Calibrating Force Signals and Video Streams

Curtis Tremblay

School of Computing, Queen’s University, Kingston, Ontario, Canada

Supervisors: Dr. R. E. Ellis and Dr. M. S. Hefny

1. Introduction

Research is currently being conducted on how to surgically stabilize wrist fractures with a dedicated mechanical testing system (figures 1 & 2). This system returns data in the form of two independent signals. Combining these signals requires an alignment of these two signals in time, a process known as ***temporal calibration.***

2. Objective

The goal of this project was to automate this temporal calibration. This will provide improved accuracy and efficiency of analysis for the remaining datasets as well as for other repeatable experiments.

3. Procedure

This automation required several steps:

i) Coarse Calibration

- Data was given a time scale based on the capture frequency of the two devices (video camera and machine signal)

ii) Fine Calibration

- The start and end points for each signal were located, and extra data points were trimmed.
- Points of interest (ex. drastic changes in slope) within each signal were located and the magnitude of these points were compared for each signal
- A least squares fit was performed on the array of points in order to provide a scaling factor. The remaining points were filled in based on their location relative to the points of interest. The results of this fit can be seen in figures 3 and 4.

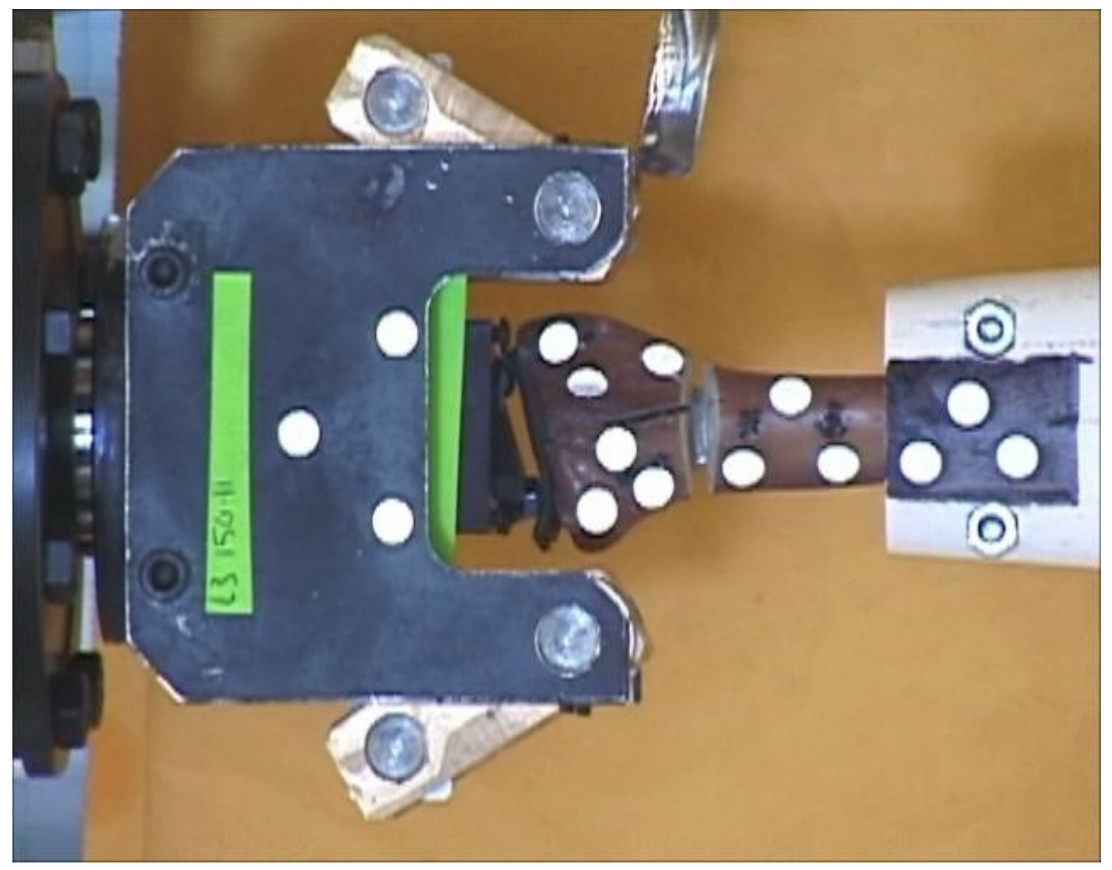

Figure 1. Distal radius machine test. This frame has been extracted from video data used for analysis. Results have been sampled in figures 4 and 5.

