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Visual interactive image clustering: a target-independent approach for configuration optimization in machine vision measurement

Key words: Machine vision measurement; Lighting scheme design; Parameter optimization; Visual interactive image clustering

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Motivation

1. Machine vision measurement (MVM) is an essential approach for product quality control in industry, especially in manufacturing and process industries.
2. The result of MVM is determined by its configuration, especially the lighting scheme design in image acquisition and the algorithmic parameter optimization in image processing.
3. In a traditional workflow, engineers constantly adjust and verify the configuration of MVM for an acceptable result, which is time-consuming and significantly depends on expertise.

Method

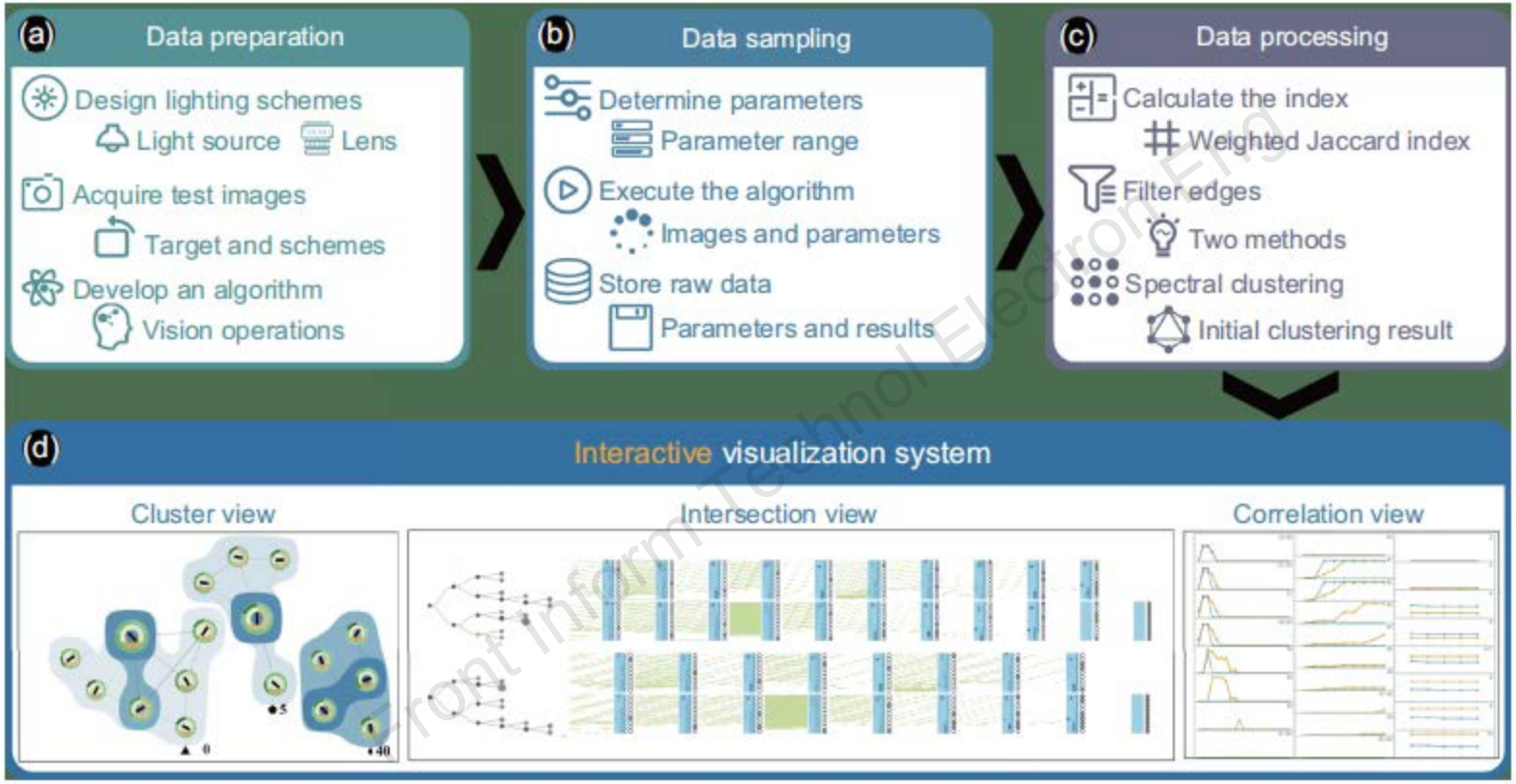
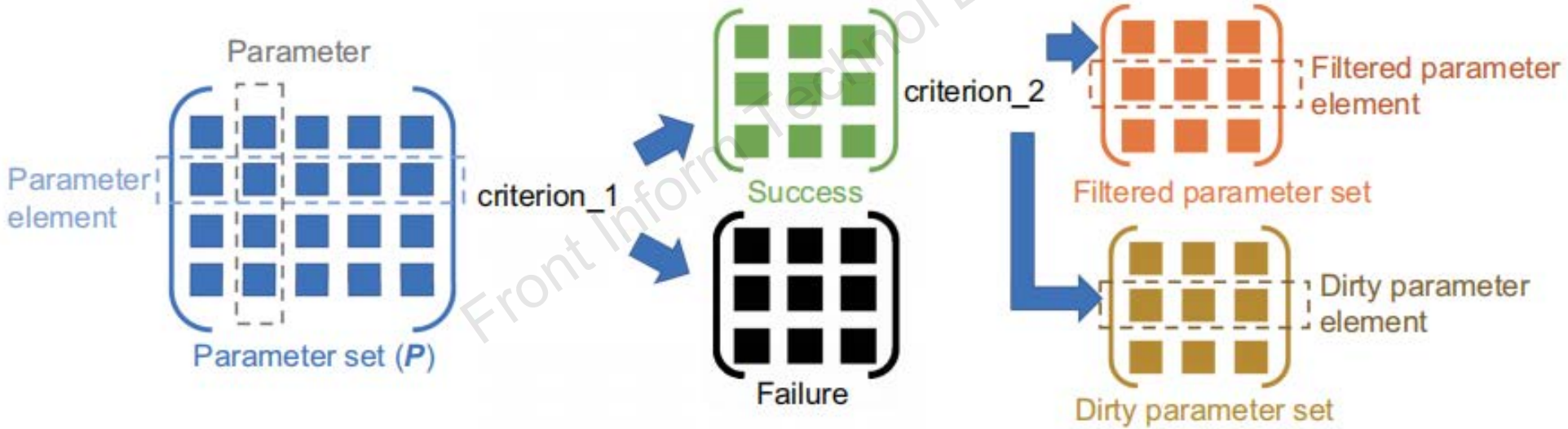


