1. Introduction

The control of saccadic eye movements can be studied at many levels of complexity and is a topic of great challenge for modellers of sensorimotor systems. In the early sixties, Young and Stark (1963) formulated a sampled-data model for the saccadic system. The idea of a sampled-data system, which either receives or sends out data at discrete time intervals and is inactive at other times, was meant to provide a simple mathematical description of the saccadic refractory period which had been noticed in pulse-displacement experiments (Westheimer, 1954). Given the well-known saccadic response to a target step, one would expect closely spaced and oppositely directed saccades in response to a brief pulse if the saccadic system were linear. In fact, the eye may stay for hundreds of milliseconds at the peripheral position reached after the first centrifugal saccade, or may even not jump at all.

In later years, when it became possible to record from single neurons in behaving animals, attempts were made to incorporate the new neurophysiological findings in models of the saccadic system. It was soon noticed that the discontinuous nature of the saccadic system, emphasized by Young and Stark, is reflected in properties of the motor part of the system (Robinson, 1973). It rapidly became clear that realistic modelling of the saccadic system requires a joint effort of neurophysiological, anatomical and theoretical work. Successful application of such an integrated approach led to the development of the internal feedback model of the saccadic system (Robinson, 1975). This model has its neurophysiological basis in the activity patterns of neurons in the periphery of the motor system as found in studies in the early seventies. It deals primarily with the metrical and dynamical properties of saccades and, unlike the sampled-data model, does not attempt to account for their timing.

Before the internal feedback model was developed, saccades were commonly regarded as classical examples of ballistic, or preprogrammed, movements. It was argued in defense of this view that, although the retina can provide sensory feedback about the target's instantaneous retinal position during the eye movement, nevertheless the long visual delays preclude the actual use of reafferent information for the control of fast eye movements. For example, in small saccades the movement is already completed before the first sensory information about the start of the movement can possibly reach the motor system. Therefore it seemed reasonable to think that saccades must be controlled ballistically, i.e., by a set of control signals which are already fully determined at the start of the movement and therefore incapable of correcting for disturbances of the trajectory imposed during the movement.

Although fully aware that sensory (or external) feedback is much too slow to be useful for controlling fast movements, Robinson (1975) proposed that saccades may still be guided rather than ballistic movements. According to his model the system...