CORRELATE Manual

Digital Image Correlation Software

Virginia Polytechnic Institute and State University

Author: David Gayman

Date: 28 December, 2012

PART I: Introduction

Digital image correlation is a powerful computer-based technique for measuring strain fields. It works by comparing two images taken at different times and determining a mathematical description of the movement, or transformation, which an object in the pictures has undergone. A set of key points common to both images must be present. For materials with rough surfaces, it is possible to track regularly varying light and hue intensity features. For smooth surfaces typically a speckle pattern which results in high contrast between points is applied. It is not necessary to order these points as the correlation algorithm is able to handle an irregular distribution.

For this version of the software, a simplified technique is employed to pick out key points in each image. This technique requires these points to have approximately the same color and stand out from other objects in the image. In future iterations of the program, it will be possible to use dense speckle patterns with multiple hues.

PART III: Installation Instructions

This software is meant to be run on a Linux computer. Download the current distribution by changing into a parent directory for the repository and run the following commands:
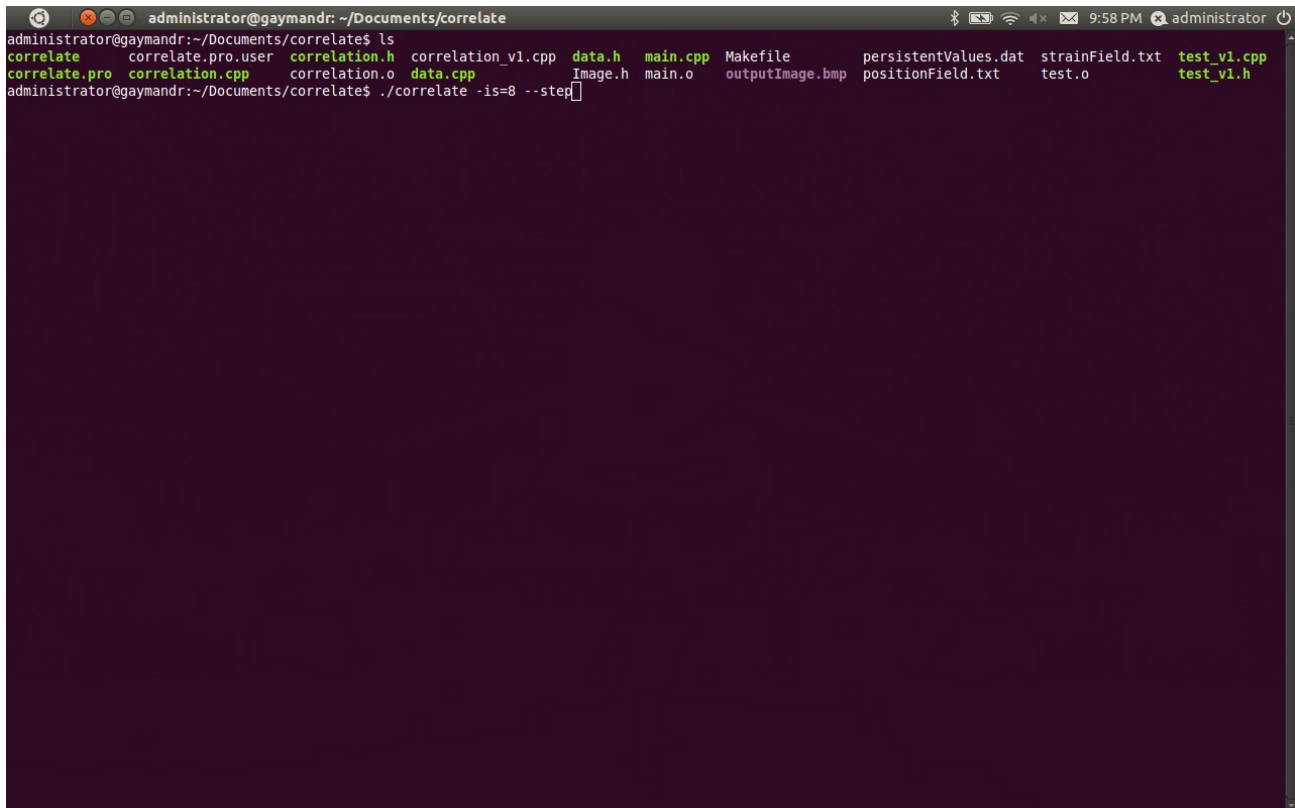
hg clone https://code.google.com/p/correlate
hg update
hg pull
qmake
make

To run the program, run ./correlate. Option flags can be used to select additional features. Part IV explains these options in detail.

