Bahia Robotics Team: Team Description and Development for Mixed Reality League*

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Abstract. This paper describes Bahia Robotics Team – the robotics competition team created by Computer Architecture and Operating Systems Group (ACSO) at State of Bahia University (UNEB) – and its experience with Mixed Reality league on previous Robocup competitions. We also describe our recent contributions for the platform development. Our research interests and work in soccer team development and new applications for mixed reality environment are also presented.

1 Introduction

Bahia Robotics Team (BRT) was created on August, 2006 at State of Bahia University (UNEB) under Computer Architecture and Operating Systems Group (ACSO). The main goal of BRT is to investigate the application of artifical intelligence methods to control robotic multiagent systems. Robocup soccer competitions was chosen as our main testbed. BRT is an open team that invites other institutions at State of Bahia, Brazil to join and cooperate with this research work. Since its foundation, University Center of Bahia (FIB) has joined BRT and worked in our first development and research.

UNEB is a *multicampi* university located on state of Bahia in the northeast of Brazil. There are twenty four *campi* covering the main regions of Bahia. UNEB offers 36 regular undergraduation, 7 master and 1 PhD courses in several knowledge areas. ACSO is the main technological research group in UNEB. At ACSO, we have three main research areas: Grid Computing, Large Scale Video on-Demand (LVoD) and Intelligent Robotics. The last area includes the BRT work. Virtual Communities is another research group from UNEB that cooperates with ACSO in Game Development area.

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FIB is the main partner of ACSO/UNEB in BRT work. FIB is a *multicampi* university center with three *campi* located at Salvador town. It offers 30 regular undergraduation courses in several areas. FIB cooperates with ACSO/UNEB in BRT in the two Robocup leagues that we have teams: Soccer Simulation 2D and Mixed Reality.

In the early 8 months of work, BRT have qualified to the first Mixed Reality (old Physical Visualiztion) competition at Atlanta during Robocup 2007. Since this qualification, we have worked with software development for new applications on Mixed Reality environment (described on section 4), platform development (section 3) and soccer team development with mixed reality micro-robots. On section 2 we describe our previous experience on Robocup competitions with emphasis in Mixed Reality league contributions.

2 Previous Robocup Experience

BRT has applied for Mixed Reality (MR) league since its first edition on Robocup 2007. In this competition the league was named Physical Visualization (PV) and our team – BahiaPV – has joined Brazilian National Team that qualified to nine different leagues on Robocup 2007. So, at Atlanta, our team was named Brazil-PV1 (because other two Brazilian teams where qualified to MR league too).

In the RoboCup 2007 Brazil-PV1 won the fourth place in the soccer tournament, being the unique brazilian team in the semifinals. This was the best result of a brazilian team during all Robocup competitions. It was considered a great result for BRT on its first year of work with Robocup competitions. Due to late deploy of micro-robots and brazilian importation policies, we got the robots only two days before our travel to Atlanta. So, we had only three or four days to work on software development to control the robots during soccer competition. The tournament was organized as a round-robin scheme where teams were divided in two groups of five teams. Brazil-PV1, Brazil-PV2, Brazil-PV3, City United and Socio formed Group A. Only two teams from each group qualified to semifinals. Socio and Brazil-PV1 were qualified on Group A. Our team played the semifinals against FC Portugal (who was the champion of this tournament) and was defeated by 1x0. Table 1 shows all results of Brazil-PV1 on Robocup 2007 soccer tournament.

In Atlanta, we have also technical presentation competition and demos presentation competions in the Mixed Reality League. Brazil-PV1 participated in the techinical presentation describing our research projetcts on Mixed Reality Environment (see section 4).

Another important participation of BRT was during Robocup Brazil Open 2007 at Florianópolis, Brazil in October, 2007. During this competition BahiaPV was the champion of Mixed Reality league. In Brazil Open, Mixed Reality league was composed only by the soccer tournament. The three brazilian teams were present in this competition: BahiaPV (Brazil-PV1), FURGBOL (Brazil-PV2) and UFRN (Brazil-PV3). We had a round robin phase with the three teams and the best two teams played a final match. All results of this competition are

Round Robin
Brazil-PV1 0x8 Socio
Brazil-PV1 5x3 Brazil-PV2
Brazil-PV1 1x1 Brazil-PV3
Brazil-PV1 8x0 City United
Semifinals
Brazil-PV1 0x1 FC Portugal
3^{rd} Place Match
Brazil-PV1 0x2 Socio

Table 1. BRT results on Mixed Reality league on Robocup 2007 at Atlanta

listed on table 2. On its earlier 18 months of work BRT has accomplished its first national championship and showed its researcher potentialities to brazilian and international ressearch comunity on Mixed Reality league.

Round Robin
UFRN 0x 2 FURGBOL
BahiaPV 2x1 UFRN
BahiaPV 1x2 FURGBOL
Final Match
BahiaPV 2x1 FURGBOL

Table 2. Mixed Reality results on Robocup Brazil Open 2007 at Florianópolis

3 Platform Development

3.1 Soccer Server

A modularized soccer server application is being developed. In order to do so, the application requirements were discussed with other MR developers, once this application's purpose is to become the league's official soccer server. For this, some parts of the system were planned and even developed in association with other groups. Considering an overview of new system's architecture as shown on figure 1, we are working on the Application Server module.

