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Tesis: “PROFILOMETRY OF SOLIDS UTILIZING STEREO PROJECTION AND CO-PHASE OF STRUCTURED LIGHT"

Resumen:

Measurement of three-dimensional objects has become a current industrial issue to improve manufacturing verification processes and reverse engineering. Measurements should not modify or influence the manufacturing lines; therefore, they should be high-quality, high-speed, and online. Hence, fringe projection profilometers (FPPs) have become a feasible solution because of their low-cost hardware, speed, and proficiency to measure static and dynamic objects. FPPs can be straightforwardly implemented with a multimedia projector and a digital camera.

Initially, most proposals acquire one image to be processed digitally later using spatial filtering. Although they can achieve the speed goal, the estimation quality can be deficient for complex shapes. In order to improve the reconstruction quality, several techniques have proposed color encoding to project and acquire three images. They are later processed by phase-shifting algorithms (PSAs). It is noticeable that these FPPs fulfill the high-speed requirement. Nonetheless, they must also have a very well-calibrated system and satisfy the following conditions: (1) non-linear intensity distortion, (2) shapes with a good diffuse reflection function, (3) avoidance or calibration of cross-talking problems, and (4) a geometry configuration eliminating/reducing self-occluding shadows. Industrial items or applications usually do not accomplish these requirements.

This thesis introduces an FPP (a proof-of-the-concept) gathering the above four requirements and performing online measurements. This FPP can also estimate or inspect a shape in a rectilinear uniform motion. The inspection is carried out by comparing a testing shape to a calibrated one with a proposed technique.

When reconstructing industrial items, this FPP needs a temporal sequence of phase-shifted fringe patterns (PS-FPs). The PS-FPs are obtained by translating the item’s movements to a phase shift through image registration. The latter is done by computing a rough estimation of the shape for each pattern. Later, a pixel matching method translates the acquired images into PS-FPs. Hence, one can employ the PSAs’ framework for phase/shape retrieval in the classical sense, considering that shapes are static. We proposed several PSAs with their spectral description and analysis to correctly retrieve the phase and phase differences from the observed patterns. By acquiring many PS-FPs, the first and second conditions are overcome. By encoding in the red and blue channels, the third requirement is met. The last one is addressed by using a co-phased technique having two projectors and a camera. This technique is a contribution to this thesis.