APPENDIX

Listed below are the seven DVC algorithm MATLAB files with a description of their functional tasks. The files are listed in the order in which they are executed.

`filelist_generator3.m`:

This function cycles through all datafiles (*i.e.*, images) and assembles a master file list containing the names of all datafiles to be processed. The total number of rows contained within the file list is equal to the total number images to be processed.

`grid_generator3.m`:

This function generates a rectangular cuboid grid of control points. The rectangular cuboid control point grid is generated by defining a 2D rectangle and extruding the rectangle to a desired depth. Independent in-plane and out-of-plane control point spacing parameters are used to determine the density of the control point grid. Each control point serves as the central location of a subvolume.

`automate_image3.m`:

This function serves as the central program that loops over all volumetric images while calling other subfunctions to perform the correlation tasks. Within this function, individual 2D image intensity data is read and sequentially stacked together to form volumetric images. User inputs are used to define the number of 2D images per volumetric image, as well as the dimensions of the discretized subvolumes. The volumetric images are passed to `cpcorr3.m` for correlation.

The volumetric displacement results of the correlation are passed back to `automate_image3.m` and used to update the control point locations for subsequent correlations. All 3D displacement data are saved in ASCII format.

`cpcorr3.m`:

This function loops over all subvolumes while calling other subfunctions to perform the NCCC calculation. Within this function, subvolumes are extracted from undeformed and deformed volumetric images. Corresponding subvolume pairs are passed to `normxcorr3.m` for calculation of the NCCC array. Individual subvolume displacement measurements are passed back to `cpcorr3.m` after determining the peak of the NCCC array. Prior to correlation, checks are implemented to ensure that the subvolume boundaries are contained within the boundaries of the volumetric image. NCCC thresholds are set such that only displacement measurements that exhibit a minimum level of correlation are valid.

`normxcorr3.m`:

This function calculates the NCCC array of deformed subvolumes with respect to corresponding undeformed subvolumes. The correlation algorithm accounts only for rigid-body translations between corresponding subvolumes. Correlation is performed in the Fourier domain and then transformed to the spatial domain in order to reduce the number of computational operations. The NCCC array contains values ranging between [-1,1]. Maximization of the 3D NCCC array provides a means for performing nearest-voxel displacement measurements between deformed and undeformed subvolumes. The NCCC array is passed to `findpeak3.m` in order to determine the interpolated maximum of the NCCC array. The location of the interpolated

maximum of the NCCC array is passed back to `normxcorr3.m` to provide displacement measurements between corresponding subvolume pairs.

`findpeak3.m`:

This function calculates the peak position of the NCCC array to subvoxel accuracies. A 3D quadratic polynomial fit is applied to the maximum and 26 nearest-voxel neighbors of the NCCC array. Maximization of the 3D quadratic polynomial fit provides a means for determining the interpolated peak of the NCCC array. Locating the interpolated peak of the NCCC array provides a means for performing subvoxel displacement measurements between deformed and undeformed subvolumes.

`displacement3.m`:

This function serves to analyze and visualize the displacement data. The displacement data can be refined and visualized using cumulative distribution functions, 3D vector plots, and displacement versus position plots projected along specimen axes. By analyzing the gradients of the 3D displacement field, normal volumetric strain components are resolved along the specimen axes.