3-D CMOS Sensor

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Background

- Traditional solid-state image sensors use pixels which measure intensity of incident light.
- However, incident angle of light contains significant information about three-dimensional structure.
- In a lens system (i.e. camera), angle information informs us about focal depth.

Concept:
Use incident angle to extract 3-D structure in both lens-based and lens-less image sensor systems.
**Cornell Technology**

- New class of angle-sensitive CMOS image sensor chip based on integrated diffraction gratings.
- Compatible with existing microchip manufacturing processes.
- Together with proprietary algorithms, can perform single-lens 3D imaging.
- Cost-effective: Obviates the need for complicated optics.
- Captures not just an image, but metrics!

**Angle-Sensitive Pixels**
• Operating principle: Angle-sensitive Pixels (ASPs) based on integrated diffraction gratings.

• Diffraction gratings create periodic intensity patterns that shift laterally in response to changes in incident angle.

• A second diffraction grating measures these shifts, which then informs 3D reconstruction algorithm.

CMOS implementation:

Zero added cost over standard CMOS imager
Market & Applications

• Personal electronic devices
  • Availability of depth information will drive apps development (e.g., measuring cup or tailor app)
  • Gesture control

• Mid/high-end digital cameras
  • Post-hoc refocusing

• Biomedical imaging
  • 3D localization of fluorescent cells
  • Low-cost flow cytometry

• Image compression
  • Entirely based on physics/optics
  • Low cost, low power
  • Interactive gaming, video conferencing

• Security, Surveillance & Defense
Status & Next Steps

• Patents
  • Issued US patents: 8,530,811; 8,809,758; 8,767,047
  • Patents pending and issued in China, Europe, Korea

• Technology
  • 3rd generation prototype chips available and demonstrated
  • 4th generation chips: improving manufacturing & design techniques
  • Application-specific proof-of-concept work in progress

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