Dimensional changes of library objects using digital image correlation

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Introduction

Library materials such as paper and parchment are very sensitive to moisture. Substantial humidity fluctuations may cause dimensional changes leading them to lose mechanical stability as can be seen in Figure 1. In order to investigate dimensional changes, the first step is measuring deformation. However, there is no established method of measuring deformation for library objects. The technique, Digital Image Correlation (DIC) is a method of measuring deformations of surfaces or in volumes of a specimen from different images.[1] DIC is inherently contactless and non-destructive method so that it cannot fail to appeal in the context of heritage sector. This study aims to see whether DIC is the useful technique to measure deformations of library objects.
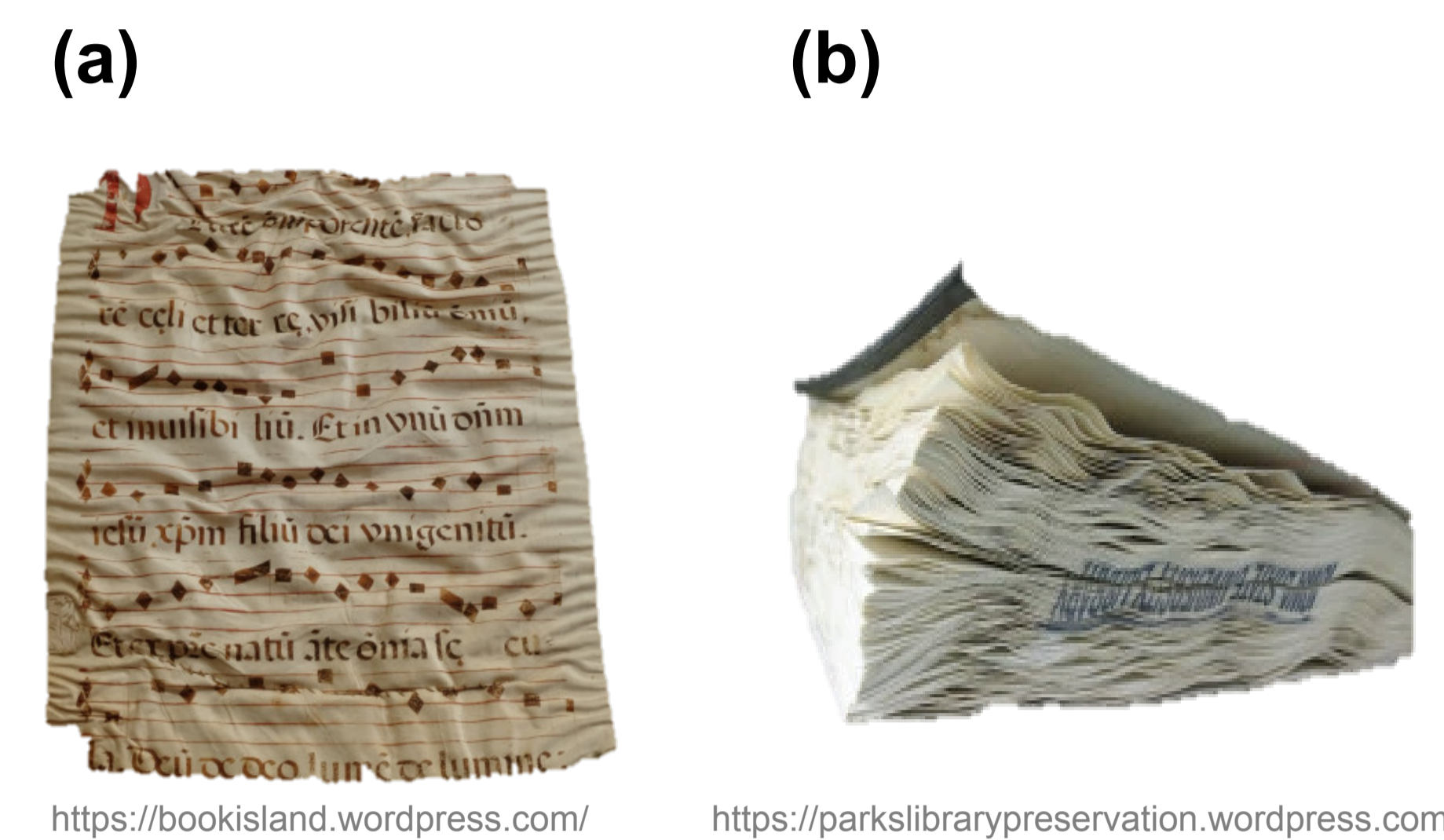
(a) **(b)**

https://bookisland.wordpress.com/   https://parkslibrarypreservation.wordpress.com

Figure 1. Warped library objects
(a) Historical parchment, (b) Paper book

Research Questions (RQ)

In order to figure out whether DIC is an appropriate measurement method, this study investigates DIC measurement technique. In general, DIC measures 2D deformation for 2D objects and 3D deformation for 3D objects. Most library objects are 2D but they have a possibility of 3D deformation such as warping. The study is based on the following research questions to determine the type of measurement technique.

