BUGS Team Description

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1 Introduction

The RoboCup simulation league provides a fast changing real-time environment. Therefore, programs running in this environment have to take this into account and should be precise and provide a fast decision-making component. Reactive agents meet these requirements and various teams in the RoboCup tournaments have shown their efficiency (e.g. Brainstormers, FC Portugal). However, these agents are somewhat inflexible because they lack pro-activeness. Agents that are based on planning algorithms are flexible in that respect but have the disadvantage that the construction of plans is a time consuming task both off-line in the preparation phase and online while executing the agent. This also includes the fact that plans have to be modified quite often in a fast changing environment, leaving an overhead due to the existence of useless plans. Our approach is a fusion of reactive behavior and tactical decision-making similar to planning. This fusion is implemented in our potential field method, which is used for determination of all possible actions, as well as for implicit team-coordination. The implementation of our method is focused on speed, modularity and simplicity: speed leaves much CPU-time for other tasks, like self localization; modularity allow relatively easy portation to other basic clients and easy debugging or changing of the algorithm; and simplicity means that we tried to use the most simple mathematics that do not generate relevant loss of precision to guarantee speed and it also means, that we stay close to human imagination to guarantee understanding and manual debugging.

Although using potential-fields is a relatively new and rarely used technique in the RoboCup simulation league, other teams have used it before: Our potential fields are similar to electric fields as described by Johansson and Saffiotti in [Johannson and Saffiotti, 2001] in the way that high values mean great attraction. And as in Latombe [Latombe, 1991] we use the potential field to represent world model states. The difference between to our approach is to that we also use potential fields for the complete decision making algorithm, to determine both the kind of action and where it is placed.

Our team is built on the CMUnited-99 library [P. Stone, 2000], which gives us the advantage of a finished base. Because of modularity of our potential field method, we were able to integrate it easily in the CMU world model and low-level part.

2 Basic use of potential fields

Decisions get more precise when more information is available, but it is hard to make fast decisions while world models get more complex. Our potential fields represent the sum of all available information about the objects in the game and also the relations between them, without specifying situations. For building a potential field it is necessary to lay a grid upon the soccer field (resolution is about 1m*1m, accordingly). Based on information about all visible moving objects, the game situation and extra knowledge about own tactic and formation, numeric entries (only integer) in all grid fields are made. These entries come from *stamps*, which represent the objects, regarding relations between them. The stamps are one of our attempts of saving calculation time by only using basic calculations; another is that there are no functions which will interpolate the resulting potential fields. This means that extreme differences between neighboring grid fields are possible (although not very probable). Every agent will call a potential field based on his own world model every few cycles (2-8). Timing depends on game situation and distribution of CPU-power.

To decide which action is next the complete field and some more information (ball position and distance between agent and ball) are necessary. The highest value within the grid always means the best position for the next action. Possible actions are: intercept ball, take position, pass ball and dribble ball.

Due to the fact that all agents produce similar potential fields, we have an implicit team play,as described in the next section.

3 Advanced use of potential fields

Suppose all agents building potential fields at the same time, each with its own view of the same situation, permanently influencing each other with their decisions. While one player holds the ball the others take position to be passable. This behavior results in building a complete way for the ball into the opponent's goal for most of the time while in ball possession. However, this scenario will not work most of the time due to interceptions, thus, alternatives are created at any time. This is the point of similarity to planning algorithms: based on the current situation we determine sets of actions, which hopefully results in a goal. This might be dangerous because our algorithm has not really a similarity with any planning algorithms from the implementation point of view but the rudimentary behavior is the same in some way, especially for the RoboCup simulation league where world model states and conditions for decision-making are changing fast. We do not need to learn specific situations to gain an optimal action, we simply interpret the seen objects and their positions. By decreasing or increasing the potential values we can push the agents into different tactical behaviour. For example we can increase the negative value for the space between the last agent and the goalie to build an offside trap. In the same way we can increase this negative value for the opponents offside space. Further changes might be the increasing of the positive value for the edge of the soccer field, to have the result of a game play over these edges. Another important aspect is that every agent possesses individual potential field parameters, although there all are initialised with same values at the moment. Through manipulating specific values owned by a single agent, completely new player-behavior can be created and each agent can be optimized towards it's own tactical position and role, it inherits within the team. As soon as our coach-module works we will have a tremendously high rate of adaptable and flexible game-play and probably this will significantly improve team strength.

4 Implementation and Hardware

The clients were developed by a group of 6 students during a 2 years lasting student project at the University of Bremen.The code for the client has been written in C++ within the last 5 months. Additionally we had to develop 2 tools with which we could improve our PotentialField approach. One tool has been written in Java and it was used to visualize the PotentialFields made by the agents (PFViewer). Currently we are still developing another tool (C++) which will be used to automatically adjust the priorities used for a customized potentialfield.

As every team we depend on exact Information about the environment we are playing in. To reach the best possible world model status and to compensate technical problems, we integrated frequently cast player messages to spread information about ball position, opponent positions and also teammate positions.

As we described, we were able to determine an action in a very fast way. This gives us the advantage to use complex position determining and further tactical behaviour. We also use a online coach who can easily change basic positions of agents and who can interpret playing statistics. All together may be run on a middle-sized PC. Our team was tested on a Pentium II 400 MHz with 128 MB of RAM. We used Redhat linux 6.2 as the operating system. All codes will be available for download on our webpage under the GNU General Public License. There you can find our paper [Meyer et al., 2002] which we send in for the RoboCup Symposium 2002. The URL is:http://www.tzi.de/grp/robocup/bugs.html.

5 Coach

We develop a tactical online coach, whose purpose is the statistic evaluation of both our own team and the opponents team. In addition, it will log frequency points of positions of all moving objects. Both will be used for game evaluation, which is necessary to re-distribute player-resources, change tactics, and re-arrange player formations. These statistics are ball losses, percentile ball possession, percentile ball position per team section (eg. defense), number of wrongly passed balls, gaining of ground and some other variables. These numbers will show the quality of each team section and in addition its' relative efficiency. Based on these values we will modify various player settings, including player type, position, relations between objects in the potential field or tactic for a single agent, and additionally player formation for a team section or the whole team.

6 Shortcomings

Because we are only working for a few months we still have a lot of mainly technical problems, which decrease our team-strength dramatically. And in opposite to these problems our problems regarding our concept are much easier to solve: our agents are mostly influenced by the world state. This means that our action depends on the evaluated objects in the world. If the opponents moves to the right side, we do this also if we want to cover them. The ball has a influence on all of our actions. So if the ball moves to on side we move to this side. If the opponents get to know how to use this against us in the game we will have a big disadvantage. This is the result of the reactive part in our potential field approach. We are not able to play within a clear defined way. Because of the potentials put on objects we always depend on these. Another weak spot, at least until the moment, is the manipulation of the relations between objects in the potential field, because side effects are possible. So changes have to be made with great care, but we will try to eliminate this by learning parameters off-line and manually assisted.

7 Conclusion

We used the potential-fields to represent all game situations. We use this approach for all possible actions, not only for a kick. We used it to decide which action we make and what the situation is. Our method is intuitive and fast at the same time. The main advantage is, that we are able to use a single algorithm to determine the agents action ("One algorithm to fit them all"). The waiving of complex rules and algorithms is another advantage.

References

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