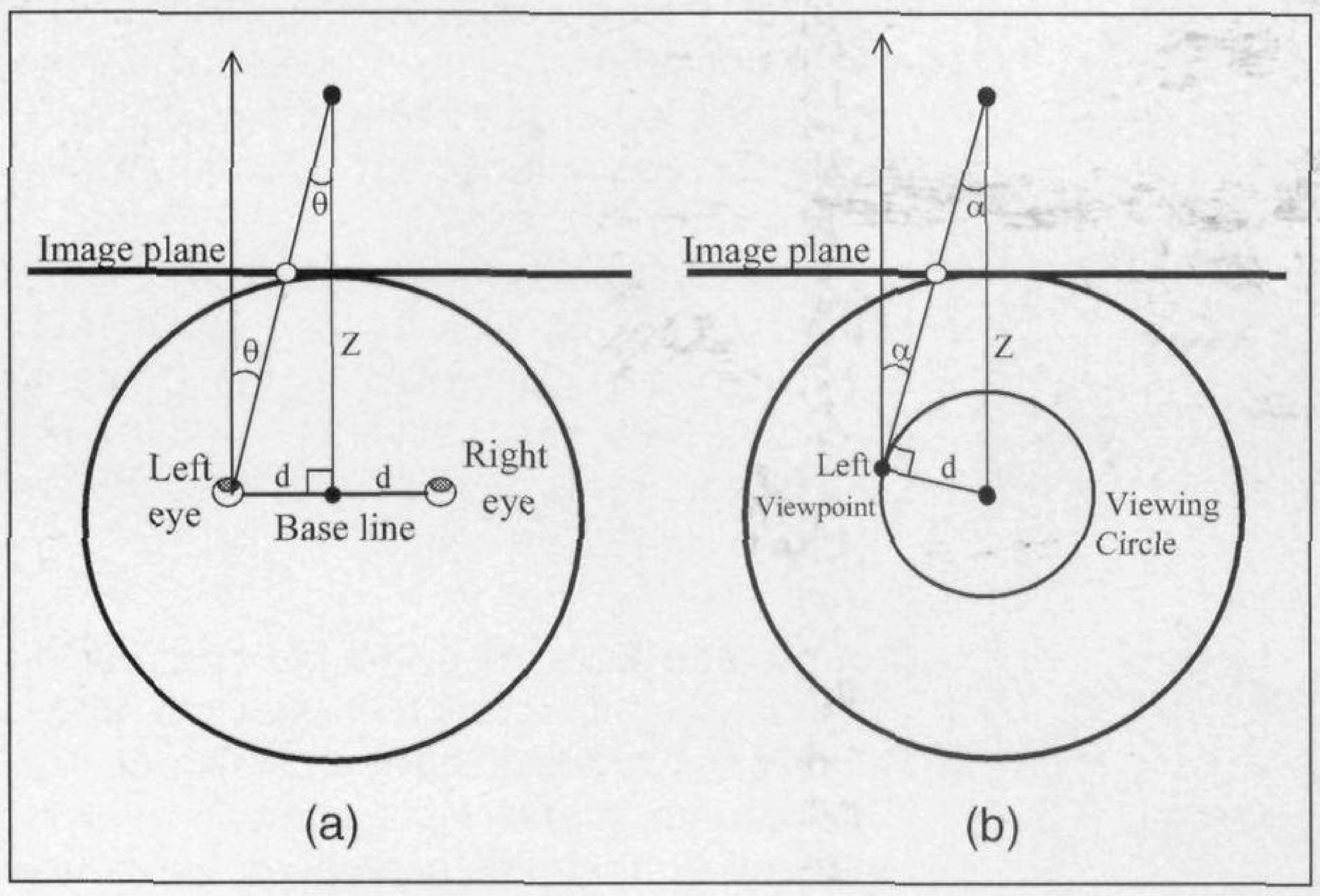

Fig. 26. Comparing disparities between cylindrical panoramas and conventional stereo pairs. (a) The disparity of conventional stereo is 2θ where $\theta = tan^{-1}(\frac{d}{Z})$. (b) The disparity of stereo panorama is 2α where $\alpha = sin^{-1}(\frac{d}{Z})$. This disparity is preserved by the central projection of the panorama onto a planar image.

the cylindrical projection and, hence, preserves the depth perception.

Below is further examination of the process that generates the cylindrical panoramas using the multiple viewpoint circular projection and creates planar images from the cylindrical panoramas using the single viewpoint central projection. Fig. 26 describes the relation between a conventional stereo pair and cylindrical panoramic stereo having the same base line of $2d$. For a point at depth Z, the disparity of conventional stereo is 2θ, where $\theta = tan^{-1}(\frac{d}{Z})$. The disparity of stereo panorama is 2α, where $\alpha = sin^{-1}(\frac{d}{Z})$. This disparity is preserved by the central projection of the panorama onto a planar image. Since the stereo disparities that can be fused by a human viewer are small, $sin(x) \approx tan(x)$ and the disparities are practically the same.