1. **What useful information can DIC provide?**
2. **What is the accuracy of DIC data?**

Methodology

Digital Image Correlation

measures a specimen deformations by tracking random surface patterns taken from images.

- Specimen: A sheet of parchment
- Camera: VC-Imager X-Lite 11M, LaVision
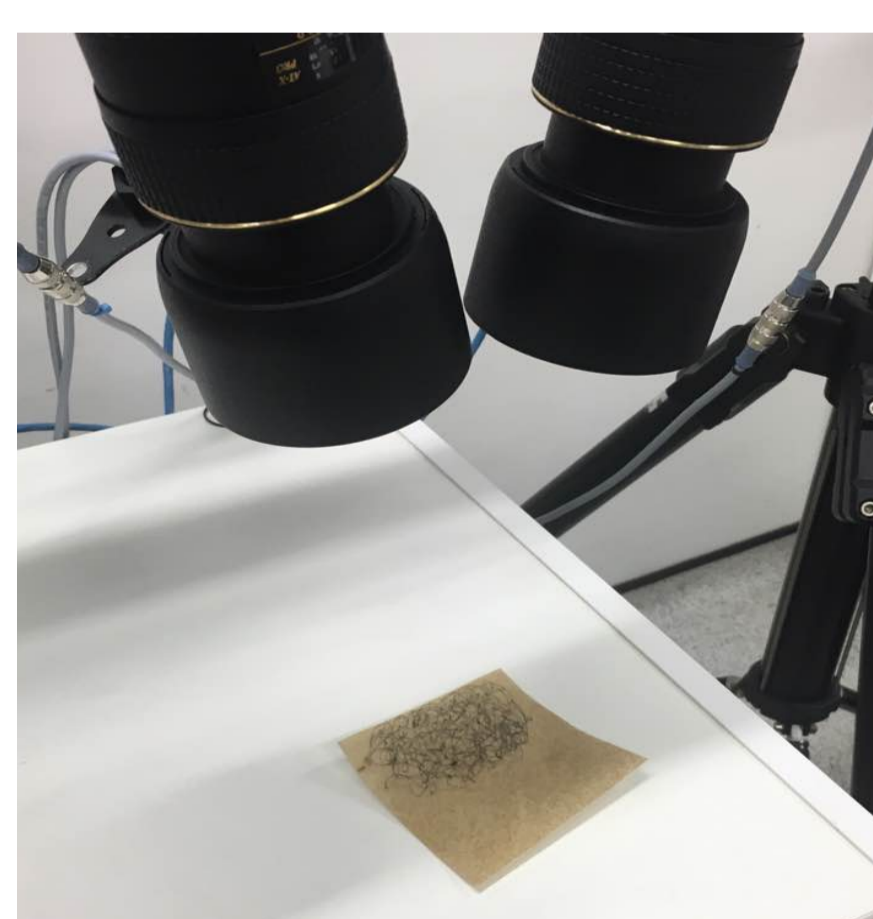- Software: Davis 8.1.6 H, LaVision

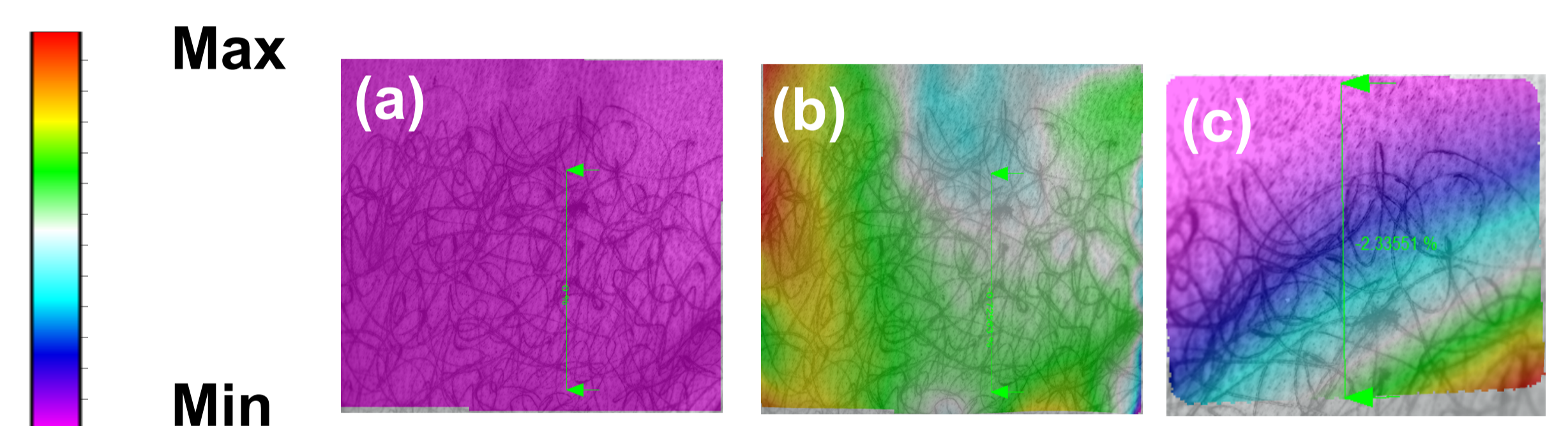Figure 2. Experimental setup for 3D deformation measurement

