DNU_Explorer Research Proposal

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Abstract. Controlling a biped robot with a high degree of freedom To achieve stable movement patterns is still an open and comple x problem. Thus, the development of control mechanisms for bipe d walking have become an important field of research. With growin g calculation power of computer hardware, high resolution realtime simulation of such robot models in effect becomes all the more applicable. This thesis presents a physical simulation of a 20 degrees of freedom real biped robot model used in RoboCup 3D Soccer Simulation Leagu e and demonstrates it sapplication for exploring biped motion control techniques.

1 Introduction

This year the 3D Soccer Simulation League has had the obvious change, Most main is the robot has become the present human robot by the spheroid. So this change has caused team's first floor control change, Under new platform. Team's editors need to consider the robot between each joint mutual function, between robot and other object questions and so on collision.

How does our research direction lie in uses the position and each joint coordinates which the known visual information and the robot own each joint information establishment transformation matrix and the corresponding coordinate system judge oneself locate and orientations.

2 Establishes the Robot's active coordinates

In simulation process, Robot each cycle all may receive the news which server transmits, in which including visual news and own each joint condition news. Through analysis vision news, we may obtain the robot on field position and the soccer position; through analyzes robot own each joint the condition news to be possible to know each joint revolved angle. Very obvious, these information cannot obtain the robot each joint concrete coordinates and the posture merely. Therefore, we decided (platform assigns in the overall situation coordinate system coordinate system) in the foundation establishes the robot a series of reference coordinate system. Considered we have already known the robot detail requirements, we the joint which may move for robot 14 establishes one to belong to this joint moving coordinate system separately, and stipulated each moving coordinate system the zero point is located this joint the center of gravity. Then establishes the level by the robot body the active coordinates, establish the second level of active coordinates by arm1_2 and leg1, establish the third level of active coordinates by arm3 and leg2_3, establish the fourth level of active coordinates by arm4 and leg4, establishes the fifth level of coordinates by leg5_6.

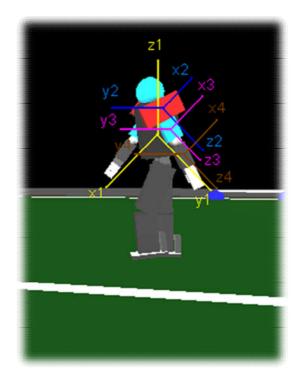


Fig. 1 Robot each joint moving coordinate system establishment.

The bodily center is the level active coordinates, joint Arm1_2 establishment in above level active coordinates, joint Arm3 establishment in second level of active coordinates (joint Arm1_2) above, joint Arm4 establishment in third level of active coordinates (joint Arm3) above.(Fig. 1)

Because the robot joint which uses all only to be able to revolve, therefore only must consider the moving coordinate system in reference coordinate system revolving then. For instance joint Arm1_2 circled the x2 axis to rotate theta the angle, may result in by the transformation matrix knowledge :

$$P_{x1y1z1} = Rot(x,\theta) \times P_{x2y2z2}$$

Revolving matrixes are below:

$$Rot(x, \theta) = \begin{bmatrix} 1 & 0 & 0 \\ 0 & Cos\theta & -Sin\theta \\ 0 & Sin\theta & Cos\theta \end{bmatrix}$$
$$Rot(y, \theta) = \begin{bmatrix} Cos\theta & 0 & Sin\theta \\ 0 & 1 & 0 \\ -Sin\theta & 0 & Cos\theta \end{bmatrix}$$
$$Rot(y, \theta) = \begin{bmatrix} Cos\theta & -Sin\theta & 0 \\ Sin\theta & Cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

Through all levels of active coordinates and world coordinates transformation, then may obtain each joint in the world coordinates concrete position.

3 Agent Action Framework

We separate the action model of the agent to four hierarchy (Fig.2).

- 1. Physical Actions: Include the physical actions and coordinate actions of the joints.
- 2. Basic Actions: The basic actions of the agent, for example move forward, turn round, jump and kick.
- 3. Advanced Actions: Advance actions base on the basic actions, include move to an appoint location, kick the ball to an appoint location and so on.
- 4. Intelligent Actions: The actions need to make a strategic decision, include run across the opponent with the ball, pass the ball to a teammate, make a goal, keep a close watch on an opponent, keep the goal and so on.

This four hierarchise are all program base on the API that the lower hierarchy supported. Each hierarchy is develops by different person whit different technology. On the premise of standards the API, the development of the four hierarchies is parallel, and the developer of high-hierarchy doesn't need to understand the detail of the low-hierarchy.

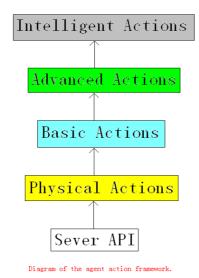


Fig. 2 Agent action framework

4 Debug Tools Develop

We developed a graphics debug tools to raise working efficiency. The running montage is below(Fig 3).

