FROM GAITS TO ROBOT, A HYBRID METHODOLOGY FOR A BIPED WALKER

NIZAR ROKBANI, ELHOUCINE BEN BOUSSADA,
BOUDOUR AMMAR CHERIF AND ADEL M. ALIMI

Research Group on Intelligent Machines, National Engineering School of Sfax, Bp W, Soukra Road, Sfax, 3038, Tunisia

E-mail: {Nizar.rokbani, adel.alimi, houcine.boussada}@ieee.org

This paper presents a methodology allowing simple and effective biped robot prototyping and validation using a multi-agent architecture for gait generation and a self assembled biped walker. The gait generator, GG, is based on PSO, particle swarm optimization, which is an evolutionary algorithm; the Obtained gaits are fitted to a robot in order to evaluate the real performances of the approach. To control the Center of Mass, COM, a fuzzy approach, FGG, is introduced allowing fast and effective stability control.

1. Introduction

Humanoid robotics has become a very active research field; within this issue bipedal and legged locomotion proposals focus on different aspects of biped walking control. Walking based on gaits is one of the oldest and most approved methodologies for walking control; the gaits are the set of coordinates that the robot controller has to ensure in order to make the body moves [1-2].

Gaits generation, GG, can be obtained using a classical modeling methodology such as direct and reverse kinematics or Lagrange based approaches [3-4-5]. These approaches are cost computing and are very close to a robot model. Intelligent approaches [6-8] are based partially on the “model free paradigm” [7]. Humans start their life with a limited capacity locomotion system, and then as they grow their locomotion system becomes more and more effective. Automatic and optimized control strategy is fitted to it according to its specific use. When becoming old, the locomotion-capacities fall once-more, and new strategies are adopted to overcome the weaknesses of the legs. The new strategy takes into consideration the degradations that affect the mechanical parts of the locomotion system. Intelligent robotics tries to offer robots some limited but very important aspects of biological life [6].

In this paper we will use a classical control schema; our contribution is the gait generation approach and the validation methodology that covers the robot prototyping and warming. The gait generation proposed here is based on the PSO gait generator detailed by *Rokbani et al* [8-9], with a new agents-based architecture. The remaing of this paper is organized as follows: in section 2 we introduce the system architecture, resume the PSO Gait generator and the new agent-based enhancements. Section 3 details the robot assembly and walking implementation methodology. Finally section 4 is reserved for discussions and further works introducing and perspectives.

2. System architecture

An alternative for gaits generation was proposed for mobile and legged robotics using fuzzy, neural, nero-fuzzy and evolutionary based algorithms. These methodologies were asked to perform this task to substitute the classical modeling. A gait generator based on particle swarm paradigm was proposed in [7], a developed version was then detailed in [9] and [10].

The system can be decomposed in three parts: the gait generator, the robot controllers and the robot assembly, see figure1. The robot controller is made up of a set of joints controllers that are ensuring the tracking of the gates obtained from the Gait generator module. The robot is controlled in two plans, the servo joints running on the lateral sides, while the COM is controlled by a rotation in the frontal plane, see figure2; The Joints controllers are classical PID one's. The COM-servo rotations are generated by a fuzzy controller. These rotations are playing key roles in both stability and global motion control.

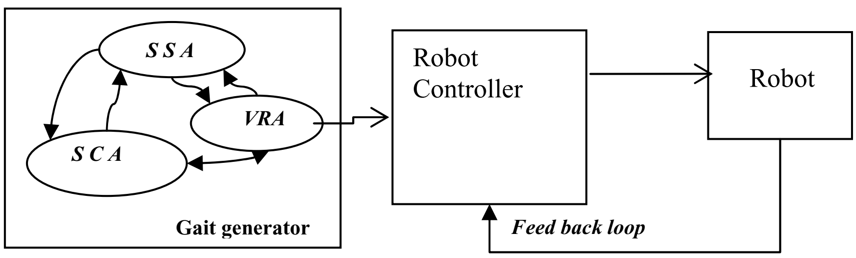

Figure 1. Agent based gait generation, SSA, Swarm skeleton Agent, SCA, Stability Control Agent, VRA, virtual robot agent..

neural or a fuzzy-neural gait generator could be more interesting and it is actually under development.

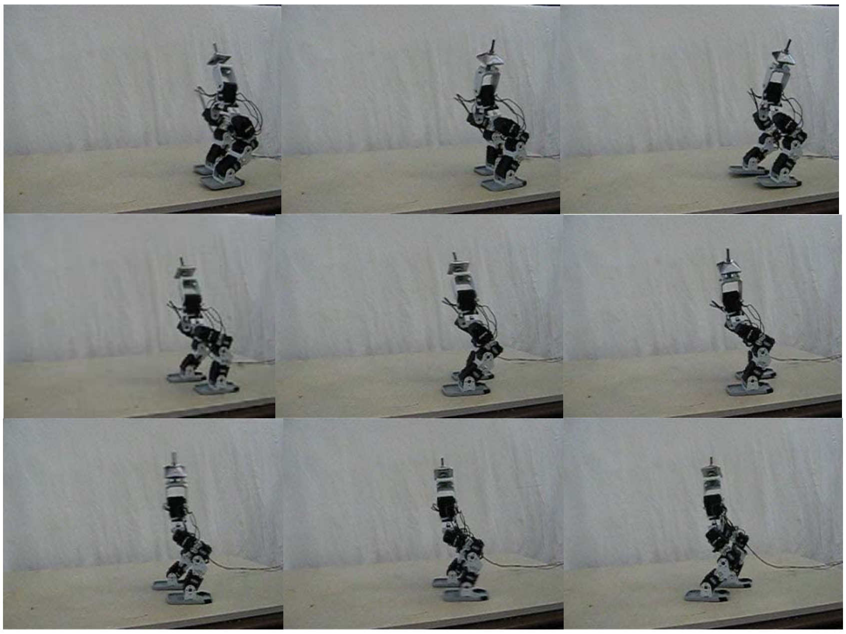

Figure 4. Screen shots showing the robot walking.

Appendix

$$v_{i(t)} = v_{i(t-1)} + c_1 * r_1 * \left[p_{lbest} - x_{i(t-1)} \right] + c_2 * r_2 * \left[p_{gbest} - x_{i(t-1)} \right] \quad \text{(A.1)}$$

$$x_{i(t)} = x_{i(t-1)} + v_{i(t-1)} \quad \text{(A.2)}$$

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