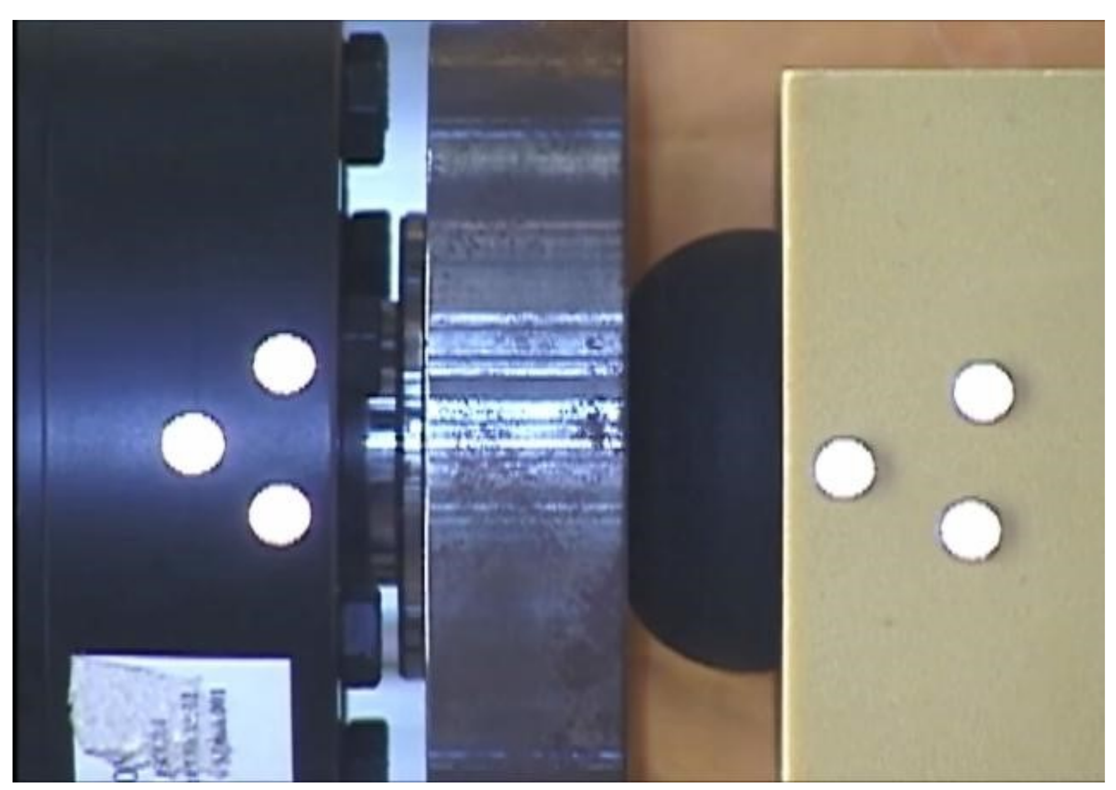

Figure 2. Sorbothane shock absorption pad test. This frame has been extracted from the video data used for analysis. Results have been shown in figure 6.

