# Coupling static and dynamic environmental information from visual system to changes in locomotion pattern for adaptive human locomotion

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"Locomotion is controlled by information; control lies in the animal-environment system" (Gibson, 1979). That sensory information plays critical role in the control of locomotion is not an issue: rather the challenge has been to identify the roles played by various sensory inputs and delineate the transformation of the sensory input into appropriate motor output. Visual information plays a critical role in adaptive human locomotion. Vision is the only modality that provides accurate and precise advance information about inanimate features of the environment. It is not surprising that most animals rely on vision to guide locomotion through complex and changing environment and Gibson in 1938 stated that "locomotion is guided chiefly by vision". The study of visual control of locomotion best exemplifies the study of animal-environment system. The importance of vision for the control of adaptive locomotion was recognized early on. Liddell & Phillips in 1944 showed that following pyramidotomy (which involves the cutting of primary motor pathway from the cortex to the spine) cats were unable to walk in challenging environments where visually guided limb movements were essential. Recently researchers have begun to quantify these motor signals which represent one of the outputs from the visual system. The challenge has been on the sensory side, specifically controlling the visual input, determining the spatial and temporal link and the transformation between the sensory input and motor output and identifying the many roles visual input plays in controlling locomotion. Basically, the roles of vision in regulating locomotion can be grouped into following two functions: (a) Proactively adapt the basic walking patterns to meet the challenges of the environment and the individual's goals; (b) Maintain dynamic stability both proactively and reactively. Clearly these two major functions are sine qua non for locomotion in normal terrestrial environment, and sensory input is essential. In this lecture I will review the contributions of vision in regulating locomotion and discuss several studies from our lab that exemplifies how static and dynamic environmental features are obtained from the changing image on the retina and how this information is used to modulate locomotor patterns for adaptive human locomotion. These results suggest possible algorithms for controlling biped robots to function in an unstructured environment.

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