PART IV: Operation Instructions

Step 1: Execute program from the command line by ./correlate. Several option flags are available. If no image sequence number is specified, then an internally-defined default is used.

Option	*Meaning*
-is=n	Analyze predefined image sequence n, where n is an integer.
--step	Step through analysis, showing results for each image in the sequence.
--enable-debug	Show information useful for debugging.
--enable-debug2	Show more detailed information useful for debugging.

Figure 1: Starting program from Linux command line

Step 2: Threshold image sequence by adjusting the "C1_lower," "C1_upper," etc. Four representative images from the sequence are displayed, equally spaced in the sequence.

Two color spaces are actively filtered, the RGB and HSV color spaces. The following summarizes how to adjust each threshold value:

Color Space	Color Component Label	Corresponding Color Component
	C1	R
0	C2	G
	C3	B
	C1	H
1	C2	S
	C3	V

The images should show only the points that are of interest for the strain calculation.
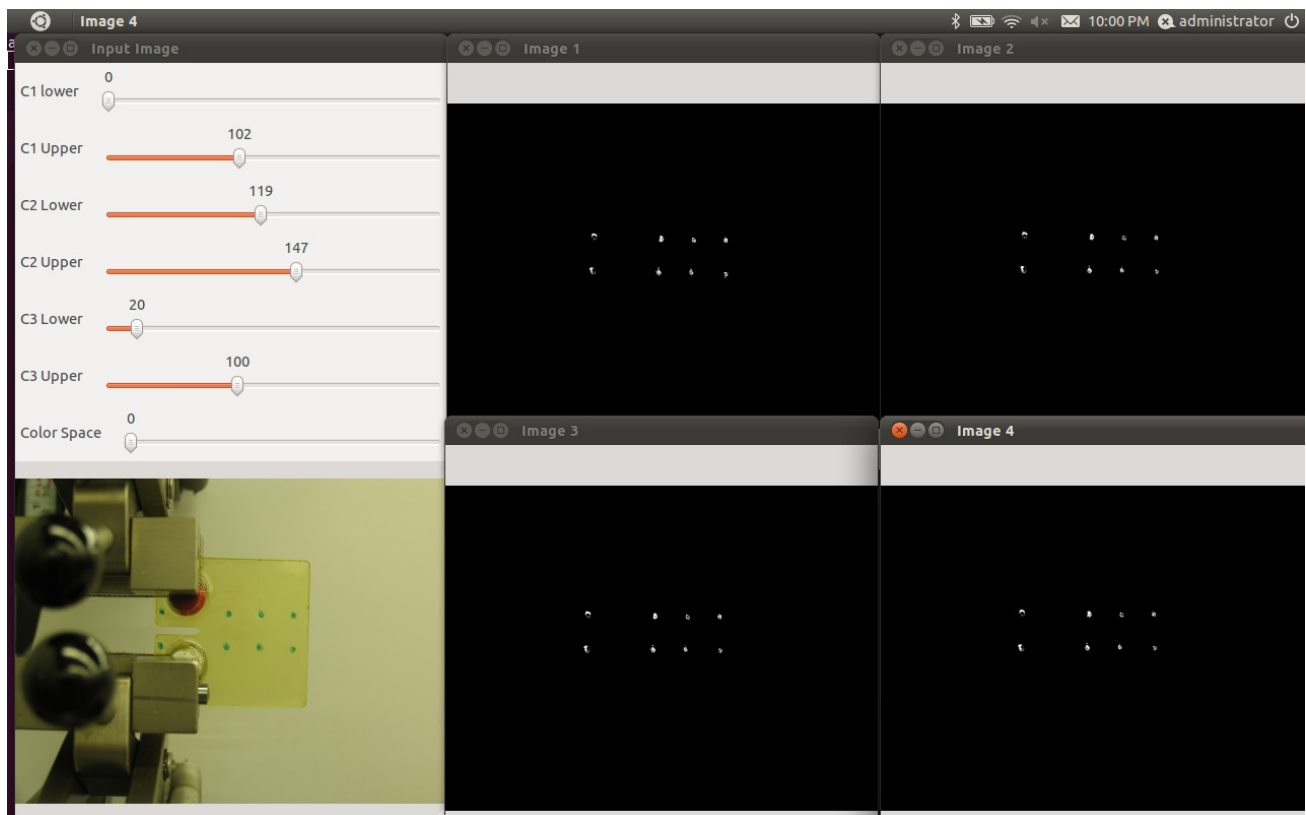

Figure 2: Thresholding image sequence

Step 3: Press any key to accept the thresholding values.

