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Kinect Study Review

1.1 Structured-Light(SL) Scanning Principle

SL is an active stereo vision technique. With a sequence of known patterns sequentially projected into the object, the object gets deformed to geometric shape. In the same time, the object is also observed from a camera located in a different direction. This brings distortion of the observed pattern. This technique makes use of the distortion to extract depth information. Kinect SL device is composed of a color RGB and a monochrome NIR camera and an NIR projector with a laser diode at 850nm wavelength.

1.2 Time-of-Flight(ToF) Scanning Principle

The ToF technology is based on measuring the time that for light to travel to an object and back to the sensor array. The general idea is to actively illuminate the scene under observation using near infrared (NIR) intensity-modulated, periodic light.

2. Quality

SL outdoor application is hard to achieve. Both of them have interference problem, systematic error, depth inhomogeneity, multi-path effects, pixels violated of dynamic sceneary, causes error from semitransparent and scattering media. SL have significant temperature drift, while ToF does not require active cooling in smaller cameras. ToF have intensity-related distance error when objects with low NIR reflectivity. Through 7 experiments, the paper finds:

For ambient background light experiment, the Kinect SL is not able to handle background light under 1μW, whereas the Kinect ToF delivers data throughout the full range of ambient light.

For Multi-Device Interference, the Kinect ToF delivers increased drift of the median, up to 5mm, and a stronger variation., On average, the Kinect^{SL} shows little interference e↲ect (RMSE <5.6mm), beside some very prominent poses (RMSE up to < 9.4mm).

For Device warm-up, the distance box plots show less variation for the Kinect^{SL} than for the Kinect^{ToF}.

For Rail Depth Tracking, the Kinect^{ToF} delivers more precise range data than the Kinect$^{SL.}$ Kinect^{SL} leads to a significant depth quantization for increasing distances. the Kinect^{ToF} delivers very stable results and the range error for the darkest rectangle is max

For Semitransparent Liquid, Kinect^{SL} performs good for thicker semitransparent liquids and indicates failure for the thinner cases.

For reflected board, the Kinect^{SL} yields nearly no invalid pixels and the depth error is close to zero. The Kinect^{ToF}, on the other hand, has a lot more problems with the superposition of the indirect illumination.

For turning Siemens Star: For the Kinect^{SL} mainly the number of invalid pixels is higher for lower speed, which is counter- intuitive. For the Kinect^{ToF} the differences between the two segments are less prominent.