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Smart speed imaging in Digital Image Correlation: Application in seismotectonic scale model experiments

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Analogue earthquake and seismic cycle models are characterized by strong variations in strain rate: from slow interseismic loading to fast coseismic release of elastic energy. Deformation rates vary accordingly from micrometer per second (e.g. plate tectonic motion) to meter per second (e.g. rupture propagation). Additionaly, deformation values are typically very small over one seismic cycle in the order of few tens of micrometer because of the scaled nature of such models.

Applying digital image correlation (DIC) methods requires image pairs which show deformation significant enough to be detected (usually >0.01-0.1 Px) and therefore the period covered by image pairs of images should scale inversely with the deformation rate. In the presented experiments high speed (>100 Hz) imaging is required to capture the rupture process while slow speed imaging <10 Hz is sufficient for interseismic loading given the accuracy of the DIC method in this application (ca. micrometer).

In order to prevent over-sampling of the cyclic process to acknowledge transmission and storage capacity limits we developed a tool which allows on-the-fly scaling of imaging frequency with strain rate based on an external trigger signal and a ring buffer. The external trigger signal comes from a force sensor that independently detects stress drops associated with analogue earthquakes triggering storage of a short high frequency image sequence from the buffer. After the event passed, the system returns to a low speed mode in which image data is downsampled until the next event trigger. Using this tool, we are able to reduce the image data by a factor of at least 10 from 3 TB for a typical experiment to less than 300 GB. In future, we plan to implement an on-the-fly virtual strain meter in the DIC software in order to trigger high-speed imaging internally instead of externally.