Zagros Team Research Proposal

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Zagros team is consisted of a group of interested students in Robocup soccer simulation. Team started work in October 2006 by designing and developing a new 3D soccer simulation agent structure from the scratch. During a 6 month period of hard work and research many goals were achieved. By announcing new Robocup rules for simulation league, team immediately started work on humanoids and so far has completed the research and development outline for the upcoming competitions. Apart from the members' interest in the field, and their previous experiences, an adaptive learning approach for optimizing biped robot walk model has been chosen as the title of some of the members' B.S. thesis. In this paper a rough draft of team's planned research approach and previous achievements is described.

Previous Works

Team started working on soccer simulation as newcomers under the name of Zagros since October 2006, but members were involved in Robocup community individually far before the above date.

To ease the primary task of development and debugging and also better observing and analyzing agents' behavior, a Linux-based trainer and a complete windows online debugger, capable of sending and receiving commands to and from agents and simulation server, were written.

Problems with synchronizing agents with spades information were solved by means of an event based structure for updating the agents' world model. A modified version of Kalman filter was implemented in order to get an accurate estimation of position and vision noise reduction. Average agent localization noise of about 4 centimeters was achieved in a complete match which is the most accurate result among competitors as far as published papers demonstrate. By announcing the new simulation league rules, members changed their research and development focus to humanoid model, bringing all the experience and achievements to the new domain.

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Proposed Research Approach

Soccer simulation, with a representation of real world, provides an interesting environment for researchers to work on related issues without having to deal with the hardware problems. Team will focus on learning and optimizing techniques to further improve the existing dynamic models in order to give an adaptive behavior to the agent.

Noise reduction is a primary task for designing an accurate controller. As mentioned, a version of Kalman filter has been developed for spheres simulation already, and will be modified to filter the humanoid vision sense.

Below is the list of team's main future research objectives to develop a skillful agent for the upcoming Robocup competitions held in Atlanta.

Walking

As the first step toward a skillful humanoid agent, walking will be performed with a traditional control method that follows a set of generated ZMPs¹ along the path. This working dynamic model for biped robot walking has been the title of the M.S. thesis of one of the team members and is already implemented in MATLAB (**Fig. 1.**).

The trajectory tracking

methods (specially generated by a series of ZMPs) to control the



Figure 1 - ZMP X trajectory in Matlab

agent balance while moving has been the subject of different research papers [1]. The process of developing agent's code of the implemented method in MATLAB could be completed in an approximately one month period.

Generated trajectory will be followed by a precise controller. The controller, knowing the exact path of the agent's joints, determines the velocity of the joint motors to direct different parts of the robot along the computed path.

Further improving the controller will be the next stage. Number of learning and optimizing methods such as Artificial Neural Networks [2], Genetic Algorithms [3] and other evolutionary algorithms [4] will be considered to give the controller an adaptive smooth behavior. For example GA could be used to search the trajectory

¹ Zero Moment Point

path, computed by the traditional dynamic model, with a small margin to achieve a better walking performance [5].

Fuzzy logic [6], as a powerful tool in dealing with imprecise environments, can significantly improve the performance of the designed controller. Inferencing current state of the world through smooth membership functions, instead of a crisp system, and determining the best parameters of controller using a powerful FIS, will probably result in a more improved and rational behavior of the agent. An evolutionary algorithm might be used to improve fuzzy membership functions as well.

Controlling Walk Speed, Following the Ball

After completing the walking action, agent has to control his speed to perform more complicated actions. Machine Learning techniques can be applied to the robot in order for it to achieve a task if the appropriate actions are not predetermined [7]. In such a situation, the robot can learn the appropriate actions by using trial-and-error in a real environment [8].

Established techniques for this purpose are genetic programming (GP), genetic algorithm (GA), other evolutionary learning methods, and reinforcement learning (RL). GP + NN or GA + NN can help robot following ball, as Floreano et al. evolved the motion of moving toward a light source using GA with NN using 240 generations [2].

Kicking and Standing Up

Same principles used in keeping robot's balance while walking or running could be applied in performing actions like kick or dribble. The effectiveness of using dynamic methods like following the path generated by ZMPs with the help of new control methods like fuzzy PID control is already proved in such fields [5], [9]. Standing up and diving to catch the ball (for goalie) are considered as mid-level actions and as one of the latest steps in developing a complete soccer agent.

Conclusion

Zagros team is a new humanoid simulation team with experienced members and a rich knowledge about the field and Linux and Windows development. Although the team is considered as a newcomer in Robocup community, members have previous background in Robocup and 3D soccer simulation. Team has already planned its future research and development outline for the upcoming 2007 competitions based on previous members experience in the field.

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