3-D Free-form Shape Measuring System Using Unconstrained Range Sensor

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Abstract: Three-dimensional (3-D) free-form shape measurement, a challenging task pursued by computer vision, is mainly characterized with single view acquisition and multiple view registration. In conventional laser scanning system, outside positioning mechanism is usually employed to acquire serial line/profile data, so as to comprise a single view. The flexibility and working range of measuring system is seriously decreased. As for registration, the ICP-based methods are difficult to realize engineering applications for its inherent shortage, while the present engineering applications are mostly based on three-point-method, a sequential registration tactic, which can not overcome problems of error accumulation and propagation. In this paper, one 3-D free-form shape measuring system using unconstrained range sensor is designed. A quasi-active stereo binocular visual sensor embedded within a scanning mechanism is used as the range sensor. Error compensation is performed by residual amendment according to camera calibration lattice. Artificial control points are designed and adhered on object and one camera is introduced to shot these control points from different positions and orientations. Then ray bundle adjustment (BA) method is used to calculate the space coordinates of all the control points, so as to set up a global control net work. Registration can be completed by mapping at least 3 control points observed by range sensor in single view acquisition into global control network. In this system, no calibration for laser plane is required and the motion of range sensor is completely free. The overlapping of neighboring region is unessential for registration. Therefore, the working range of the system can be easily extended and good capacity for global error control is provided. The measuring precision mainly depends on the quality of global control network. Experimental results show that relative distance error of control points is no more than 0.2%. The proposed measuring system contributes to the engineering application of 3-D free-form shape measurement.

Key words: shape measurement, multiple view registration, bundle adjustment, global control network

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