

Abstract

Bipedal stabilization and walking has often been modelled using a multi-degree of freedom inverted pendulum from a control systems perspective. The double inverted pendulum and its cart-pole equivalent provides a range of interesting control options in the form of an underactuated system which is useful for the development of control paradigms for bipedal walking. Bipedal walking involves control and motion planning under a wide range of state and load variations. The associated non-linear system involves stabilization and motion generation which has been the interest of several researchers in terms of developing new control strategies. Neuro dynamic control has been considered in this thesis due to its emergence as a new method and its similarity with natural neural control in human walking. Reinforcement learning based control scheme for bipedal system which may be used in humanoid robotics or in active prostheses situations is considered. A model based on the bond graph technique combined with a musculoskeletal representation of the physical system has been developed to study the basic system performance. Various linear and non-linear controllers have been designed and studied. Further, neuro dynamic approach to Reinforcement learning, Q learning in comparison with sliding Mode control have been studied and analysed on variants of the system. Motion planning for bipedal robots was carried out for stabilization with Fuzzy Logic Control using zero moment point error and its derivatives as input and ankle joint correction angle as output. Experimental verification of some of the control schemes was carried out on a rotary inverted pendulum using sliding mode control and state feedback control.