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Segmentation and focus-point location based on boundary analysis in forest canopy hemispherical photography

Key words: Fisheye lens, Least squares method, Image segmentation,
Ecology in image processing, Hemispherical photography

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Motivation

- The forest canopy is the most direct and active interface layer with regard to interaction with the environment, and forest structural analysis is one of the key problems faced in ecological research. Among the various indirect techniques, the use of digital hemispherical photography (DHP) has soared in the past few years partly due to the advent of digital photography and continuing improvements in computer technology.
- Different cameras with different fisheye lenses will have different imaging ranges. So, a fixed radius and center cannot meet the requirements of the hardware. Most importantly, the radius and the center cannot be found in the hardware specifications.

Main idea

- The objective of our study is to propose an effective focus-point location segmentation algorithm to confirm the center and radius of a circular region image, which will provide technical support for the introduction of high-performance image acquisition equipment in DHP.



Method

- The boundary of a forest canopy hemisphere image was analyzed via histogram, rectangle, and Fourier descriptors.
- Based on the above analysis, the blue component of the digital hemisphere canopy image is transformed to a binary image using the threshold of the histogram.
- The morphological opening would be used to remove the scattering points.
- The least squares method has been adopted to find the position of the center and obtain the radius accurately.

Major results

- Some ideal images were acquired under an overcast sky and the proposed method was applied to those to calculate the center and the radius. The results were compared with manual measurements.

Table 2 Comparison between instruments allowing center and radius calculation (unit: pixel)

Camera	Fish lens	Image size	Center (x_0, y_0)		Radius	
			Proposed	Manual	Proposed	Manual
Olympus E-500	ZUIKO DIGITAL 8 mm F1.8	450×508	(240.7352, 259.7178)	(241, 260)	185.4170	185
SIGMA SD1 Merrill	SIGMA 8 mm F3.5 EX	510×495	(280.5317, 243.8697)	(281, 244)	212.3763	212
Canon EOS 1DS Mark III	EF 8–15 mm USM	750×500	(374.0723, 252.6003)	(374, 253)	243.9720	244
iPhone 6S	OREA 0.42×	750×563	(368.8520, 346.7060)	(369, 347)	196.4401	196
Canon EOS 5D	SANYANG 8 mm F3.5 AE	800×533	(398.9051, 260.8717)	(399, 261)	260.2174	260
Nikon D300	Nikon 8 mm f/2.8	1000×945	(450.2681, 372.2106)	(450, 372)	273.8018	274
SONY A7R II	MADOKA 180	1000×1000	(498.5290, 496.4679)	(499, 496)	487.7187	488
Canon EOS 5D Mark III	EF 8–15 mm USM	1200×1200	(543.8606, 627.3253)	(544, 627)	493.2448	493
Canon EOS 5D Mark II	EF 8–15 mm USM	2784×1856	(1382.7000, 931.0079)	(1383, 931)	680.8354	681
Canon EOS 5D Mark II	EF 8–15 mm USM	4080×2720	(2026.0000, 1365.6000)	(2026, 1366)	990.8092	
Canon EOS 5D Mark II	EF 8–15 mm USM	5616×3744	(2798.2000, 1878.5000)	(2798, 1879)	1366.7000	



Major results (Cont'd)

- We compared the center of the circle with the center of the image.

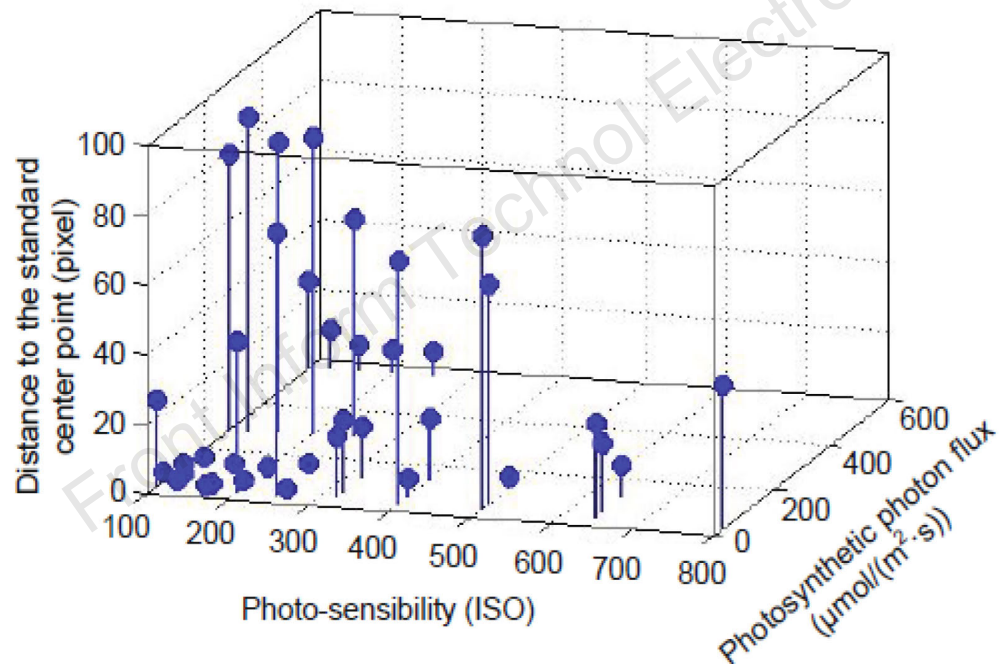


Fig. 11 Sample data from the experiment on April 25, 2015

Conclusions

- We presented a detailed analytical process for the boundary points, which had linear distributions under the influence of the light source location.
- This method has proven its usability in terms of effective implementation and acceptable computing costs.
- Then the conditions suitable for collecting images were determined from the calculation of the center under different light conditions.