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[illegible]

Directed by Dr. Barrie Frost

[illegible]

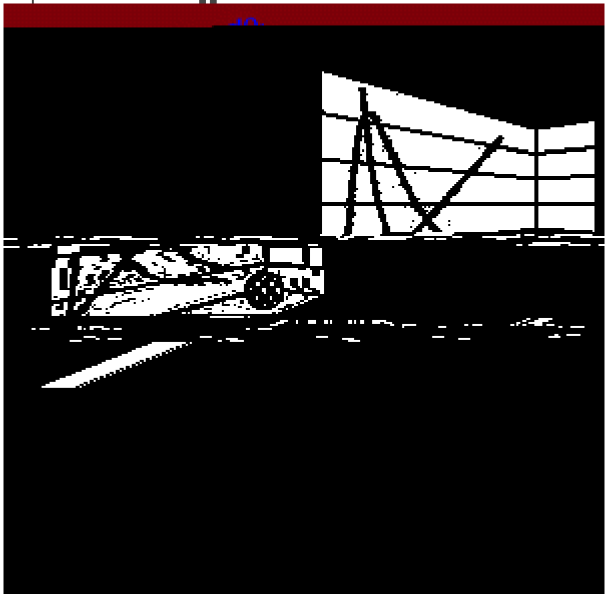
Supported by:

A main focus of our lab is to investigate the functions of the visual system by using various animal models. Our research includes analysing the responses of cells in the pigeon optic tectum, Nucleus Rotundus and various other visual nuclei. Using [illegible]

[illegible] Computer controls the [illegible]

Spike2. Using these procedures we have discovered neurons that are specialized for processing object motion, colour, motion of objects in 3D space, time to collision, etc. Other visual pathways have been studied which appear to be processing self-induced optic flow.

Time to Collision



We have found neurons in the pigeon Nucleus Rotundus which are highly selective for objects which are going to collide.

Wang, Y.C. and **B.J.** Some neurons in the nucleus rotundus of pigeon compute time to collision. *Society for Neuroscience Abstract*, 1991, 17, 1380.

Wang, Y. and B.J. "Time to collision" is signalled [illegible] nucleus rotundus of pigeons [illegible] neurons in the [illegible] *Nature*, 1992, 356, 236-238. (Written up in Current Biology, 1992, 2, 371-372).

Wang, Y., Jiang, S. and **Frost, B.J.** Visual processing in pigeon nucleus rotundus: luminance, colour, motion and looming subdivisions. *Visual Neuroscience*, 1993, 10, 21-31.

Sun, H.-J. and **Frost, B.J.** Responses of time-to-collision neurons in the nucleus rotundus of pigeons to accelerating and decelerating stimuli. Society for Neuroscience Abstract, 1997, 23, 453.

Frost, B. J. and Sun, H.-J. [illegible] Vision and Ophthalmology Abstract, 1997.

Sun, H.-J. and Frost, B.J. Computation of different optical velocities of looming objects. Nature Neuroscience, 1998, 1(4), 296-303. [illegible]

Objects [illegible]

[illegible] respond specifically to textured objects moving "in front" of textured backgrounds but do not respond to "holes" or apertures in textured fields. [illegible]

Frost, B.J., Wang, Y-C. and Jiang, S-Y. Leading edge occlusion specificity in tectal and n. isthmi cells in the pigeon. ARVO *Abstracts*, 30, 300, 1989.

Wang, Y.C. and B.J. Functional organization in the nucleus rotundus of pigeon. *Society for Neuroscience Abstract*, 1990, 16, 1314.

Frost, B.J. Subcortical Analysis of Visual Motion: Relative motion, figure- [illegible] -induced optic flow. In F.A. Miles and J. Wallman (Eds.) *Visual Motion and its role in the Stabilisation of Gaze*. Elsevier, Amsterdam, 1993, 159-175.

Frost, B.J. [illegible] in the pigeon. Chapter 5. In: M.V. Srinivasan and K. Venkatesh (eds.) *From [illegible] to Seeing Machines*. [illegible] Press, London, 1997, 80-

elevator moving up or down. We have investigated the relationship between the depth of the stimuli presented and the self [illegible]

checkerboard pattern with alternating up and down motion squares. Subjects still experienced vection despite the absence [illegible]

the direction of vection. The [illegible] there was a corresponding [illegible] direction of vection.

Telford, L., Spratley, J. and **Frost, B.J.** The role of kinetic depth cues in the production of linear vection in the central visual field. *Perception*, 1992, 21, 337-349.

Telford, L. and **B.J.** Factors affecting the onset and magnitude of linear vection. *Perception and Psychophysics*, 1993, 53, -692.

