Software for Molecular-sensing Application-oriented Postprocessing

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1. Background and objective

Pressure sensitive paint (PSP) measurement system has been established and now widely used for many engineering problems. However, PSP measurement needs a lot of post-processing steps such as smoothing, marker detection, image registration, and temperature calibration (Fig.1) and their manual processing is very time consuming. Therefore, there is an increasing demand on development of software for post-processing of PSP measurement.

The objective of this study is to develop user-friendly GUI-based software [SMAP] for automated image data processing for PSP measurement.

2 Functions of SMAP

2.1 Smoothing

As the image taken by the CCD camera includes shot noise, noise reduction method is indispensable for accurate PSP measurements. Five type of filter: Cell average, Median, Selection, Compact, Wavelet transform are prepared for developed software SMAP. Especially, wavelet transform is effective for noise reduction as it does neither create unphysical peaks nor smear the physical discontinuity.

2.2 Marker detection and Image registration

It is important to estimate the model displacement correctly during wind-on in the wind tunnel test, as the ratio of the wind-off image to the wind-on image is necessary for computing the pressure data for PSP measurement. Figure 2 shows an example of pressure distribution obtained without the image registration, which shows importance of the image registration. In most cases, the image registration depends on evenly-pointed markers located on the model surface as reference points as shown in Fig. 3. The marker points are usually read by a person manually and the pixel locations in the image are determined. Therefore, both manual and automatic marker detection are prepared in SMAP as shown in Fig. 4, as it is necessary in order to advance image data processing efficiently.

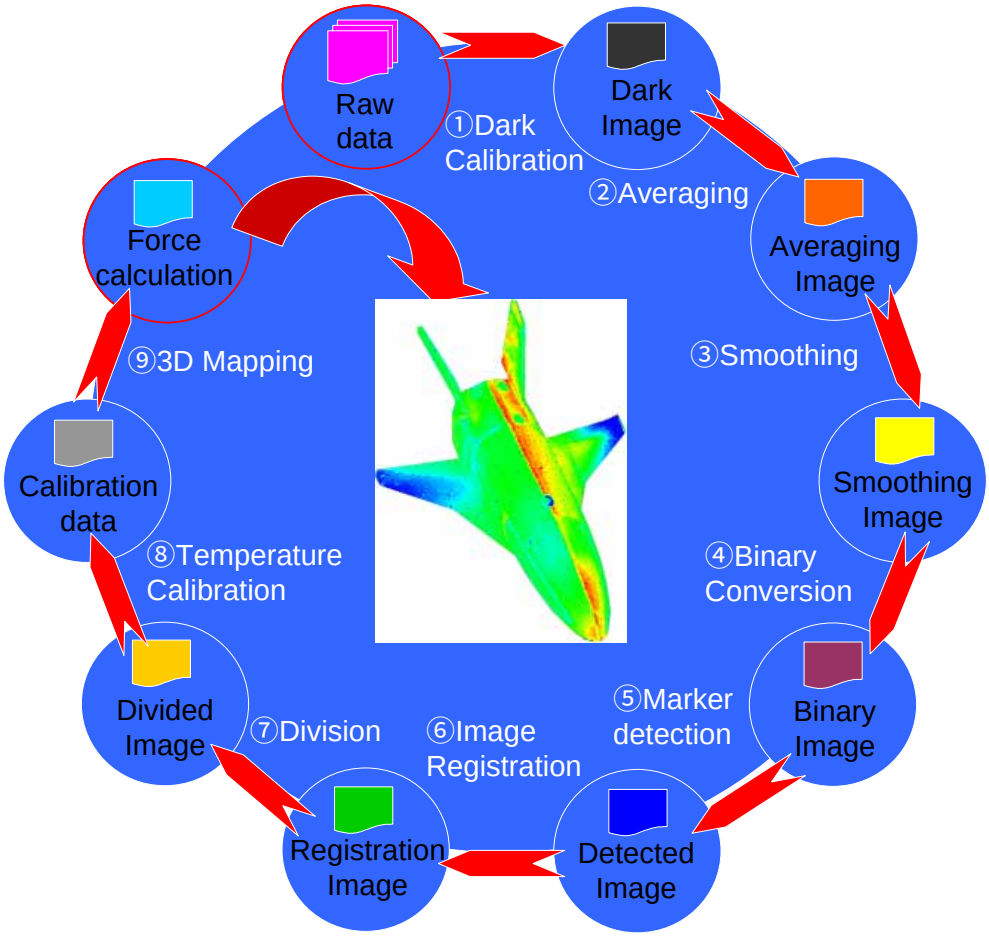

Fig. 1 Flow chart of image data processing of PSP measurement.

