

Simulation of a Humanoid Soccer Robot

Team Description Proposal for RobCup2007

Sama3D

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Abstract. This document describes the ideas of implementing and simulation of a humanoid soccer robot for Robocup 2007 3D Soccer Simulation section. Based on the successful experiment in implementing the Agent Soccer robot and the changes that have been done recently (From Agent to Humanoid) we are going to simulate a humanoid robot for the competition. After extracting the walking parameters, the implemented system goes through a learning procedure that enables the robot to estimate the next movement parameters.

Keywords: Zero Moment Point (ZMP), Artificial intelligence, Artificial Neural Networks (ANN), Radial Basis Function (RBF)

1 Introduction

One of the main challenges in simulation and implementation of the humanoid robot is finding a suitable walking-pattern model. With this pattern the robot will be able to execute and run the issued command without falling down.

Several walking-pattern methods have been studied, including Zero Moment Point (ZMP) walking, rhythmic walking, ballistic walking. Simulation and implementation of all these methods has shown that all of them have the capability of being used in a walking pattern.

The first step in the method that has been used in our robot is implementing a walking pattern based on ZMP. In ZMP method, the aim is finding the point, where the center of gravity is maintained over the continuous movement of robot in all times [1,2,4].

This method can be developed by a mathematical model of kinematics of each part that have a degree of freedom. In this model for each degree of freedom a 3-dimension rotation matrix is considered and for each joint a translation vector can be used.

Using the mentioned method can impose a huge calculations load on CPU for each step. We can decrease this calculation load by using a learning procedure. An artificial neural network is utilized for realizing this idea.

After training the neural network with the extracted parameters from ZMP method, The robot will be able to calculate the next step parameters without using the ZMP method but ,by using the trained-neural network. based on the issued commands, the trained neural network calculates the next step parameters including new coordinates and angles intelligently. Utilizing this method will cause in increasing speed and calculation efficiency that can be considered as a positive factor in soccer robots.

After implementing the above system ,the simulated robot is tested and simulated with Webots® Simulation environment.

2 Implementation

If a predefined movement considered for robot (e.g. 20 degree movement of knee),using ZMP method we can calculate the motion parameters for robot so that it maintain its balance. This can be done by 3 dimensional rotation matrix that is utilized for each movement .

It can be shown that the problem of calculating the next step parameters using ZMP method is a structured problem and can be learned to a machine by a learning process. Fig.1 shows the method of extracting the ZMP parameters. After initial modeling of the robot different movement and walking patterns that is needed for robot in playing environment , is applied to it. Then the next step parameters for each movement and walking patterns is calculated using ZMP and stored in a database.

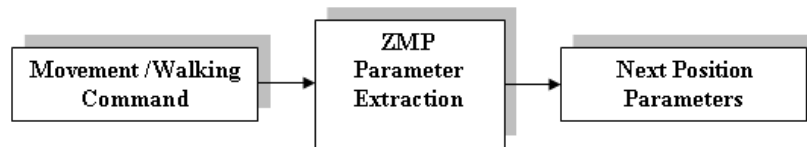


Fig. 1. .Extracting ZMP Parameters for the next position parameters.

The next step is training a neural network with the available inputs (movement command) and outputs(ZMP parameters) in database. Block diagram of a training system has been shown in fig.2.In each iteration , error is calculated and is fed to a correction system. After applying the new correction on error the system is trained again. This procedure is repeated till we reach to a desirable error value.

By developing a trained neural network now it's possible to apply the movement command directly to the trained network. As it can be seen in figure 3 ,when a movement command is issued ,first this command is analyzed by the trained network

and then the required movement parameters for the next step is extracted and given to the robot.

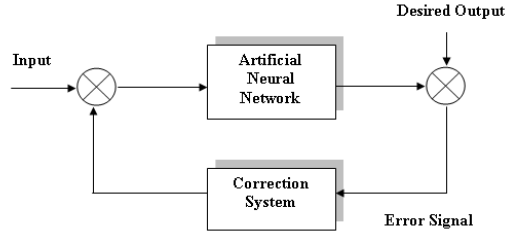


Fig. 2. Training method for an ANN .The network is trained with inputs and outputs that are available in the database .

Considering the fact that the problem is an interpolation of current position and the next position in one step a RBF (Radial Basis Function) is developed for the system as the neural network [3].

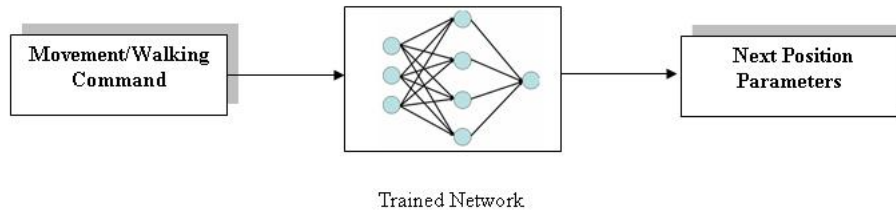


Fig. 3. Using Trained network for direct estimating of the ZMP parameters

3 Conclusion and Current Works

The structure of the humanoid robot is so that it needs a regular and accurate pattern for walking. so achieving a dynamic solution for this pattern is obligatory at the first step of work. we have successfully implemented this pattern by ZMP method.

The next step is to give the robot an intelligence so that it can think and decide based on the learning procedure that is developed by an ANN .The first simulation of the above learning procedure was done in MATLAB® and satisfying result acquired.

Now we are going to integrate these all together in a single programming environment and test and simulate the result in Webots® simulation environment.

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