Step 4: Each image is processed in turn, and the displacement and strain fields are stored in the files "positionField.txt" and "strainField.txt." If --step was enabled, then each image is shown after processing. A visualization of the strain field at each time step is also shown. Press any key to continue processing.
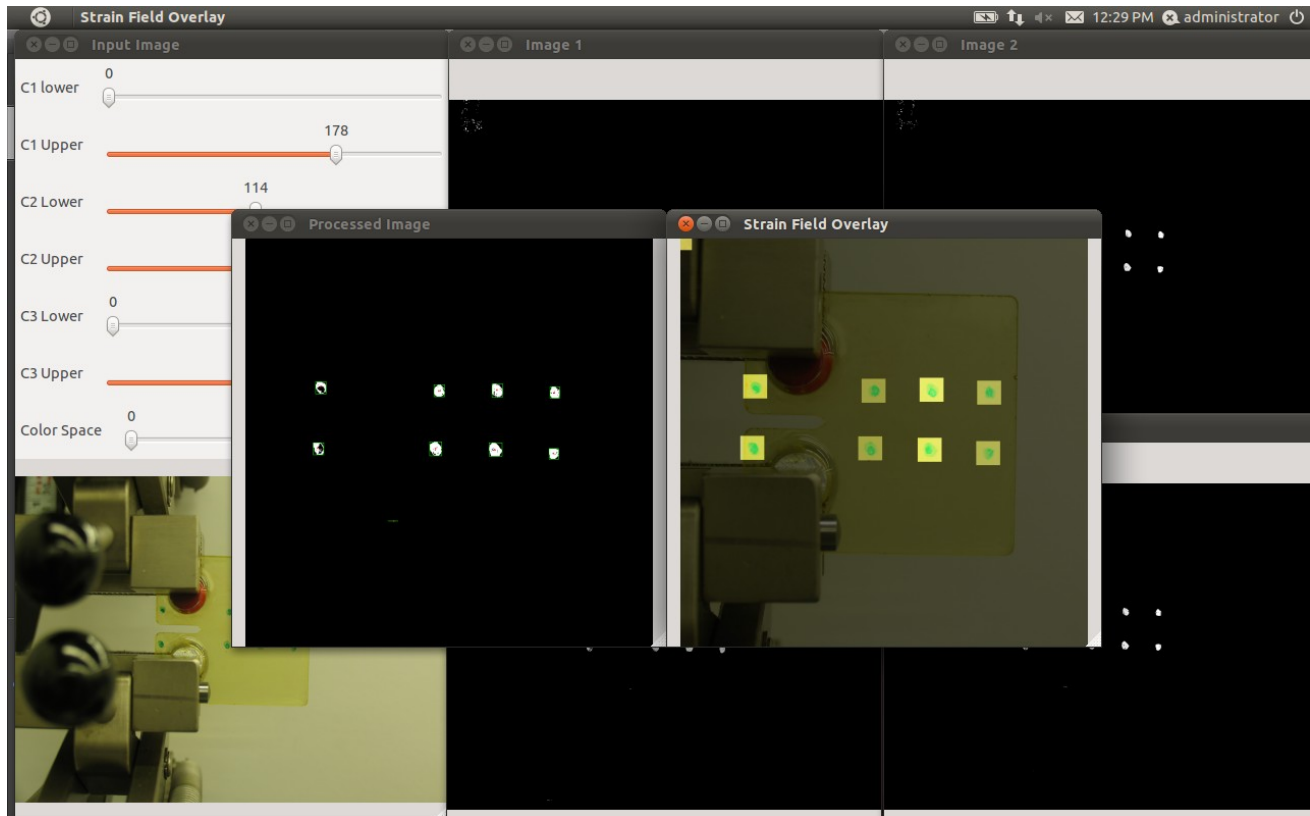

Figure 3: Processed image displayed after each step

Step 5: The final image in the sequence and a corresponding strain field visualization is displayed after all processing. Press any key to exit the program.

Step 6: The format for the data files is given in APPENDIX A. A visualization of the strain field is generated after CORRELATE has executed. Third-party software such as Tecplot can also be useful when interpreting results.

