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ANALYSIS OF OCULOMOTOR SYSTEM USING ITS MATHEMATICAL MODEL

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In order to realize various optic axis movements, by which a moving target can be caught in a fovea, a mathematical model of oculomotor system is developed for the movements of a head and an eyeball. As illustrated in Fig.1, an image signal from retina and an acceleration signal from semicircular canal are used as control inputs to muscles of eyeball to realize appropriate eye movements taking into account the displacement of a head rotation.

For easiness of discussion, the model considers only horizontal movements and omit its saccadic control mechanism. Its model is synthesized as given by Fig.2 on the basis of anatomy and physiology of a visual system illustrated by Fig.1.

The dynamics of an oculomotor system which keeps the image of a target centered on the fovea, is realized as a combination of basic physiological eye movements, such as vestibulo-ocular reflex, optokinetic nystagmus and smooth pursuit eye movements. They are confirmed to be realized as dynamics by the interruption of signals from semicircular canals according to their blockade or immobilization of the head and/or by no signal from retina in darkness, etc.

It becomes clear from various simulation experiments that the basic eye movements are precisely understood by the dynamic and frequency characteristics of the proposed mathematical system under different conditions. In addition, it is made clear that even complicated eye movements are systematically described as its dynamics under definite conditions and difference of signals from retina and/or semicircular canals.

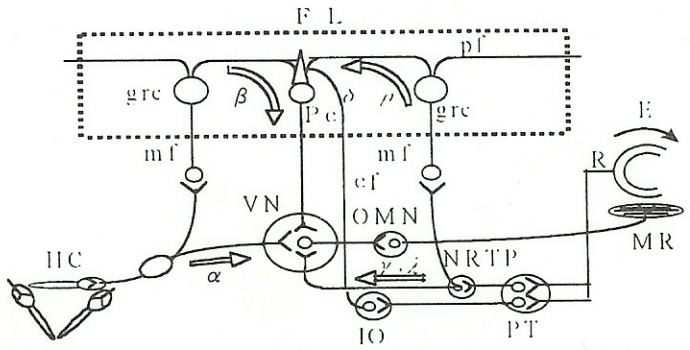

Fig.1 Outline of neural paths for eye movement

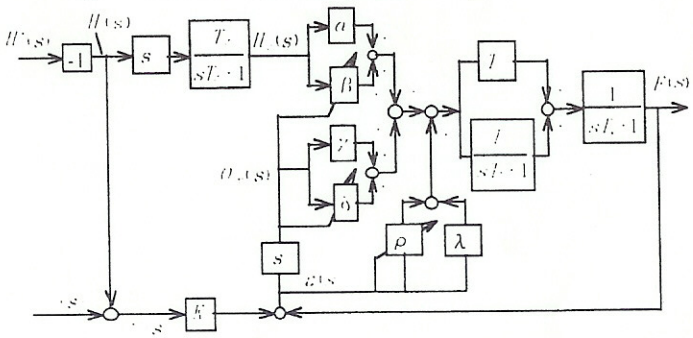

Fig.2 A mathematical model of eye movement.