Neuronal Control and Learning for Adaptive, Fast Dynamic Walking of the Biped Robot *“RunBot”*

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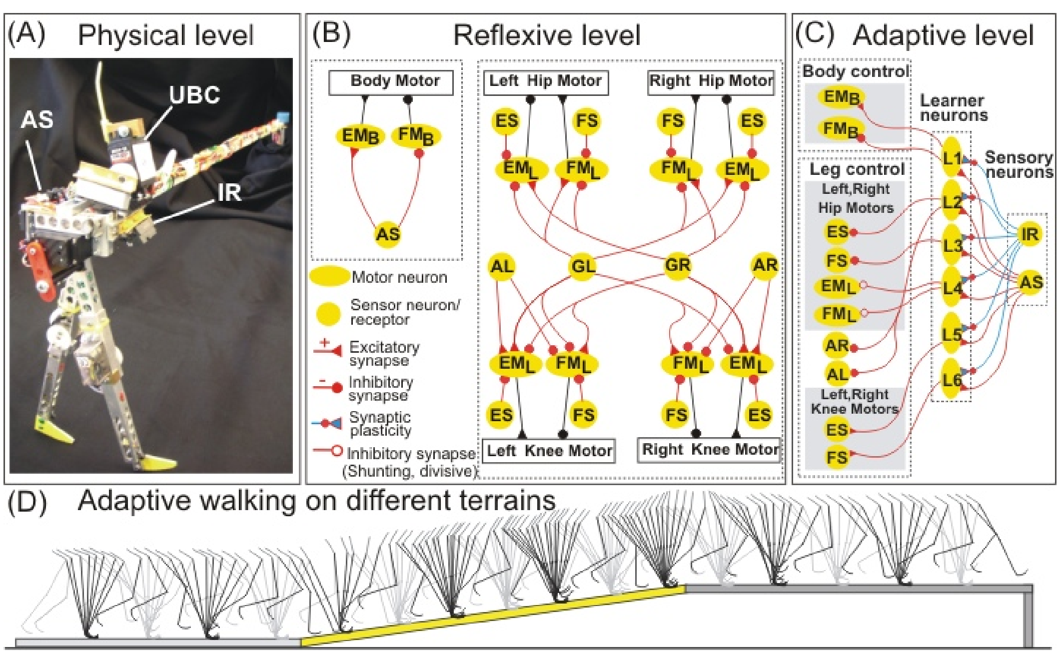
The RunBot system has been developed during the last four years [1]. It is created on the basis of three different levels:

The physical level : The biomechanical design of RunBot has some special features (see Fig. A), e.g. small curved feet and a properly positioned center of mass allowing it to perform dynamic walking during some stage of its gait cycles [1].

The reflexive level : A low-level neural structure (see Fig. B) generates dynamically stable gaits. The reflexive network for controlling leg-motor neurons (EM_L, FM_L) is driven by signals coming from ground contact sensors ($G_{L,R}$), stretch receptors ($A_{L,R}$) and extensor as well as flexor sensors (ES, FS), while an accelerometer sensor (AS) is used to trigger the body reflex via the body-motor neurons (EM_B, FM_B). Changing some neural parameters of the network can regulate walking speed of RunBot and adapt its locomotion to different terrains [1].

The adaptive level : The network can learn using mechanisms of simulated synaptic plasticity emulating the idea of learning to avoid a long-loop body-reflex. The learning goal is to finally avoid the reflex and thereby learn to also change gait parameters in an appropriate way as well as control the posture of its body (UBC) to prevent RunBot from falling during walking on different terrains (see Fig. D). This requires an adaptive network (see Fig. C) of six neurons (L1,...,6) which converge onto different neurons at the reflexive network effectively changing their activation parameters. This paper shows that Runbot is an adaptive dynamic walking machine which doesn’t use any trajectory control, but instead fully relies on its two neuronal control levels.



Reference

T. Geng, B. Porr, F. Wörgötter, Int. J. Robot. Res. 25, 243 (2006).