	NextCycle							
		Prev	viousCycle		GotoCycle			Designed by Beng Gu
on VisionInfo VelInfo	1							
Rarm_UJ_1_2		Lleg_HJ_1		Rleg_HJ_1		Front View		Side View
512 Angle1	0.36512	Angle	2.33248	Angle	-0.00025		404	
54 Rate1	1.36544	Rate	0.33658	Rate	-2.33641			•
58 Angle2	1.35221	Lleg_UJ_2_3	3	Rleg_UJ_2_	3	• • ••••••••••••••••••••••••••••••••••		• • •
21 Rate2	1.25015	Angle1	3.22159	Angle1	2.33521			
Rarm_HJ_3		Rate1	1.00257	Rate1	-5.02123			
54 Angle	-0.00025	Angle2	2.36152	Angle2	1.33561			
58 Rate	0.36999] Rate2	-2.33324	Rate2	1.53124	•		†
Rarm HJ 4		Lleg HJ 4		Rleg HJ 4		<u></u>		-
35 Angle	-0.00025	Angle	1.12224	Angle	0.37214	Î Î		1
54 Rate	-4.32510	Rate	-2.33611	Rate	-1.85774			
		Lleg_UJ_5_6		Rleg_UJ_5_6		• •		•
GetJointInfo			-2.33621	Angle1	-4.43217			
) Rate1	-0.00185	Rate1	-2.77412			
	-	Angle2	89.41622	Angle2	2.99821	• •		-+
SetJointInfo			0.55523	Rate2	-1.88342			
	Angle1 Angle1 Angle2 Rate1 B8 Angle2 Ram_HJ_3 Angle B8 Angle Ram_HJ_4 Angle B8 Ram_HJ_4 Angle Rate	312 Angle1 0.36512 34 Rate1 1.36544 58 Angle2 1.35221 Rate2 1.25015 Ratm_HJ_3 1.25015 54 Angle 0.00025 58 Ratm_HJ_4 Angle 0.00025 64 Angle -0.00025 54 Ratm_HJ_4 54 Angle -0.00025 54 GetJointInfo -4.32510	112 Angle1 0.36512 Angle 14 Rate1 1.36544 Rate 136544 Rate1 1.36544 Rate 58 Angle2 1.35221 Lleg_UJ_2_3 1 Rate2 1.25015 Angle1 Ram_HJ_3 Rate1 54 Angle 68 Rate 0.36939 Rate2 56 Rate 0.0025 Angle2 68 Rate 0.0025 Rate2 68 Rate 4.32510 Rate 14 SetNeithfon Rate2 Rate2	312 Angle1 0.36512 Angle 2.33248 34 Rate1 1.36544 Rate 0.3658 58 Angle2 1.35221 Lleg_LUL_2_3 11 Rate2 1.25015 Angle1 3.22159 Ratm_HJ_3 Rate1 1.00257 54 Angle 0.00025 Angle2 2.36152 56 Rate 0.36939 Rate2 2.3324 56 Rate 0.00025 Angle2 2.36152 58 Rate 0.36939 Rate2 2.3324 56 Rate 0.00025 Angle2 2.3324 57 Angle 0.00025 Angle2 2.3324 58 Rate 4.32510 Rate 2.33611 59 Rate 4.32510 Rate 2.33611 59 Rate 2.33611 2.23621 3.22159 59 Rate 2.33611 2.33621 3.2156 50 GetUointInfo Lleg_UU_5_6 4.32510 4.32510 50 SetLointInfo 2.33621 3.41622	12 Angle 0.36512 Angle 2.3248 Angle 14 Rate1 1.36544 Rate 0.3658 Rate 58 Angle2 1.35221 Lleg_UJ_2_3 Rleg_UJ_2_3 1 Rate2 1.25015 Angle1 3.22159 Angle1 8am_HJ_3 Rate1 1.00257 Rate1 1.00257 Rate1 54 Angle 0.36999 Rate2 2.33152 Angle2 56 Rate 0.36999 Rate2 2.33248 Rate2 56 Rate 0.36999 Rate2 2.33242 Rate2 56 Rate 0.36999 Rate2 2.33241 Rate2 57 Angle 0.0025 Angle 1.12224 Angle 58 Rate 4.32510 Rate 2.33611 Rate 54 Angle -0.0025 Rate 2.33611 Rate 54 Angle -0.0025 Rate 2.33611 Rate 54 Rate 4.32510 Rate 2.33611 Rate 56 GetJointInfo Rate1 Angle1 2.33621 Angle1 57 SetIngetInfo Rate1 Angle2 2.341522<	312 Angle1 0.36512 Angle 2.3248 Angle 0.00025 44 Rate1 1.36544 Rate 0.33658 Rate 2.33641 58 Angle2 1.35221 Lleg_LU_2_3 Rleg_LU_2_3 Rleg_LU_2_3 1 Rate2 1.25015 Angle1 3.22159 Angle1 2.33521 Ram_HJ_3 Rate1 1.00257 Rate1 5.02123 54 Angle 0.00025 Angle2 2.36152 Angle2 1.33561 56 Rate 0.36939 Rate2 2.3324 Rate2 1.53124 56 Rate 0.30639 Rate2 2.3321 Rate2 1.53124 56 Rate 0.30639 Rate2 