Research on RoboCup Simulation 3D

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Abstract. Humanoid robots will be used in RoboCup-2007 simulation 3D league. As a participating team, we have challenging researches to do. To develop a successful humanoid soccer simulation team, some of the directions that we believe are promising in achieving our goals are proposed.

1 Introduction

RoboCup offers an integrated research task covering the broad areas of AI(Artificial Intelligence) and robotics. Such areas include: real-time sensor fusion, reactive behavior, strategy acquisition, learning, real-time planning, multi-agent systems, context recognition, vision, strategic decision-making, motor control, intelligent robot control, and many more. It attracts so many researchers in these years, and including us. We have started researching on RoboCup simulation 3D since 2005, and the results achieved by our team are delightful.

On the roadmap towards simulation league finals in real robots[8], the 3D soccer simulation league takes a big step forward to the RoboCup's ultimate long-term goal this year. The competitions will be very different from matches we had in previous years, *simspark*[6] with humanoid robots will be used in RoboCup-2007.

As a participating team, we have challenging researches to do. We divided our planning work into two main parts:

- Research on the new challenge due to the new humanoid simulator;
- Advanced researches based on our previous work.

The paper is organized as follows. In section 2, we describe the new challenges in RoboCup simulation 3D and our proposal. Then we describe advanced researches based on our previous work in section 3, followed by the summary in section 4.

2 New Challenge: Humanoid Behavior Generation in the Dynamic and Adversarial Environment

In order for a humanoid robot team to actually play a soccer game, various humanoid behaviors must be implemented including: biped walking, running, kicking, getting-up, etc. Humanoid behavior generation is one of the most formidable

issues due to its many degrees of freedom. Coordinating several effectors of the same robot to perform a behavior is the key research problem.

Many studies have been conducted on biped locomotion control, and many biped locomotion methods have been proposed[1, 13]. However, most of the past studies concentrated on the typical periodic and stable biped locomotion, they are not suitable to the *dynamic* and *adversarial* environment, with moving objects, some of them rational agents that are playing a game against your team.

For the aforementioned reason, we are interesting in researching on efficient **real-time** method to generate humanoid **adversarial behaviors**. To start a more complex research, we choose some methods which have been implemented by RoboCup humanoid teams.

In [10], the *online generation of trajectories for omnidirectional walking* was proposed. It has a low computational complexity and can be implemented on small onboard computers. They control the humanoid robot using a framework that supports a hierarchy of reactive behaviors. The design of the trajectories was based on kinematics and dynamic constraints. The gait can be parameterized using walking direction, walking speed, and rotational speed, so it is possible to continuously compensate for deviations from the desired walking direction using visual feedback.

A face-to-face ball passing is implemented in [7]. They decomposed a given task into a sequence of modules. Each of which consists of a set of motion primitives that have control parameters to realize the appropriate primitive motions. Then, these parameters are learned by sensori-motor maps between visual information and motor commands. The controller accomplishes a given task by selecting a module, a motion primitive in the selected module, and its appropriate control parameters learned in advance.

In order to succeed in such real soccer game environments, humanoid robots need to perform stable dynamic and adversarial behaviors. However, the humanoid robots of today still do not satisfy the aforementioned demands and their level of dynamically stable mobility is insufficient in the context of the real and uncertain environment[13], since the humanoids can not cope with unexpected external forces or sudden contacts with the environment. Humanoid robot often collides against others in the 5 vs. 5 soccer simulation competitions. This is the fact that development and implementation of soccer robot satisfied algorithm has been, so far, scarce. Hereby, behavior generation of humanoids research has still a long way to go, and it is our furture research.

3 Advanced Researches based on Previous Work

Although the humanoid simulation server is different from the sphere one, some features are the same, such as vision perception, soccer rule, etc. Thus, we can do advanced researches based on our previous work[12]. They are stated as follows.

3.1 Agent Architecture

Based on our no-strict layered agent architecture with singleton modules[12], we plan to implement the *plug-in mechanism*, which enable us only change one module when the server changes. It will makes the agent architecture more flexible, considering the server is still under development, there will be many changes of the server in the near future, such as perception, humanoid model.

3.2 World Model

In order for an agent to behave intelligently it is important that he keeps a world model that describes the current state of the environment. The humanoid robot has many sensors, such as joint sensor, touch sensor and gyro sensor. Intelligent integration and fusion of information from these distributed multi-sensor requires an optimization-centered approach, thus *real-time multi-sensor fusion*[2, 5] technique should be applied.

3.3 Communciation Among Agents

In our current implementation, the agents only use communication to help teammates improve their knowledge about the state of the world. This is important since it makes the agents robust to lost messages. But, spoken messages was restricted to 20 bytes in the new server. To keep this advantage, we need more efficient message encoding algorithm. And there're still a lot to do to help decision making by the communication among agents[9].

3.4 Strategy and Decision Making

We built a *Rule based System* for decision making last year. Although it was proven efficiency, but it is impossible that one strategy can win against different opponents. *Opponent modelling* is essential in finding different strategies for different opponents. *Case based reasoning*[11] is a common method for opponent modeling in multi-agent systems, we consider making some efforts on it in the future.

While using available artificial intelligent techniques in the decision making, we're still seeking for motivations from cognitive science[4] and real human decision making[3].

3.5 Development Tool

A time saving and high performance tool, named *seu-3d-toolkit*, was used to test server enviroment, train the agents and calculate statistics of matches in the last year. The research on development tool will go on with our other researchs.

4 Summary

In this paper, we briefly described the new challenge in RoboCup soccer simulation 3D league. To develop a successful humanoid soccer simulation team, the following are some of the directions that we believe are promising in achieving our goals.

- Humanoid behavior generation in the dynamic and adversarial environment;
- Flexible agent architecture;
- Real-time multi-sensor fusion;
- Communication among agents;
- Opponent modelling;
- Effective development tool.

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