- Friday, May 22, 1998
  Perceiving Self-Motion in Depth

1.0 Here are the minutes for the YORKVIS meeting that took place on May 22nd. These minutes are published simultaneously on the web page.

2.0 Steve Palmisano gave a talk entitled "Perceiving self-motion in depth: the roles of stereoscopic, changing-size, ground plane and jitter information"

2.1 The phenomenon Steve considered in his talk was vection, that is, the sensation of self motion that can be evoked by viewing visual motion compatible with self motion even though the observer actually remains stationary.

2.2 Optic flow is a significant stimulus for evoking vection. Optic flow is the pattern of light reaching the eye caused by motion of the HEAD and is not to be confused with 'retinal flow' which is also affected by motion of the eye-in-the-head.

2.2.1 Research has concentrated on the focus of expansion (from which the optic flow streams); global flow rate and time-to-contact estimates which can, at least theoretically, be extracted from the optic flow (assuming optic flow can be extracted from retinal image motion).

2.2.2 But other factors in the optic array might also play a role, for example binocular information about the attributes of the self-motion or about the three dimensional layout of the world.

2.3 To investigate the role of some of these other factors, Steve established two measures of vection strength: (i) time to onset -- ie the time from stimulus onset until vection is first experienced-- and (ii) the total duration of vection, that is the amount of time spent vecting during a three minute stimulus presentation time.

2.4.0 For exps 1-3; optic flow simulated forward motion

2.4.1 Exp 1: one eye vs two eyes (full stereoscopic simulation): latency-to-vect shorter and duration longer when two eyes open

2.4.2 Exp 2: 2.More compelling vection displays (ie more objects and larger display): two eyes (ie stereo) still produces more compelling vection than one eye (ie shorter onsets and longer durations)

2.4.3 Exp 3: synoptic (both eyes SAME image presented at optical infinity) vs stereoscopic (eyes' images with appropriate disparities). Synoptic displays provided vergence and disparity info that environmental objects were infinitely distant. Vection durations were significantly longer for stereoscopic displays. However, the corresponding trend for vection onsets did not reach significance.

2.5 When optic flow simulated sideways movement (so-called "lamellar flow": lamella: thin layer, plate or membrane), there was no difference between one-eye-open and full stereoscopic presentation (Exp 4); even when the 3D structure was the same for sideways and forwards displays (Exp 5).

2.6 Conclusions from Exps 1-5: optic flow viewed through two eyes improves vection for forwards motion - but not for sideways motion. Steve states "Evidence suggests that this advantage is due to stereoscopic optic flow providing extra purely binocular info about the speed of self-motion in depth." but there is clearly a non-stereoscopic contribution of having two eyes open since the difference in exp 1 was larger and clearer than for exp 3.

3.0 Optic flow with changing size cues might help by providing either

motion cues (eg. rate of expansion)
layout cues 3.1 Exp 6 showed that for a smallish number of elements (20-30), adding an appropriate size change to the components of the optic flow (so they got bigger as they simulated getting nearer) evoked a much faster (c25 secs as opposed to over a minute) and more persistent vection. Curiously, for more elements (>50), the advantage of changing size disappeared. Presumably this is because more elements in itself makes the stimulus more effective (Exp 2), so we have saturation effects.
3.2 Exp 8 compared the effect of adding size to clouds of moving elements as opposed to ground plane simulations. Changing size improved both, but improved vection to ground plane simulations more.

3.3 Conclusion: Changing size might contribute more to layout cues than motion cues. If it was motion, then clouds and planes should be the same. The reason it helps ground plane simulation might be to do with providing information about the horizon ie. layout information. Changing size of unrelated points can provide information only about each point, not a larger structure -- unless the various dots are seen as belonging to bigger objects, of course....

4.0 The optic flow in many situations contains elements not only created by the overall trend in motion (towards a particular point) but also by irrelevant vibrations. These might be caused by up-down head translation during walking or the vibrations of an aircraft coming in to land. Because they are translational, such motions cannot be cancelled out of the retinal motion by the vestibulo-ocular reflex. Is the effect of this 'jitter' to improve vection by reducing adaptation to an on-going continous motion field. Or by adding more parallax information about the three dimensional layout? Or does jitter degrade vection by introducing yet another visual-vestibular conflict (high frequency vibration with no accompanying vestibular cues)?

4.1 Optic flow plus jitter evokes vection with faster onset and better persistence (Exp 9) which does not depend on the amount of jitter (Exp 10). Vection here refers any sense of self motion, including a sensation of jiggling up and down in a way compatible with just the jitter component.

5.0 Conclusions The overall conclusion is that vection is a response to a complex array of stimulus aspects determined by a variety of cues including binocular cues, jitter and changing size cues as well as the global properties of the optic flow.

Stephen Palmisano