2.3324 Rate2 1.53124 57 Angle 0.00025 Angle1 1.12224 Angle 0.37214 54 Angle 4.32510 Rate 2.33611 Rate 1.8574 54 Rate 4.32510 Rate 2.33621 Angle1 4.43217 55 GeUointInfo	112 Angle1 0.36512 Angle 2.33248 Angle 0.00025 14 Rate1 1.36544 Rate 0.33658 Rate 2.33641 158 Angle2 1.35221 Lleg_UJ_2_3 Rieg_UJ_2_3 11 Rate2 1.25015 Angle1 3.22159 Angle1 2.33521 12 Rate2 1.25015 Angle1 3.22159 Angle1 2.33521 12 Rate2 1.25015 Angle1 3.22159 Angle1 2.33521 13 Rate1 1.00257 Rate1 5.02123 1.33561 56 Rate 0.36999 Rate2 2.3324 Rate2 1.53124 14 Lleg_UJ_4 Rieg_UJ_4 Angle 0.37214 1.35774 14 Rate 4.32510 Rate 2.33611 Rate 1.35774 14 Lleg_UJ_5.6 Rieg_UJ_5.6 Angle1 4.43217 15 Rate1 0.00185 Rate1 2.77412 15 Angle2 98.41622 Angle2 2.99621 4 <td>112 Angle1 0.36512 Angle 2.33248 Angle -0.00025 14 Rate1 1.36544 Rate 0.33658 Rate 2.33641 138 Angle2 1.35221 Lleg_UJ_2_3 Rieg_UJ_2_3 Rieg_UJ_2_3 11 Rate2 1.25015 Angle1 3.22159 Angle1 2.33521 Ram_HJ_3 Rate1 1.00257 Rate1 5.02123 5.6 68 Rate 0.36999 Rate2 2.33248 Rate2 1.53124 75 Angle 0.00025 Angle2 2.33152 Angle2 1.51124 8 Rate 0.36999 Rate2 2.33248 Rate2 1.53124 8 Rate 0.36999 Rate2 2.33211 Rate2 1.53124 8 Angle 0.00025 Angle 1.12224 Angle 0.37214 8 Rate 4.32510 Rate 2.33611 Rate 1.85774 14 Rate1 9.2012.5 Rate1 2.77412 Angle1 2.39621 6 <</td>	112 Angle1 0.36512 Angle 2.33248 Angle -0.00025 14 Rate1 1.36544 Rate 0.33658 Rate 2.33641 138 Angle2 1.35221 Lleg_UJ_2_3 Rieg_UJ_2_3 Rieg_UJ_2_3 11 Rate2 1.25015 Angle1 3.22159 Angle1 2.33521 Ram_HJ_3 Rate1 1.00257 Rate1 5.02123 5.6 68 Rate 0.36999 Rate2 2.33248 Rate2 1.53124 75 Angle 0.00025 Angle2 2.33152 Angle2 1.51124 8 Rate 0.36999 Rate2 2.33248 Rate2 1.53124 8 Rate 0.36999 Rate2 2.33211 Rate2 1.53124 8 Angle 0.00025 Angle 1.12224 Angle 0.37214 8 Rate 4.32510 Rate 2.33611 Rate 1.85774 14 Rate1 9.2012.5 Rate1 2.77412 Angle1 2.39621 6 <

Fig. 3 Agent Information Analyzer

In this tool, the state of an agent can be viewed in two 2D views. Front view and the side view. At the bottom of the window is the state of the eighteen joints.

5 Future Work

How uses the kinematics and the misfortune kinematics solves the robot some joint after to carry out some order condition as well as some joint expected arrives concrete order which some kind of state of motion needs. How analyzes the robot the joint to be opposite in the fixed coordinate system differential movement, Jacobians matrix as well as the robot speed relations. In order to analyze the robot the acceleration and the inertia, we will also study the robot dynamics as well as the robot static relations. In order to let the robot from a displacement in position to another position, We will also study and this correlation way and the path plan, How does this mainly manifest between the movement section lets have the controlled movement sequence, will use each kind in the concrete realization process to approach processing the method.

6 References

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