8 Left-Right Vergence

The imaging process introduces a shift between the left view panorama and the right view panorama. This shift is not related to the depth parallax and, in particular, points at infinity may not be aligned. Since the stereo disparity of points at infinity should be zero, aligning the points at infinity will correct this shift. Fig. 27 illustrates this process. A point P_∞ located at infinity is projected by a reference central projection into point S and by the left circular projection into P'_∞. The angle β between these points is the misalignment of the left circular projection relative to the reference central projection. $\beta =< (SCP'_\infty) =< (CP'_\infty V_R) = \sin^{-1}(R/L)$. For vergence on points at infinity, such that they will be aligned in both panoramas, the left panorama and the right panorama should each be rotated towards the reference circular projection by β.

9 Concluding Remarks

The theory of omnistereo imaging has been presented. This includes the special circular projection that can provide panoramic stereo in 360 degrees and several methods to realize this projection. The simplest method that was presented to create Omnistereo panoramas is mosaicing.

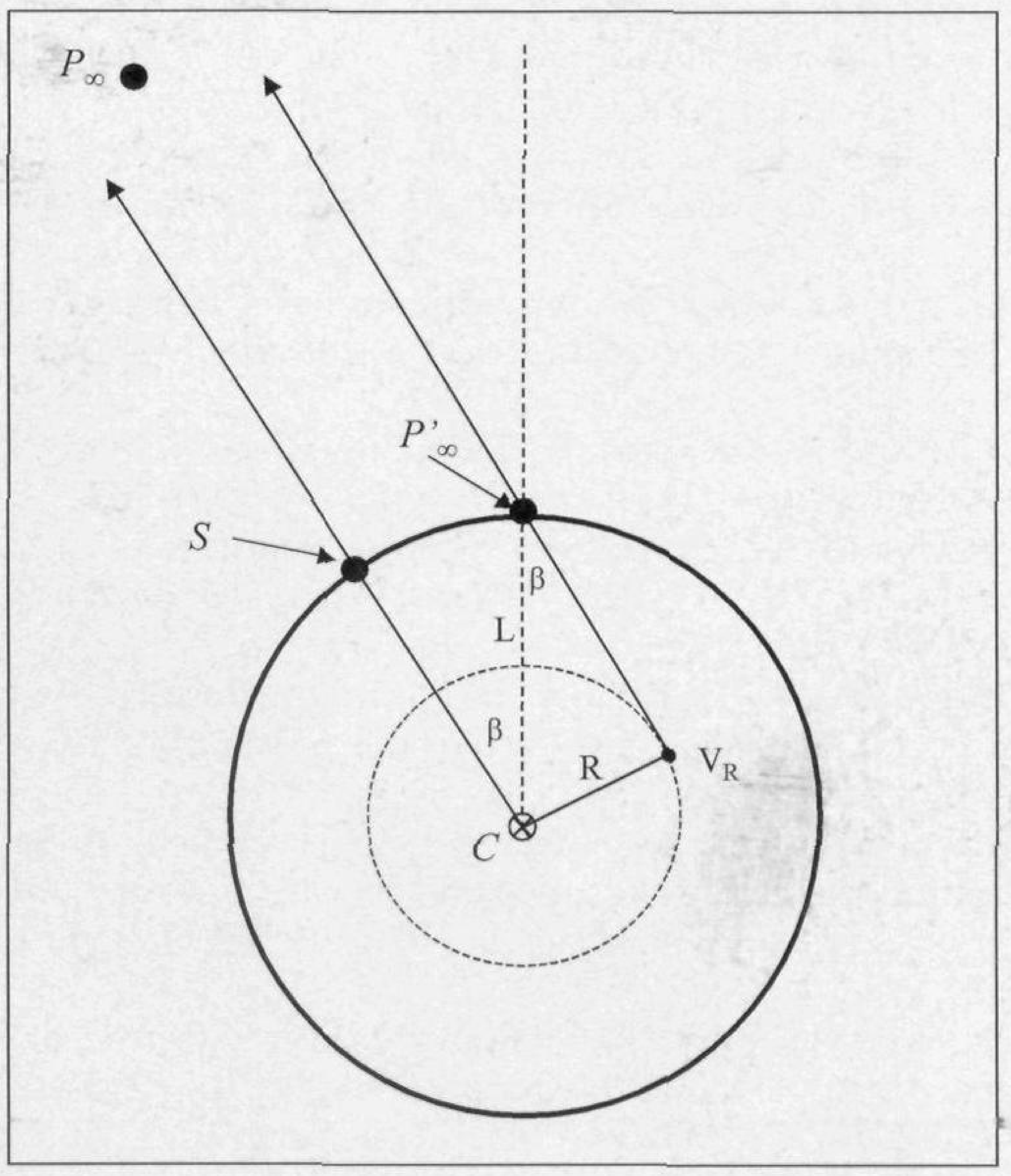

Fig. 27. Vergence for left circular projection.

Mosaicing by pasting strips from a rotating camera is applicable to static scenes. In addition, two optical systems, having no moving parts, were presented for capturing stereo panoramic video. One system is based on spiral mirrors and the second system is based on spiral lenses. While not constructed yet at the time of writing this paper, the optical systems represent possible principles that may enable to capture real-time movies having the stereo panoramic features. Omnistereo panoramas can also be rendered from models of virtual scenes.

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