Stereo Rotation Standstill

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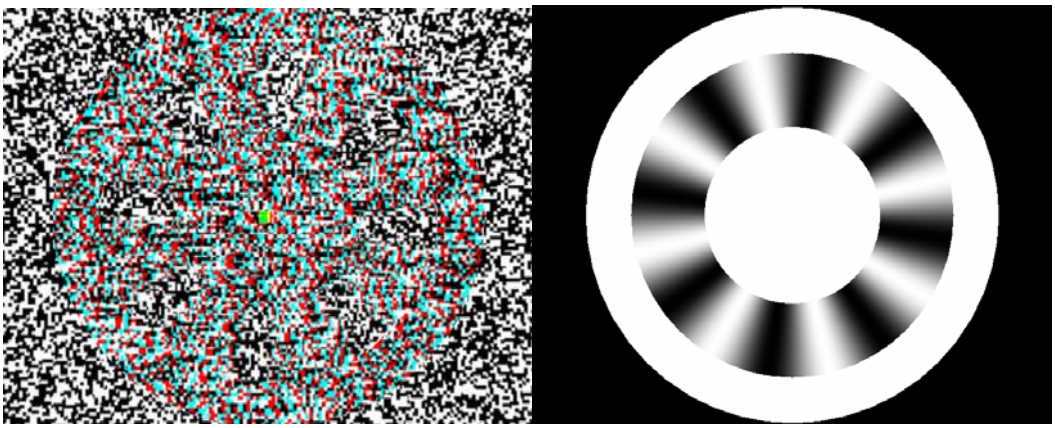
The term “stereo rotation standstill” refers to a new illusion: a rotating spoked wheel defined only by disparity cues is perceived as stationary. The accompanying movie demonstrates the illusion. In the movie I used a circular sinusoidal grid to imitate the spokes. The figures below show a red-cyan anaglyph stereo picture of a spoke wheel with its disparity map.



Stereo rotation standstill is seen best when fixating the center of rotation. When fixating the periphery of the wheel, one starts tracking single spokes and can therefore infer the wheel’s rotation.

When increasing the rotation speed above 30°/s, the illusion of the wheel standing still starts decaying. When the number of spokes is reduced to four or less, the spoked wheel appears to make sudden orientation changes, giving the impression of a jerky rotation rather than standing still.

When the stationary random dot pattern containing the disparity cues is replaced by a dynamic random dot pattern with stereo cues, one perceives a flickering and rotating stereoscopic wheel. The perceived rotation is somewhat jerky.

Stereo rotation standstill is different from simple stereo motion standstill, where a rapidly shifting pattern is perceived as motionless (Tseng et al. 2006). While the rotation standstill illusion occurs over a broad range of speeds and spatial frequencies and is seen best with low rotational speeds, the stereo motion standstill occurs in a limited range of higher translational speeds and spatial frequencies just below the spatial and temporal resolution limits of stereo vision.

I conclude that the stereo rotation standstill or the impression of jerky rotation arises with an ambiguous stimulus: the stereo system is fed with a rotating pattern; the luminance based motion system receives an almost stationary stimulus. In the reverse situation with a turning dot pattern and a stationary stereoscopic wheel, the wheel is perceived as rotating (“stereo pseudo-rotation”). However, when looking at a single spoke, one recognizes that the stereoscopic wheel is not moving.

I hypothesize that while there exist translation detectors with a selective input from disparity detectors (cf. Lu et al. 2002), global rotation detectors (the human equivalent of the high order rotation detectors first found by Tanaka et al 1989 in monkey MSTd) with a selective input from disparity are either missing or inhibited by the presence of a stationary luminance pattern. The need for having separate systems for analyzing global translation of either disparity or luminance cues become obvious if one is looking at the surface of a lake: fallen leaves and other detritus float on the surface and stay in place, whereas the waves move on with the wind. Having two independent rotation analyzers with input from disparity or luminance cues would have been a luxury: waves usually do not rotate.

Tseng C-H, Gobell JL, Lu Z-L & Sperling G. (2006) When motion appears stopped: Stereo motion stillstand. PNAS 103, 14953-14958

Lu Z-L & Sperling G. (2002) Stereomotion is processed by the third-order motion system.. J. Opt. Soc. Am. A. 19, 2144-2153

Tanaka K & Saito H. (1989) Analysis of motion of the visual field by direction, expansion/contraction, and rotation cells clustered in the dorsal part of the medial superior temporal area of the macaque monkey. J. Neurophysiol. 62, 626-641

http://www.vertigocenter.ch/duersteler/index.html