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Light field imaging for computer vision: a survey

Key words: Light field imaging; Camera array; Microlens array; Epipolar plane image; Computer vision

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Motivation

- Light field (LF) imaging technology has made great contributions to computer vision because it uses cameras or microlens arrays to record the position and direction information of light rays, acquiring complete three-dimensional (3D) scene information.
- Light field imaging has achieved great success in various studies. Over the past 25 years, more than 180 publications have reported the capability of LF imaging in solving computer vision problems. We summarize these reports to make it easier for researchers to search the detailed methods for specific solutions.

Method

- In the 120-year history of light field imaging, the rapid application of optical field imaging technology to computer vision has occurred mainly in the last 25 years. Therefore, the research studies summarized in this report were selected primarily from this period. The main developments over that period were as follows: (1) from 1996 to 2010, initial development and application of light field imaging; (2) from 2010 to 2015, rapid development of light field imaging in computer vision research; (3) from 2015 to 2021, peak period of light field imaging.

Method

- We summarize the development of light field imaging technology in computer vision, and discuss the possible research directions and challenges of light field vision. In most cases, we provide a comprehensive list of references to enable researchers to better select and summarize the advanced ideas, along with the key methods.

Major results (reviews)

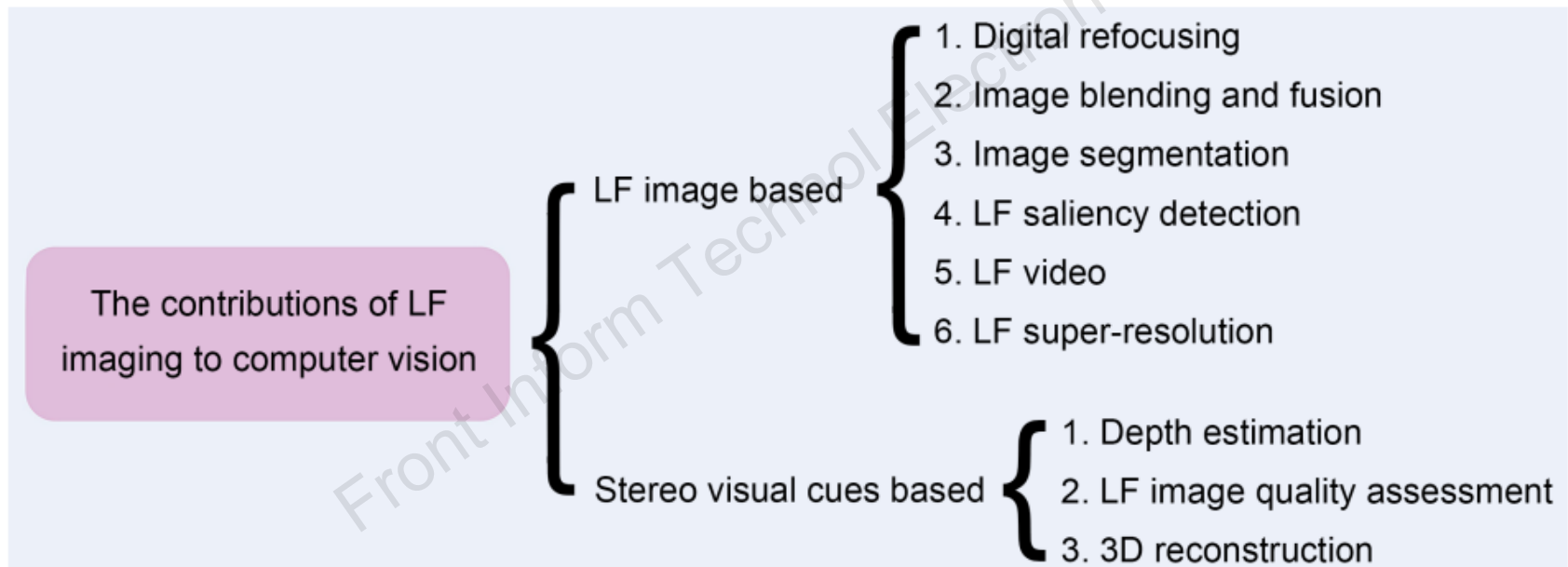


Fig. 1 The contributions of light field (LF) imaging to computer vision

Major results (reviews)