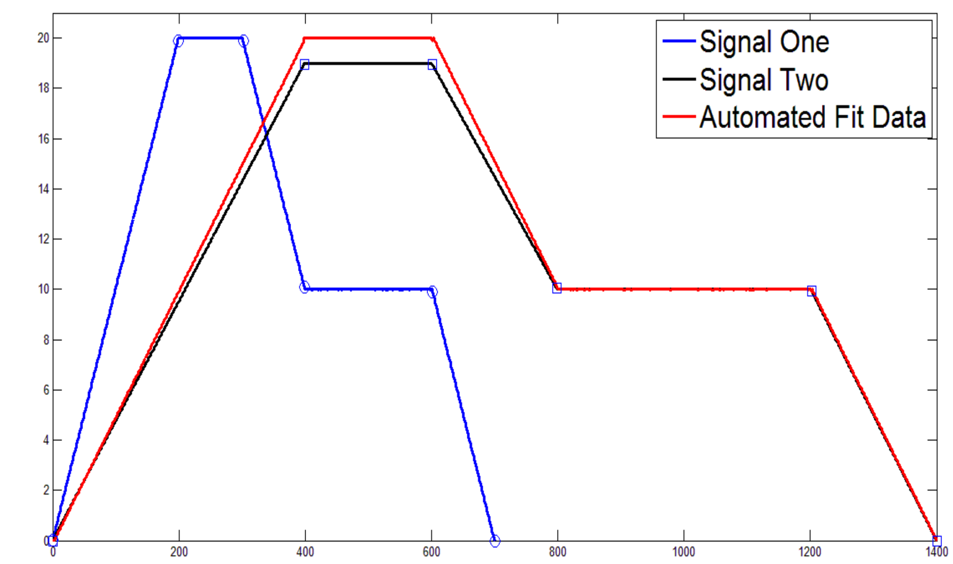

Figure 3. User Generated Test Dataset. Signal one has been scaled to match signal two.

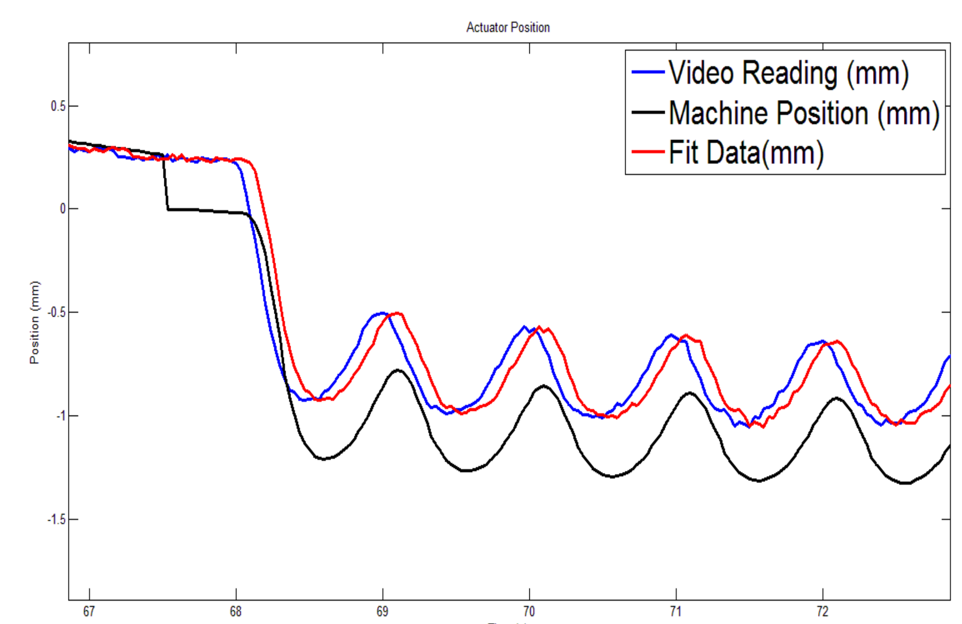

Figure 4. Distal radius actuator position graph. Calibrated data follows the time scale of the machine signal while using the values from the video data.

