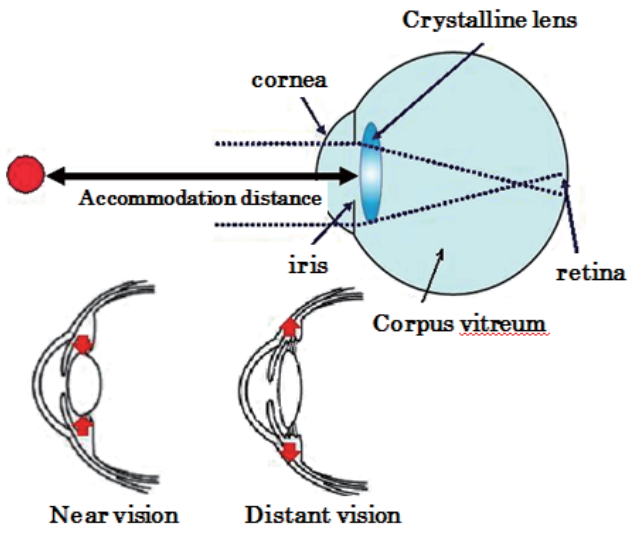

Fig. 1. Principle of lens accommodation.

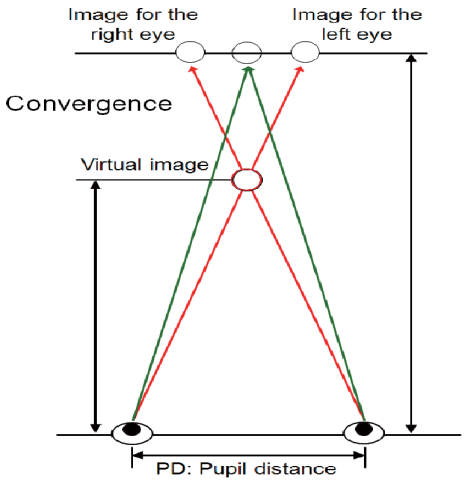

Fig. 2. Principle of convergence by binocular parallax.

commodation is always fixed on the screen where the image is displayed, while convergence intersects at the position of the stereo images. As a result, eye fatigue, solid intoxication, and other symptoms occur. However, we obtained results that indicate the inconsistency between accommodation and convergence does not occur (Miyao *et al.*, 1996). Even so, it is still often explained that inconsistency is a cause of eye symptoms. One reason is that we could not simultaneously measure accommodation and convergence in our previous study, and the proof for the results was insufficient.

To resolve this inconsistency, it was thought that measuring simultaneously accommodation and convergence was needed. We therefore developed a method to simultaneously measure accommodation and convergence. Comparison with measurements of natural vision is essential in investigating stereoscopic vision. For such comparisons, it is first necessary to make sure that the measurements of natural vision are accurate. We therefore focused on whether we could accurately measure natural vision, and we report the results of those measurements.

2. Method

Informed consent was obtained from the subjects before the experiments, and the study was approved by the Ethical Review Board of the Nagoya University Graduate School of Information Science.

The experiment was done with six healthy young males (age: 20∼37). Subjects were given a full explanation of the experiment in advance, and consent was obtained. Subjects used their naked- eyes or wore soft contact lenses (one person with is uncorrected vision, 5 who wore soft contact lenses), and their refraction was corrected to within ±0.25 diopter. (“Diopter” is the refractive index of lens. It is an index of accommodation power. It is the inverse of meters, for example, 0 stands for infinity, 0.5 stands for 2 m, 1 stands for 1 m, 1.5 stands for 0.67 m, 2 stands for 0.5 m, and 2.5 stands for 0.4 m).

The devices used in this experiment were an Auto Ref/Keratometer WAM-5500 (Grand Seiko Co. Ltd., Hiroshima, Japan), and an eye mark recorder EMR-9 (NAC Image Technology Inc., Tokyo, Japan).

The WAM-5500 provides an open binocular field of view while a subject is looking at a distant fixation target, and has two measurement modes, static mode and dynamic mode. We used the dynamic mode in this experiment. The accuracy of the WAM-5500 in measuring refraction in the dynamic mode of operation was evaluated using the manufacture’s supplied model eye (of power −4.50 D). The WAM-5500 set to Hi-Speed (continuous recording) mode was connected to a PC running the WCS-1 software via an RS-232 cable and allows refractive data collection at a temporal resolution of 5 Hz. We do not need any special operation during dynamic data collection, except depressing the WAM-5500 joystick button once to start and again to stop recording at the beginning and end of the desired time frame, respectively. The software records dynamic results, including time (in seconds) of each reading for pupil size and MSE (mean spherical equivalent) refraction in the form of an Excel Comma Separated Values (CSV) file. (Queirós *et al.*, 2008; Sheppard and Davies, 2010).

On the other hand, the EMR-9 was to measure the eye movement using papillary/corneal reflex method. The horizontal measurement range was 40 degrees, the vertical range was 20 degrees, and the measurement rate was 60 Hz. This consisted of two video cameras fixed to the left and right sides of the face, plus another camera (field-shooting unit) fixed to the top of the forehead. Infrared light sources were positioned in front of each lower eyelid. The side cameras recorded infrared light reflected from the cornea of each eye while the camera on top of the forehead recorded pictures shown on the screen. After a camera controller superimposed these three recordings with a 0.01 s electronic timer, the combined recording was recorded on a SD card. Movement of more than 1 degree with a duration greater than 0.1 s was scored as an eye movement. A gaze point was defined by a gaze time exceeding 0.1 s. This technique enabled us to determine eye fixation points. The wavelength of the infrared light was 850 nm. After data were