Fig. 1 Pipeline of visual interactive image clustering: (a) data preparation; (b) data sampling; (c) data processing; (d) visual analysis with our visualization system

Method (Cont'd)

Sample interesting algorithmic parameters for all images under different lighting schemes (data sampling).



Method (Cont'd)

Weighted Jaccard index (WJI) using algorithmic parameters to measure the relationship among images (data processing).

$$\mathrm{WJI}\left(\boldsymbol{P}_i, \boldsymbol{P}_j\right) = \frac{\sum\limits_{e} f^{e}}{\sum\limits_{e'} f^{e'}}, \tag{1}$$

where

$$\begin{cases} e \in \boldsymbol{P}_i \cap \boldsymbol{P}_j, \\ e' \in \boldsymbol{P}_i \cup \boldsymbol{P}_j. \end{cases} \tag{2}$$

Method (Cont'd)

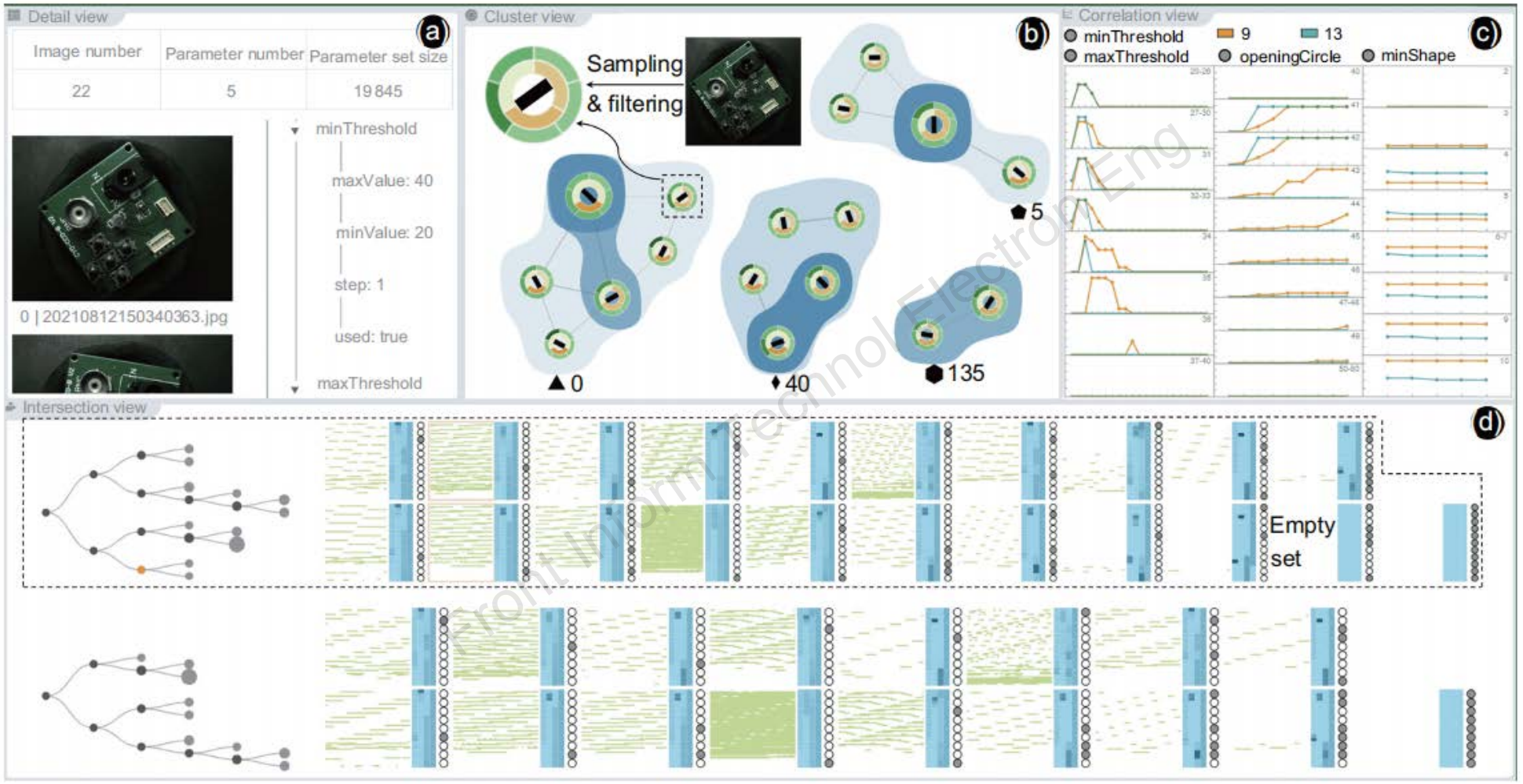


Fig. 3 System interface: (a) detail view provides basic information about the sampled data; (b) cluster view shows the clustering result with multi-layer bubbles as identification; (c) correlation view uses a matrix-based line chart to present the correlation between two parameters; (d) intersection view presents the intersection process of selected parameter sets (References to color refer to the online version of this figure)

Conclusions

1. We propose an explainable measurement to assess the relationships among images using algorithmic parameters.
2. We propose a target-independent approach, visual interactive image clustering, which is based on parameter sampling and visualization to facilitate configuration optimization in MVM.
3. We present VMExplorer, a visual analytics system with coordinated views, which supports the configuration exploration of images and parameters.

Guodao SUN is an associate professor at the College of Computer Science and Technology, Zhejiang University of Technology, Hangzhou, China. He received his PhD degree in control science and engineering from Zhejiang University of Technology, Hangzhou, China, in 2016. He is interested in exploring large data using interactive visual analytics with focus on data such as urban data, social data, and video data.