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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 | [illegible] |
| Canon EOS 5D Mark II | EF 8–15 mm USM | 5616×3744 | (2798.2000, 1878.5000) | (2798, 1879) | 1366.7000 | [illegible] |

# Major results (Cont’d)

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

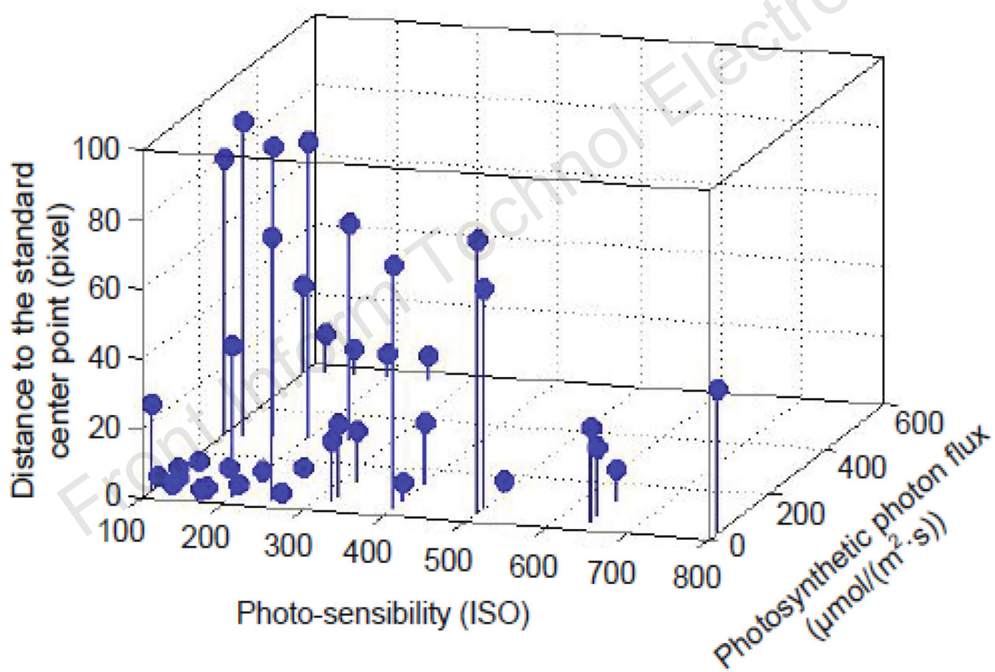


Fig. 11 Sample data from the experiment on April 25, 2015

# 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.