Real-Time Video Phase-Locked Loops

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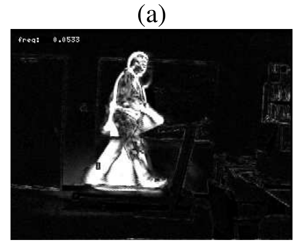
In the perception of gaits, timing is everything; specifically, the relative timing of the individual motions in a gait, and when events occur periodically, as they do in a gait, then relative timing is equivalent to phase. The importance of phase in gaits appears in the medical, psychology, and computer vision literature.

(a)



(b)

Figure 1. vPLL demo: (a) a sample sequence of oscillatory motion, and (b) the magnitude output of the vPLL.

The video phase locked loop (vPLL) [3] is a novel system that perceives gaits, is sensitive to the phases of the component motions of the gait, and is model-free. vPLLs provide a mechanism to perform two critical tasks in gait perception: frequency entrainment and phase locking [1]. A vPLL can lock on oscillations in pixels that arise because of oscillatory motion. In doing so, the vPLL matches its internal oscillators to the oscillations in pixel intensities, thus performing frequency entrainment. Phase locking occurs as individual phased-locked loops at each pixel site lock simultaneously. The abundance of data extracted by the vPLL makes gait recognition possible.

In this demonstration we show a vPLL operating in real-time. The vPLL locks to oscillations in the gait of a person walking on a treadmill and also detects translational motion. As the vPLL system extracts phase information in the form of a phasor configuration, the configuration is also displayed in real time.

Best [2] provides an excellent introduction to phase-locked loops. Their application to vPLLs is found in Boyd [3]. Figure 1(a) shows, as superimposed frames, an image sequences of an oscillatory motion, a person walking on a treadmill. The vPLL processes the sequence locking on the oscillations. Figure 1(b) shows the result as the magnitude of the oscillations as determined by the vPLL. While we have chosen to display the magnitude signal, the vPLL also captures frequency and phase information.

There is ample information derived by a vPLL to recognize various oscillatory motions. We use Procrustes shape analysis to perform recognition-related tasks [4], such as averaging and matching the phase patterns that emerge from the vPLL. Our demonstration includes a real-time display of the captured phase patterns. The variations in phase that arise from different motions is evident as the phase configuration display changes.

References

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