論 文 の 要 旨

題　目　A Study on Monocular Stereo Vision Using High-Speed Catadioptric System
（高速カタディオプトリックシステムを用いた単眼ステレオ視に関する研究）

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Stereo vision is a range-sensing technique for distant real-world scenes using two or multiple images observed at different viewpoints with triangulation. Typical stereo vision system made up of two cameras with synchronization to capture stereo images has the problems of fixed views, limited baseline and son on. For a wider field of view without decreasing resolution, active stereo systems that mount cameras on pan-tilt mechanisms have been reported, which are classified into two kinds: multiple cameras on a single pan-tilt mechanism and multiple pan-tilt cameras. However, both kinds of these systems are difficult to switch their viewpoints quickly and are high cost using multiple cameras or mechanisms. Monocular stereo system has the advantages of only one camera used as multiple virtual cameras. Many monocular stereo methods have been proposed using catadioptric system or other mechanism. Chapter 1 and Chapter 2 in this thesis describe the introduction and related works of this topic. However, these stereo systems have not been used as an active stereo to switch quickly and expand the field of view for wide-area surveillance.

To solve these problems, in this thesis a monocular stereo tracking system was proposed that expands on the concept of monocular catadioptric stereo with a relatively long-width baseline to an active stereo that can control the pan and tilt directions of mirrored virtual cameras quickly for the wider field of view. Chapter 3 introduces the concept of proposed system consisting of a mirror-based ultrafast active vision system and a catadioptric mirror system. The former consists of a high-speed vision system that can capture and process images in real time at a high frame rate, and a pan-tilt mirror system for ultrafast gaze control that enables a frame-by-frame viewpoint switching of pan and tilt controls of mirrored virtual tracking cameras at hundreds of frames per second. The catadioptric mirror system can be designed flexibly to meet different requirements such as stereo tracking, 3-D motion tracking or wide baseline stereo system. By accelerating video-shooting, computation, and actuation at the millisecond-granularity level for time-division multithreaded processing in ultrafast gaze control, the active vision system can function virtually as two or more pan-and-tilt tracking cameras. Chapter 4 introduces the 3-D shape measurement with tracking. By switching between 500 different views in a second the proposed system functions as a catadioptric active stereo with left and right pan-tilt tracking cameras that can virtually capture 8-bit color 512 × 512 images each operating at 250 fps to mechanically track a fast-moving object with a sufficient parallax for accurate 3-D measurement. Chapter 5 introduces the real-time three-dimensional multiple targets motion tracking aiming to localize dozens of markers on multiple moving objects in real time by switching five hundred different views in 1 s. By combining real-time video processing for marker extraction, our system can function as J virtual left and right pan-tilt tracking cameras, operating at 250/J fps to simultaneously capture and process J pairs of stereo images at real time. Chapter 6 describes the monocular wide baseline stereo measurement system, which has wider and adjustable baseline. Geometry relationship, control algorithm and frame interpolation strategy were coordinated to assure the steady operation of the system. Several experiments for moving objects in 3-D space are described to demonstrate the performance of the monocular quick active stereo system for both 3-D shape measurement with different baselines and real-time multiple targets motion tracking. Finally, chapter 7 makes a summary and conclusion of the thesis.