For image registration, not only marker detection using reference points but also the edge detection using the characteristic points of the model is prepared in SMAP. As a result, even if the displacement of a model is large and a model configuration is complicate as like space-shuttle-type model, the image registration could perform accurately by using these methods as shown in Fig. 5.

2.3 Temperature calibration

Temperature calibration is necessary for accurate PSP measurement. This operation is easily performed using SMAP. The user defines the symmetric line dividing pressure and temperature area as shown in Fig.6 and the user inputs reference temperature and calibration coefficients which are obtained by calibration test. Then, temperature calibration will be automatically completed.

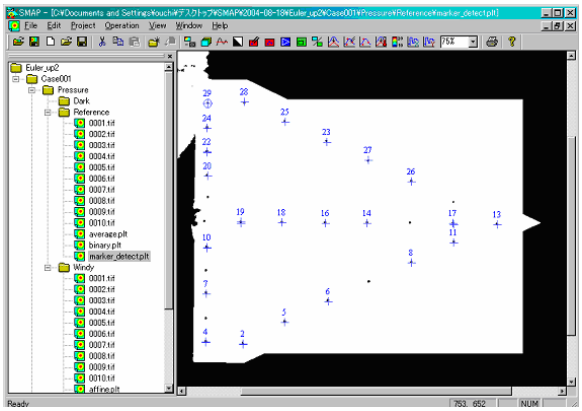

Fig. 4 Image of automatic marker detection in SMAP.

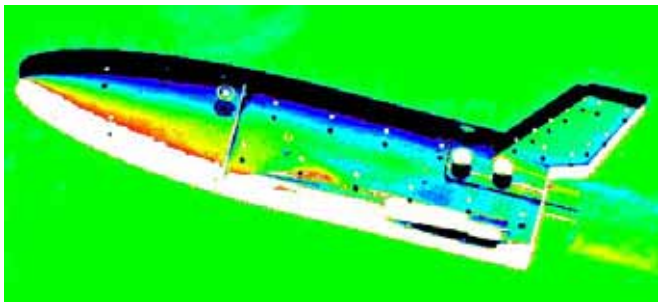

Fig. 2 Obtained pressure distribution before image registration.

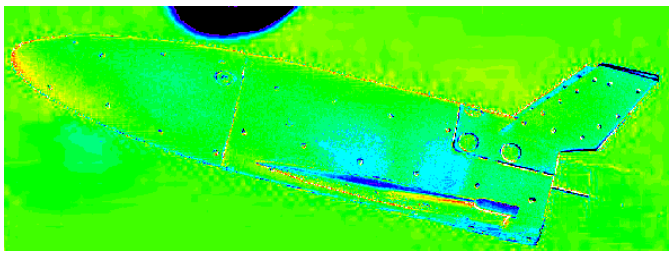

Fig. 5 Obtained pressure distribution after image registration.

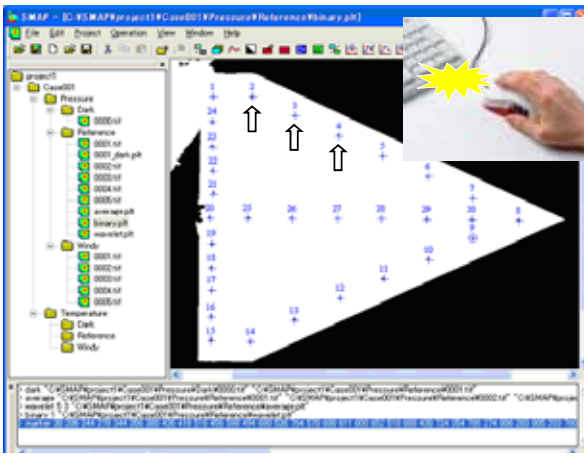

Fig. 3 Image of manual marker detection inSMAP.

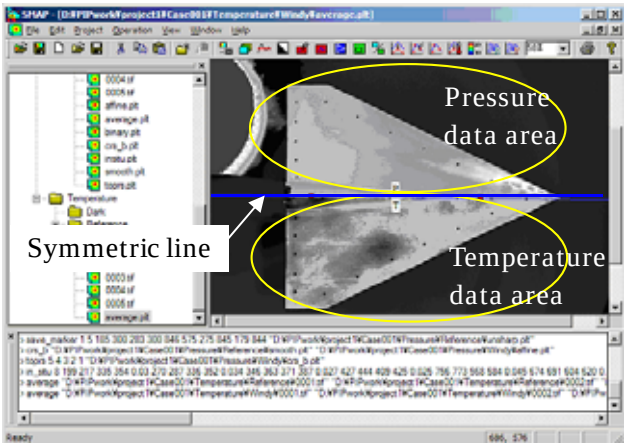

Fig. 6 Image of temperature calibration in SMAP.