Miracle 3D Soccer Simulation Team description 2013

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Abstract. 3D inverted pendulum model applied to a humanoid robot walking humanoid robot, now. The robot's gait is abstracted into a three-dimensional inverted pendulum to analysis. To solve the equations of motion of the robot centroid time walking robot. Method using inverse kinematics calculated the angle of each joint of the leg, and can achieve humanoid robot gait planning to write code.

Keywords: 3D inverted pendulum, Gait Planning, Kinematics

1 Introduction

Hefei Normal University Miracle3D Simulation Robot Soccer Team was established in September 2009. Miracle3D took part in the national competition. The bottom comes from Anhui University of underlying early version. Stopped in the middle of the competition for years, and now re-join the project.
The following are some of the preparation and the results of the work of our group for the entries.

2 Structure of Miracle

For now the competition requirements, we optimized code structure and expansion.
The relationship between the various modules of the player program shows a clear layered structure. As shown in Fig1.

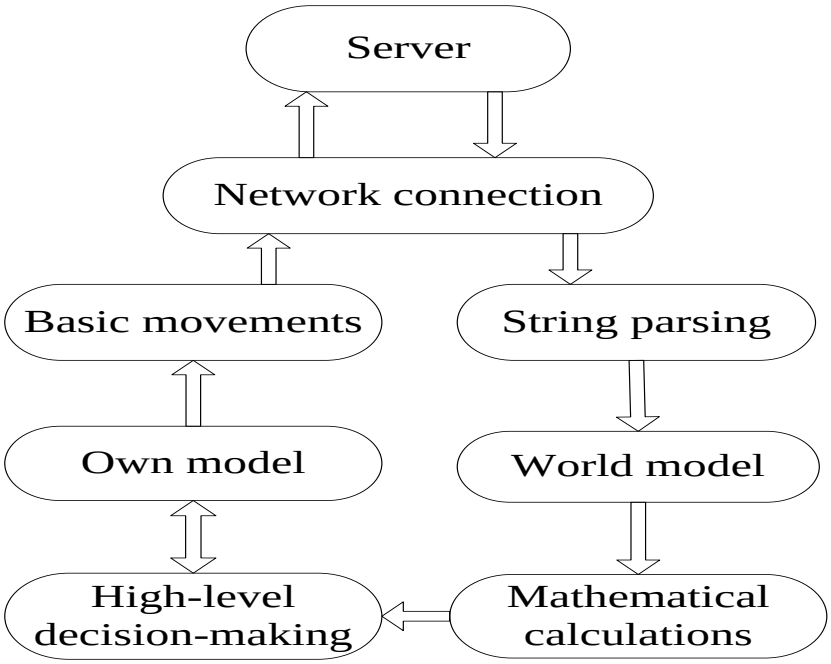

Fig.1. Module structure

Our underlying modules by the message parsing layer and action layer, high-level decision-making four blocks.

Message parsing layer：The message sent by the server parses out the stadium and Agent required information.

Mathematical calculation layer：Agent gait planning, and calculate the angle of each joint of the leg you want to walk.

Actions layer：Agent action packed, and when needed call forward, backward, diagonal walking, and then evolved to a lateral direction to walk.

High-level decision-making：The design strategies pitch Agent it humanlike offensive and defensive.

2009 player program on the basis of functional modules, we increase their own models and mathematical calculations. Joint angles and pitch information obtained from string parsing through the gait planning to work out the right trajectory, kinematics knowledge re-use for mathematical calculations, and high-level decision-making, to update its own model, and then fed back to the high-level decision-making, better to work out its own model, to call most appropriate walking action, thus completing the robot walking.

3 Miracle Kinematics

The forward kinematics solves rod position according to the joint angles. Usually used for robot center of gravity, a graphic description of the robot state

and decision collision with the environment, the robot simulation on the basis of. 6-degree-of-freedom robot kinematics equation is defined as (1)：

$$T_1T_2T_3T_4T_5T_6 = P \quad [1] \quad (1)$$

The matrix T_i is defined as (2)

$$T_i = \begin{bmatrix} R_i P_i \\ 0001 \end{bmatrix} \quad (2)$$

Ti homogeneous transformation matrix $\sum_i$ to $\sum_{i-1}$ from the coordinate system, R_i is a rotation matrix, P_i is the position vector. Known the rotation matrix and the position vector, solves the end actuator relative to the position P of the reference coordinate system for the forward kinematics solver.

Currently we have achieved through the rotation of the centroid of the matrix and the position, the rotation matrix and the position of the leg portions, each joint angle of the leg be solved by the inverse kinematics.

Here we use analytical method for solving successively through artificial methods to get the optimal joint angle method, the accuracy of the above have greatly improved in accuracy.

4 Miracle Gait Planning

Centroid trajectory is actually a robot trajectory. Here, we adopt a model of three-dimensional linear inverted pendulum gait planning, the method has been realized. We can use the latest action in the World Cup. The following is the movement of the center of mass of the three-dimensional linear inverted pendulum model obtained the formula[2-4] .

$$x(t) = x(0)\cosh(t/Tc) + Tc\,\dot{x}(0)\sinh(t/Tc) \quad (3)$$

Among, $Tc = \sqrt{z/g}$,(z is the height of the centroid, g is the acceleration due to gravity). $x(0)$, $\dot{x}(0)$ are zero moments the centroid position and speed [5] . Since the robot walking certain speed, where the termination of a walk cycle speed as a walk cycle began to speed, then：

$$\begin{bmatrix} \dot{x} \\ \dot{y} \end{bmatrix} = \begin{bmatrix} (C+1)/(T_c S)x \\ (C-1)/(T_c S)y \end{bmatrix} \quad (4)$$

Among $C = \cosh(T_{\sup} / T_c)$, $S = \sinh(T_{\sup} / T_c)$, $\dot{x}$, $\dot{y}$ are respectively the x-direction and y-direction speed[6-7]. $T_{\sup}$ is the supporting time. It is assumed that the starting point is $(-x,0)$, endpoint is (x, y).The initial velocity of the walking cycle can be calculated by the formula (4)[8-10]. The initial velocity and the initial position into (3), one can obtain the trajectory of the centroid is shown in Fig2.

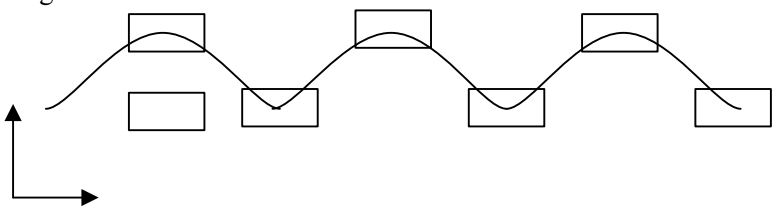

Fig.2. Center of mass motion trajectory

Here we confront prior position and velocity of the heart to be set, and then the game progresses process, the real-time dynamic adjustment of the location of the centroid.

5 Future Work

From past experience, the robot walking speed is one of the key to winning in the game. Our team in action layer is still not perfect. Oblique walking there are problems to be solved. In addition, good decision-making is also vital win. Our decision-making is still in the initial construction phase. Implementation of the decision-making is also a focus of future work. Our team is still a long road to go.

6 Summary

Although to carry out the RoboCup simulation of 3D time is not long, but through their own efforts and experience to ask each team has formed a brand new team. Despite my limited capacity to carry out a short time, but I am still overcome a lot of difficulties, solve a lot of problems. We also work harder to achieve higher goals.
Finally, we are very much looking forward to be able to participate in the competition, get more opportunities for the exchange of learning!

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