Marlin, S.G., Feldman, R. and **Frost, B.J.** Ambiguous foreground/background motion cues and vection. *Association for Research in Vision and Ophthalmology Abstracts* [illegible]

Animal Vection

We are studying the behavioural responses of animals (Pigeons and Locusts) to various speeds of wholefield motion patterns. Translocational visual flow fields can produce head bobbing in pigeons and flight in tethered locusts.

Pigeon Bobbing Pigeon Landing

Troje, N. and **Frost, B.J.** Head-[illegible] *Journal of Experimental Biology*, 2000, 203:935-[illegible]

Troje, N.F. and **Frost, B.J.** [illegible] *Society for Neuroscience Abstract*, 1998.

[illegible] 1990 [illegible] a program to [illegible] conspecific recognition in pigeons, having shown convincing [illegible] video images.

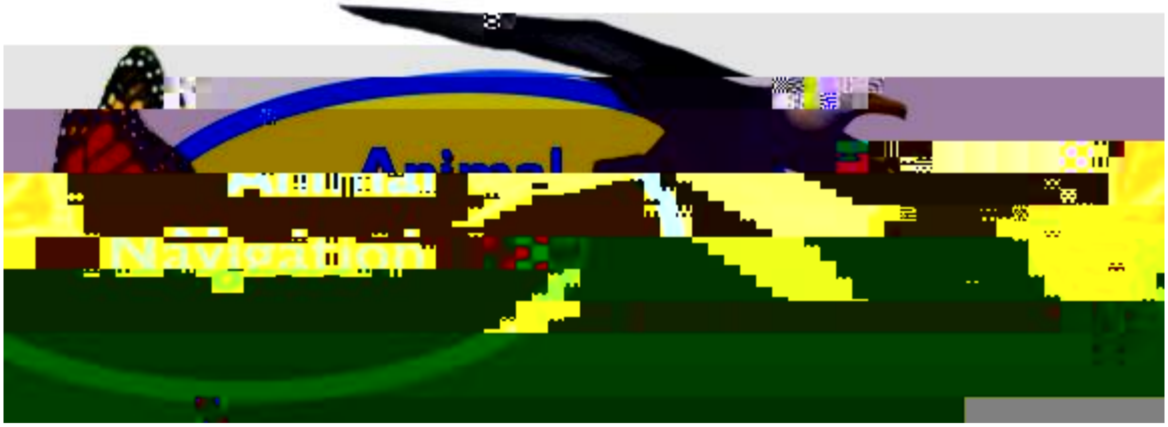
In collaboration with Dr. Nikolaus Troje we have constructation programs [illegible] a virtual pigeon, using professional anim

under computer control. Click here to view a video of a Virtual "Female" Pigeon, which is a receptive female modeled after a live female.

[illegible]

controlled video and virtual animals [illegible]

Frost, B.J., Troje, N.F. and David, S. Pigeon courtship behaviour in response to live birds and video presentations. *5th International Congress of* [illegible], 1998.



Monarch Butterflies

Monarch butterflies (Danaus plexippus) from the eastern North American [illegible] journeys in the autumn, [illegible] more than 3,500 km from Eastern USA and Canada to their over-wintering grounds in the neovolcanic belt in Central Mexico. See their migration map. Follow the Monarch's spring and fall migration via Journey North.

This research is conducted in co

Figure 1

Flight in tethered insects is typically induced by directing a flow of air horizontally toward their heads. We have developed a [illegible] flight simulator [illegible] directs the flow of air vertically [illegible] butterflies (Fig. 1). Click [illegible] movie of their simulator flight. RealPlayer video, size 1593KB.

A very low friction bearing allows the butterflies to steer their intended flight directio[illegible] of their virtual migratory journey (Fig 2.).

But what does the Monarch Butterfly use to navigate [illegible]

[illegible]

We have shown that monarchs use a time-compensated sun compass but not a magnetic compass, during migratory flight [illegible] orientation 90° (Fig. 2B,C), while those tested under simulated overcast conditions were not significantly oriented suggesting [illegible]