The visualization generated by CORRELATE consists of an overlay of the lightness component, which is proportional to the strain field strength. This is combined with the final image in the sequence.
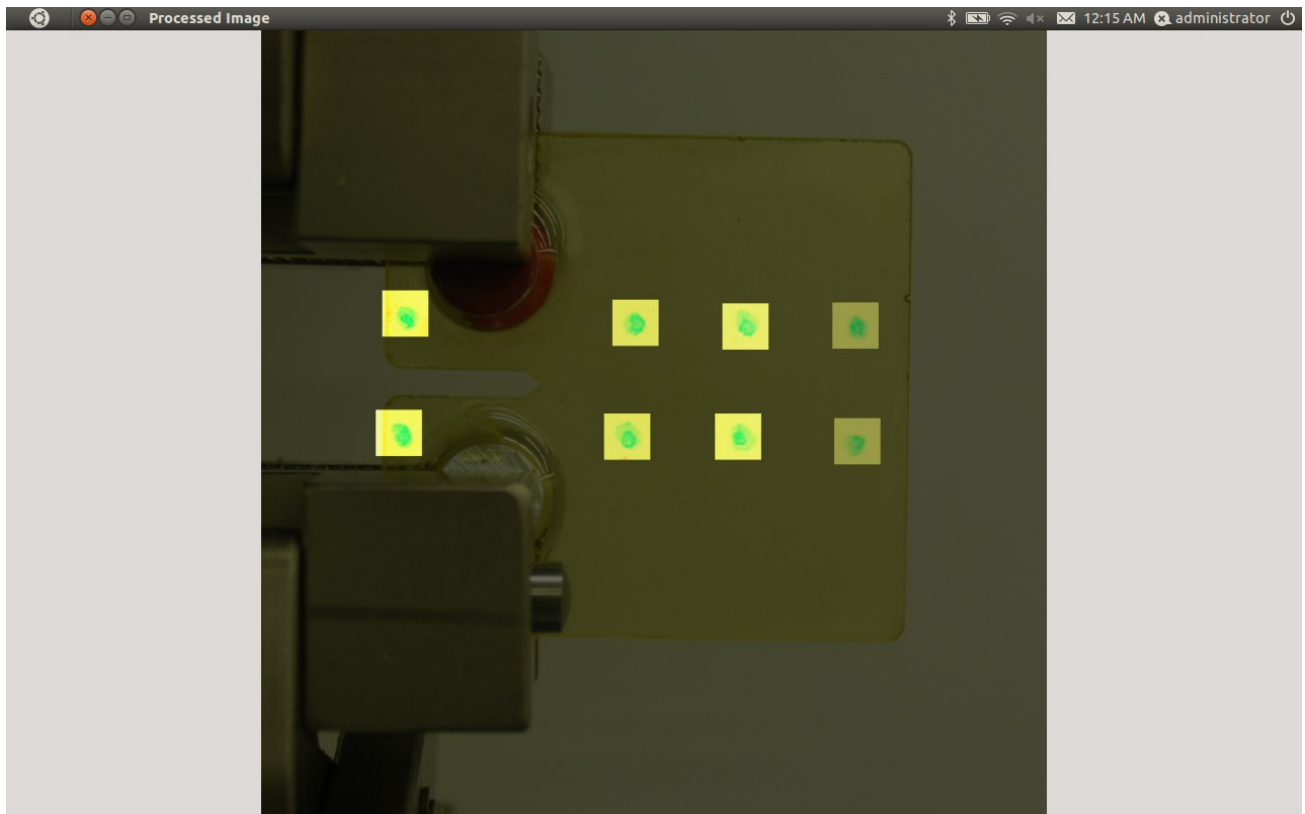
Figure 4: Visualization of strain field by varying intensity, generated by CORRELATE

APPENDIX A: Data File Standards

Two data files are generated by CORRELATE. The first is "positionField.txt." Blocks of information are delineated by a single carriage return. The first block contains internal information which the algorithm uses to calculate strain. Each subsequent block lists the horizontal and vertical (in that order) locations of the points which are being tracked at each time step. Points are listed in the order they are detected from the first image in the sequence, where internal techniques are employed to ensure subsequent points are stored in the same order. Values of -1 indicate a dropped point, meaning that it was not possible to detect a point during a particular time step. Units of position are image pixels.

The second file, "strainField.txt," contains the calculated strain field. The values at each point is listed for each image, where time steps are again separated by a carriage return. Four strains are given for each point, which are in order the xx, xy, yx, and yy directions. Zero strain is assumed to exist everywhere in the initial image. The strain calculation is not run for dropped points. Thus zero values for strain at points in images other than the first can indicate either machine-zero or a failed strain calculation. The corresponding location in the position field file must be used to make a determination.