

Comparison of other 3D imaging methods

Camera Arrays

Combine multiple cameras together along with point correspondence matching and reconstruction of a 3D scene with high-resolution texture.

Structured illumination

Project a known pattern into the scene such that its appearance in the image varies uniquely with depth. Typically combine this with a color camera. Many modern systems now combine stereo cameras with structured illumination.

Depth Camera or Time-of-Flight Camera

Two common types:

- **Phase Modulation:** The camera exposes synchronously with a modulated light source at 10s of MHz. The camera samples at 2 or 4 different phases of the modulation to recover the magnitude and phase at each pixel. The phase shift by the 3D scene is recovered.
- **Time of Flight:** The camera sensor has the ability digitize the time between emission and reception of a pulsed light source (flash-lidar). The time delay is converted to range and combined with the intensity to make a point cloud.

Plenoptic Cameras

A microlens array is placed in front of the camera sensor. Lighfield 1.0 places the microlenses one focal length away from the sensor such that pixels subtended by each microlens measure the angular variation in the field and the microlenses sample the spatial variation. Lightfield 2.0 places the microlenses farther than 1 focal length from the sensor such that each microlens and subtended pixels act like a miniature camera in a dense camera array.

	Camera Arrays	Structured Illumination	Depth Camera / Flash Lidar	Plenoptic
Method	Parallax	Parallax	Phase modulation or Time of Flight	Parallax
Pros	High-resolution Scalable Many geometries possible Can cover full 4 pi around object	High-resolution Single camera Provides texture to featureless objects	Low computational complexity No correspondence problem	High-resolution Very good light collection efficiency Single camera Simpler correspondence problem than stereo
Cons	Correspondence problem High computational complexity Multi-camera synchronization	Sensitive to IOPs of seawater Mostly IR only in COTS products	Low-resolution Limited perspective Low-power IR	Limited perspective Loss of spatial resolution from native sensor resolution High computational complexity
Example	Stanford Multi-Camera Array	Kinect 2010	Basler ToF camera	Raytrix R26

Table 1: Comparison of several types of 3D imaging methods that can acquire a 3D image from a single exposure.