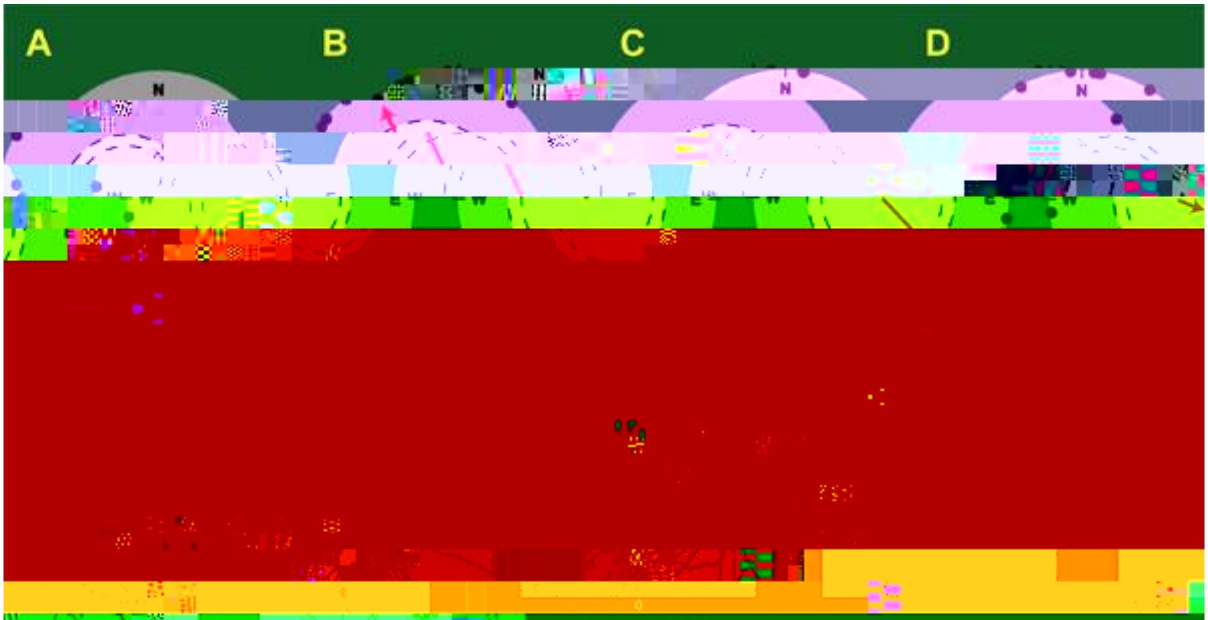


Figure 2

[illegible] light patterns as part of their time-compensated sun compass, [illegible]sted [illegible]heir compound eye being occluded (Fig 3).

[illegible] containing stimulus without sun shades (G & H) [illegible] stimulus with [illegible] sun shades. None of the polarized light stimuli led to time-

When given a direct view of the sun, migratory monarchs with their polarized light detectors painted out were still able to use their time-compensated compass (Fig. 4C, dorsal-rim not occluded; Fig. 4F, dorsal rim area occluded).

We have condu[illegible]
[illegible]
of the University of Otago on the Keep the Titi Forever project.

[illegible] **Frost, B.J.** and Mouritsen, H. At-sea distribution of Waved Albatrosses and the Galápagos Marine Reserve. Biological Conservation, 2003, 110:367-

The Purpose of the Virtual Reality Group

[illegible] mechanisms to the behavioral development of Virtual and Artificial Sensorial Environment Research (VASER). We do this by exploring the perceptual consequences of various types of stimuli and body motion constraints. We are also involved in research into basic perceptual mechanisms using human and animal models behaviour and physiology). Much of our work focuses on the distinctions between self motion and object motion and the segregation of objects using motion cues.

Overview of our present system

We have built several VR platforms. A virtual world is generated using custom made programs in OpenGL on Silicon Graphics [illegible] esented on a Virtual i/O light-weight head-mounted LCD display. Head tracking is accomplished using an Ascension Flock of Birds 6DOF head tracker mounted on the helmet strap. Our Cyber bike is a standard mountain bike that has been modified to allow real world motion of the bike wheel (using optical sensors) and the steering (using standard pots) to determine the speed and direction of movement in the virtual world.

The SGI takes the position information from the bike and uses this to compute the 3D arrangement of the objects in the

[illegible] large VR space subjects ride stationary bikes or walk on a treadmill to explore the full spatial extent of the space. The viewpoint is dynamic and is determined by the steering angle and translational velocity of either the modified stationary [illegible] linked to the SGI [illegible] bike or treadmill which SGI workstation. Both of these means of transportation [illegible]

[illegible] to simulate safety and emergency procedures).

Using pigeons we study how simple or complex sounds, ranging from infrasound to higher frequencies are processed in the [illegible] mammals, and use [illegible] higher frequencies, and complex sounds including species-specific vocalizations. The [illegible] analyzes the data obtained from the various auditory neurons. [illegible] auditory program also

Frost, B.J. [illegible] e-field sounds in decerebrate rats. *Society for Neuroscience Abstracts*, 1995.

Wild, J.M., Karten, H.J. and **Frost, B.J.** Connections of the auditory forebrain of the pigeon (Columba livia). *Journal of Comparative Neurology*, 1993, 337, 32-62.

Frost, B.J., B[illegible]-Whet Owl, Aegolius acadicus. *Canadian Journal of Zoology* [illegible]-1959.

Wise, L.Z., **Frost, B.J.**, Shaver, S.W. The representation of sound frequency and space in the mid brain of the Saw-Whet Owl. *Society for Neuroscience Abstracts*, 1988, 14, 1095.