Initial Results

Max

Min

(a) **(b)** **(c)**

Figure 3. Deformation indicated by colour
(a) Non-deformation, (b) 2D deformation, (c) 3D deformation

— 2D deformation — 3D deformation
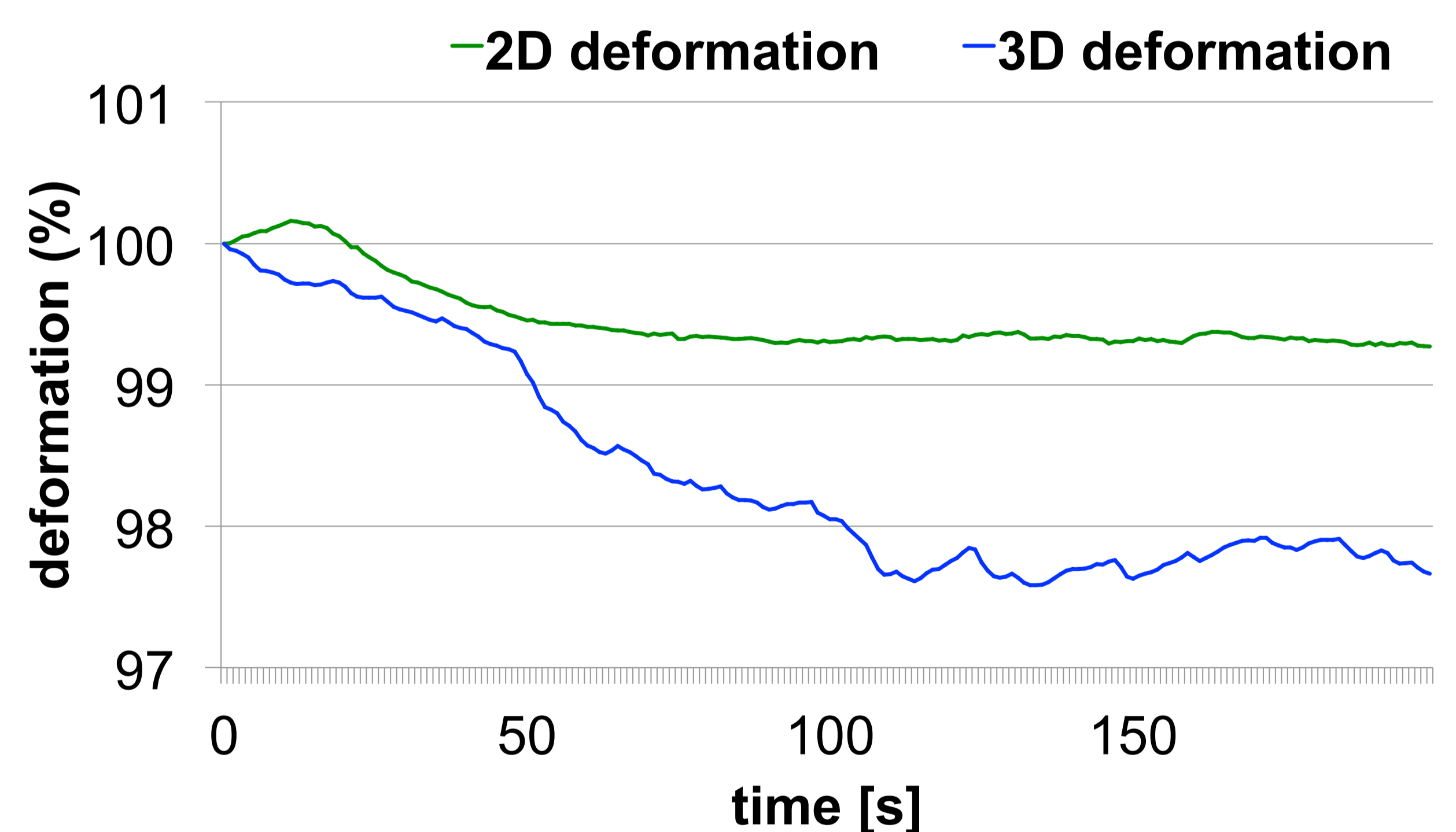
deformation (%) vs time [s]

Figure 4. A sheet of parchment deformation percentage (%)

Figure 3 shows the different deformation in 2D and 3D. In Figure 4, less deformation occurred in 2D and it had some increases in the length at the beginning of the test. This implies that there was a possibility of data loss in 2D deformation. Since it could not measure the out-of-plane deformation such as warping.

Intended Outcomes and Future Work

The project will establish the deformation measurement method for library objects. This will increase an understanding of mechanical behaviours of library objects by measuring their deformations. Future work will develop experimental setup to get more useful data from DIC (RQ 1) and investigate the software to optimise calibration technique (RQ 2).

Reference [1] Bornert, M., Hild, F., Roux, S., & Orteu, J. (2012), *Full-Field Measurements and Identification in Solid Mechanics* (Chapter 6. Digital Image Correlation, pp. 157 - 190), John Wiley and Sons.