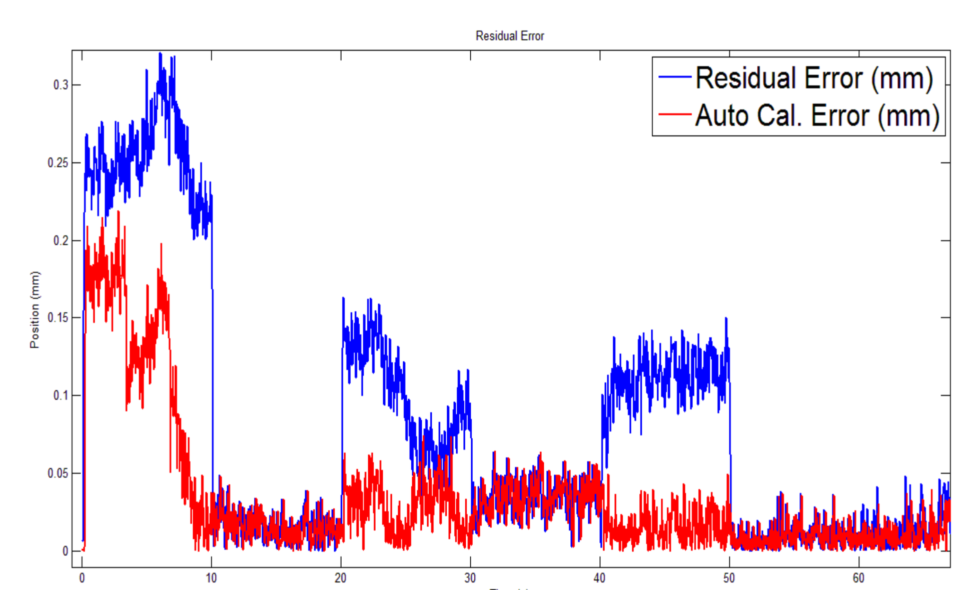

Figure 5. Residual error between the two signals for distal radius test. Automatically calibrated data shows a more consistent and lower error.

4. Results

Following the implementation of the automated calibration, the residual error between the two signals decreased beyond the values obtained through manual calibration (shown in figures 5 & 6).

Calibration time also significantly decreased, often requiring only a single iteration through the automated calibration code.

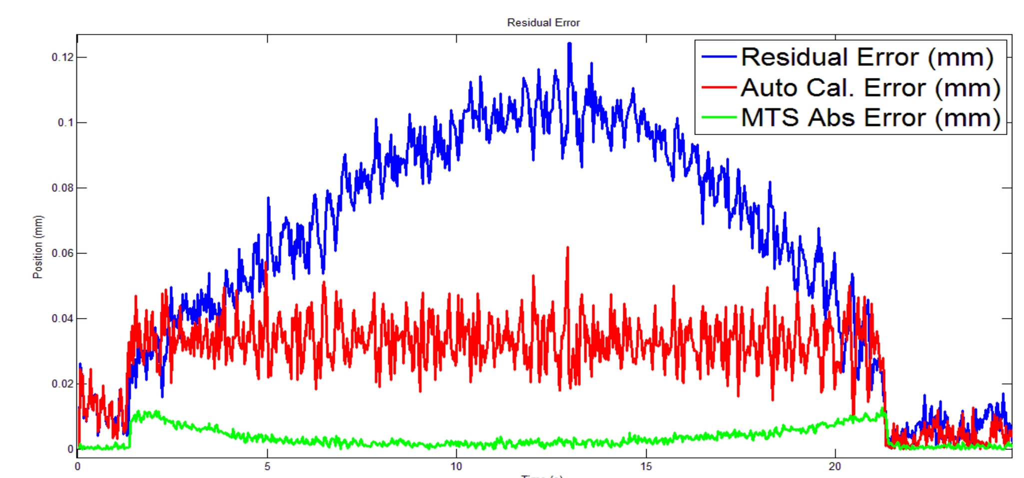

Figure 6. Residual error between the two signals for sorbothane test. Calibrated data shows a lower residual error.

5. Discussion

Although the automated calibration showed success for the trials examined, to ensure its continued success for future application, the following steps should be taken:

- Threshold values for points of interest should be procedurally determined to accommodate greater variety of input signals
- Machine data should be resampled to capture more accurate signal values
- Timer should be based off machine signal rather than the camera signal in to better accommodate rapid movements of the testing apparatus
- Spatial calibration should be performed to obtain a better fit between signals