Exper.	0 to 254	0.26	≈0.1	11
Interpolant	Sample 17	Exper.				

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Results

Two of the sample sets (Sample 14 and 15) had DIC results supplied from 9 participants with 12 different code implementations including both global and local implementations. Both samples supplied a realistic speckle image with known displacement and strain gradients that the participants were to determine. Only one result could be submitted, and then the bias and noise errors of the results were investigated. This required a compromise between spatial resolution and noise when doing the analysis. The "error" for all 12 codes plotted in Figure 1 is the difference between the submitted result and the known answer for Sample 14. Both bias and noise errors were observed. It is interesting to note that some codes (Code A) applied more filtering, but had lower noise, while other codes (Code E) had less filtering and bias error, but more noise in the results. These results illustrate the fundamental compromise between noise and spatial resolution.

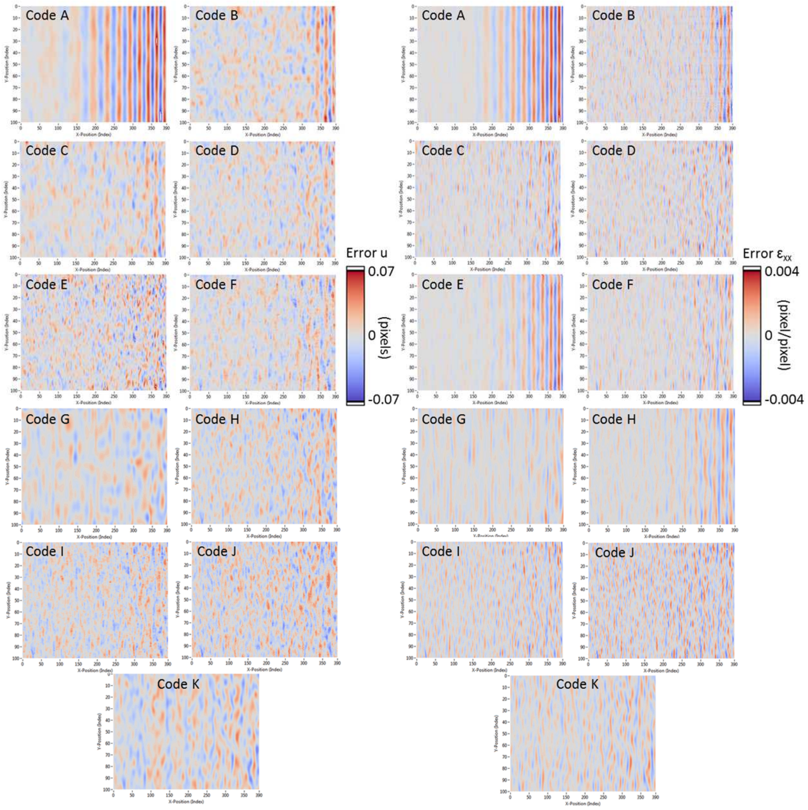

Figure 1. Full-field error plots for all 12 codes. Displacement (left) and strain (right) with all scales identical [1].

Conclusions

The complete results of the challenge are available in a journal article already published [1], but in brief, nearly all the codes supplied excellent results. The largest difference amongst the codes was in the trade-off between spatial resolution and noise. Unfortunately, the current challenge images did not have a high enough spatial gradient to truly challenge the DIC codes. To remedy this, a second 2D challenge has been initiated with images more suited to determination of spatial resolution [4]. New images will be available at www.sem.org. Researchers are strongly encouraged to use these images for better understanding of their commercial codes, improvements in their own DIC codes, and for publications that claim improvements in DIC algorithms. The current state of journal publications makes it impossible for readers to verify improvement claims made in journal articles. Instead, using the DIC Challenge images as a benchmark allows a clear path to an improved understanding of 2D DIC.

Future Work

The DIC Challenge format is continuing forward by developing images for Stereo-DIC, Scanning Electron Microscope DIC, and Digital Volume Correlation. Interested participants should contact the author for inclusion in future challenge rounds.

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