

VIBRATION OF THE HUMAN EYE

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Introduction

Sound and vibration can effect human vision. The body has reflex mechanisms which attempt to compensate for these effects.

Vibration Sources

Either the target object or the observer may undergo vibration. An example where both effects could occur is in the cockpit of a fighter aircraft.

Many fighter aircraft have a "head-up" display. This display is a system which projects data onto the windshield just below the pilot's line of sight. Note that a fighter aircraft can undergo substantial vibration, particularly if it is flying near the transonic velocity. The resulting vibration can cause the blurring of the data image.

Passive Vibration

Eye resonant frequencies are highly variable between individuals. The fundamental frequency tends to occur between 20 and 70 Hz, according to Reference 1. Some individuals experience blurring caused by the excitation of the eye resonance when humming or playing a musical instrument. Resonance may also occur in a few vehicles and near some industrial machinery.

Pupil Dilation

Sound can cause dilation of the pupil, according to Reference 2. Dilation can begin at a sound pressure of 75 dB. This level corresponds to busy traffic or a noisy restaurant. Laboratory studies show that a rapid resumption of the normal pupil diameter occurs when the noise source is suddenly removed.

Psychological Effects

The effects of sound and vibration can be psychological as well as physiological.

For example, building vibration may cause suspended light fixtures to oscillate. This could be an annoyance to the occupants, who might feel less secure in the building.

Reflexes

The eye is part of control system, as discussed in Reference 1. There are several reflex mechanisms which are part of the control loop. These reflexes attempt to compensate for the target object vibration or for the observer's own vibration.

One reflex is the "vestibulo-ocular" reflex. Head rotation is sensed by the semicircular canals in the ear. This reflex attempts to maintain a stable line of sight.

Another is the "pursuit reflex." The eye rotates to follow the moving object. This reflex is only useful for target vibration below 2.5 Hz for sinusoidal vibration and 1 Hz for random vibration. The exact frequency limits also depend on amplitude.

References

1. M.J. Griffin, Handbook of Human Vibration, Academic Press, London, 1990.
2. C. Harris, Handbook of Acoustical Measurements and Noise Control, McGraw-Hill, New York, 1991.