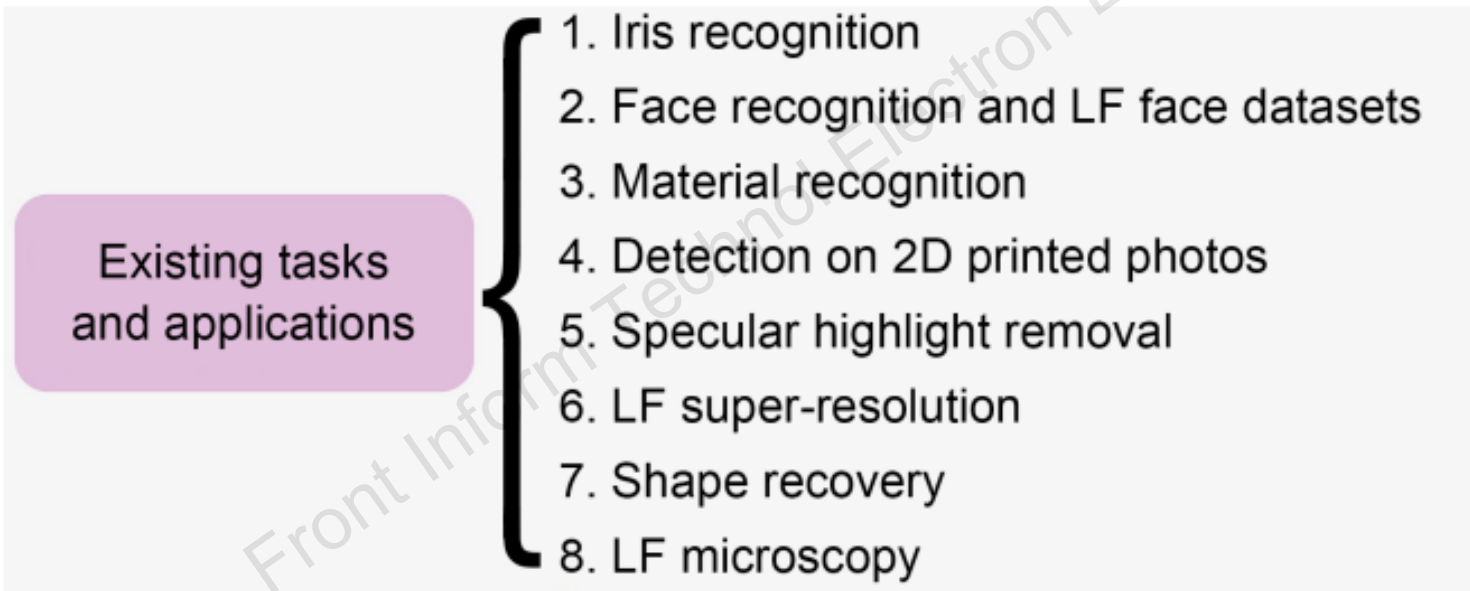


Fig. 2 Eight existing tasks and applications

Major results (reviews)

