亮点报道：以“偏”盖“全”！偏振打破三维成像桎梏

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传统三维成像在弱纹理、强反射等复杂条件下精度受限；偏振三维成像虽能提供几何线索，但面临畸变、绝对深度丢失、自然场景不适三大挑战。现有方法引入先验或多源融合，却缺乏对空间不连续性的处理，易导致深度跳变。

西安电子科技大学刘飞教授团队提出并实现了一种场景级被动高精度偏振三维成像方法。通过设计集成式偏振立体成像系统，研究基于偏振特性和立体视觉约束的迭代优化算法实现场景级偏振测量和三维重建，系统性地解决了非连续场景偏振三维重建、绝对深度获取以及多帧融合尺度归一化等关键难题，实现了场景级的高精度三维信息获取。该研究融合了立体视觉与光场偏振信息，将不连续场景的三维重建过程建模为一个数学优化问题，并将来自偏振的像素级表面法线场信息与立体视觉提供的绝对尺度信息作为相互约束条件，引入统一的优化框架中。

未来，通过与多光谱偏振成像和深度学习先验建模相结合，可进一步抑制强杂散光等干扰，有望在自动驾驶、遥感监测、文化遗产保护等场景中发挥重要作用。

Highlights: Polarization unlocks scene-level 3D imaging

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The rapid development of AI and autonomous systems demands high-precision, robust real-time 3D perception in complex scenes. Methods like stereo vision, structured light, and LiDAR suffer from reduced accuracy under weak textures, strong reflections, mixed materials, or ambient interference—especially the unresolved trade-off between long-range detection and high precision.

The Prof. Fei Liu 's team at Xidian University has proposed and implemented a scene-level passive high-precision polarization 3D imaging method. An integrated polarization stereo imaging system was designed and developed an iterative optimization algorithm based on polarization characteristics and stereo vision constraints. This approach systematically resolves key challenges of polarization 3D imaging including discontinuous targets, absolute depth interpretation and dynamic reconstruction. Finally, scene-level high-precision 3D imaging is realized. Moreover, the mathematical solution for the high-precision 3D inversion problem based on polarization cues in discontinuous natural scenes also contributes to a deeper understanding of light-matter interaction and multi-dimensional information fusion.

In future, by integrating multispectral polarization imaging and deep learning-based prior modeling, interference from strong stray light and other disturbances can be further suppressed. This holds promising potential for important applications such as autonomous driving, remote sensing monitoring, and cultural heritage preservation.

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