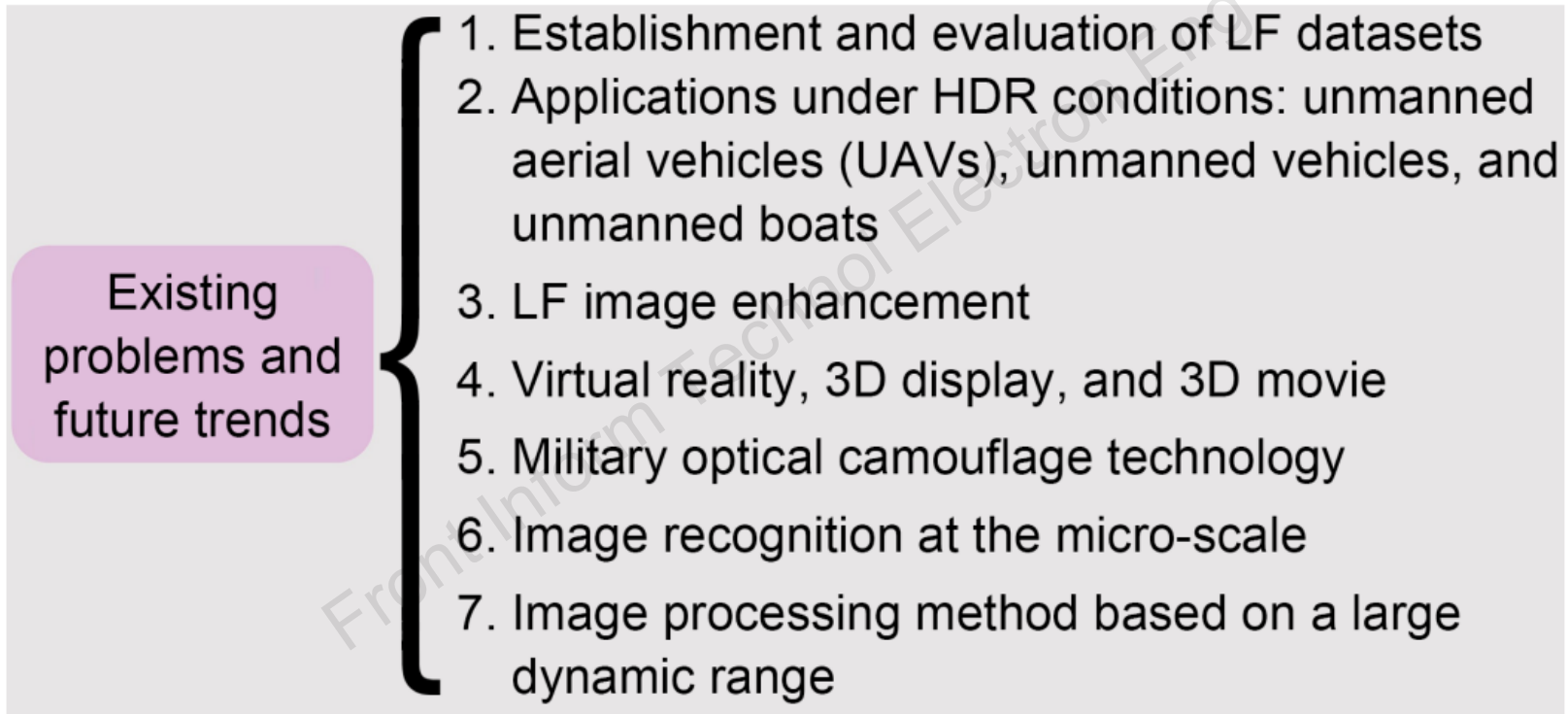


Fig. 3 Seven existing problems and future trends

Conclusions

- Light field imaging technology aims to establish the relationship among light information in the spatial domain, visual angle, spectrum and time domain, and realize coupling sensing, decoupling reconstruction, and intelligent processing.
- We have summarized the importance of light field imaging technology for computer vision tasks and listed representative contributions from all interested researchers.

Conclusions

- The representative studies were focused mainly on depth estimation, image segmentation, saliency detection on light field, light field image quality assessment, image blending, fusion, face recognition, and light field super-resolution. Applying spatial information, angular information, and epipolar plane image information in the light field to computer vision tasks was also investigated. Benefiting from the progress of software and hardware, light field cameras are gradually applied to industrial detection, unmanned systems, and virtual reality fields. It has significant academic value and industrial application prospects.



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