Old soccer server was very dependent from human abilities and interaction. A human referee was responsible for detecting goals and anything else. This application is more autonomous, providing automatic detection of goals and playmodes, as well as detecting when the ball goes out of the field. Soccer server controls duration of matches, score, playmodes. It also permits that an operator interrupts the match, if some unexpected event happens, or if a team asks for

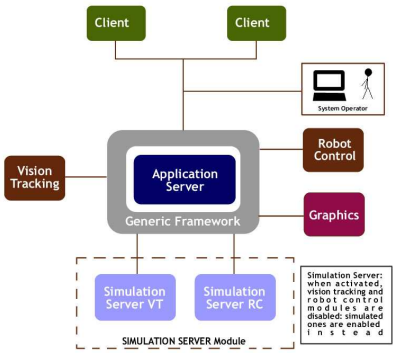

Fig. 1. System's Architecture. Server boxes represent what are being constructed by BRT.

timeout. In the latter case, it will guarantee that timeout duration would be respected.

New flags were included too. They will make localization easier, and help in performing events like corner kick and goal kick. Soccer server also detects physical collision with specified flags, such as those representing the goalposts. Figure 2 shows the flags names and their localization on the field. It is possible to notice that in the new server the field will have a penalty area and a goal area.

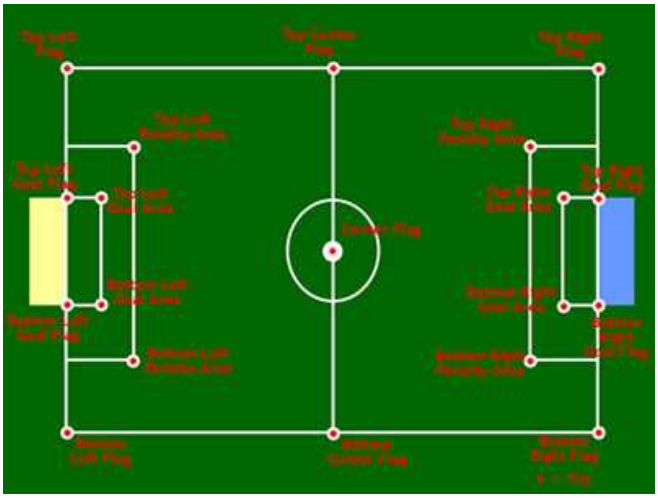

Fig. 2. Old and new flags on the field.

As mentioned before, server will detect playmodes, which didn't exist in latter version. We think this way some new events can be better handled. It was included a warming up mode, so the teams can play friendly matches with relaxed rules. Other playmodes are kick off, penalty, play on, corner kick, goal kick, time over, timeout and frozen. Frozen mode is activated by the system operator. Within this mode all robots are stoped in current position, as well as the ball. Operator decides from where they should restart when frozen is deactivated.

We added features to the information that is sent to the robots. Now they'll receive their scores, and when match is near to the end, the remaining time will be sent, so the teams can implement something like "emergency strategies".

Things like cycles duration can be setted when server is started, if the operator wants so. Cycle, as standard, will be 66 milliseconds, as in latter version.

Soccer server application is a modularized software, written in C++. Thus, improvements and extensions will be easier to be done in the future. It has new protocols and commands, so in order to old clients and robots can be used with it, special modules and/ or implementations must be done. This application will be open source when it's finished, becoming part of league's public resources. This Application Server will be the official server for the soccer tournament during Robocup 2008 at Suzhou.

3.2 Simulator

The Simulation Server module is composed by Simulation Server VT and Simulation Server RC modules showed on figure 1. Server VT will simulate the Vision Tracking module which is responsible to get camera images and translate it into robots positions to the server. The idea is that the Server VT module can simulate the vision process for the robots, but without the need to have real robots or a camera. That way, development teams can debug their applications even without a complete Mixed Reality environment.

The Server RC will simulate the Robot Control module. It will receive from the Application Server the commands sent to robots and it will update the robots positions and send this information to the Server VT module. When it is requested by the Application Server, VT sends the current robots positions. The same idea can be applied to all physical objects that would be over the screen and that any developer wants to simulate.

The Simulation Server can turns easier to have a greater number of developers on Mixed Reality league and can turn the new micro robots technology accessible to many developers even if they do not have a full environment with a camera and large screen or even real robots. That way the same client codes that works with Simulation Server should work as well with real robots. The Simulation Server is an excellent tool for the Mixed Reality League education purposes because it turns possible to many classes use the environment even if the school have limited resources (robots, screens, cameras).

4 Research Projects on Mixed Reality Environment

The research projects under development in BRT can be divided in two groups: artificial intelligence research and educational initiatives. The former group is aimed in investigation of the application of well-known strategies used in other robotics soccer league on the Mixed Reality soccer tournament. We can also validate new proposals from BRT to 2D Soccer Simulation in the Mixed Reality League. Educational initiatives represent an effort to turn easier for young students to be initiated in the robotics building and control. The ideas and projects are presented in next subsections.

4.1 Educational Initiatives

The RoboCupJunior (RCJ) is a project on educational robotics directed to young students with focus on education, stimulating a development atmosphere to expand the knowledge and awakening the curiosity on technology. Nowadays, RoboCupJunior consists of three challenges: soccer, rescue and dance [3]. Making a transition in RoboCup, from junior league for senior leagues, is a great challenge to young students. MR league, through the micro-robots , makes possible a larger integration between the two levels because of its physical and simulated environment (mixed reality). With no engineering intervention, youth's students can develop their projects using Mixed Reality micro-robots. The environment proposed by MR is the most favorable road for the students coming from RCJ towards the advanced researches developed in the senior leagues of RoboCup. Mixed Reality provides integration among universities (whose researchers will develop new applications and games for MR) and schools (where the students will use the results of the researches produced in the university), filling out the gap between the two levels.

Less complex than the soccer, the game MR-Minos presents the ideal environment to be the newest sub-league of RoboCupJunior, because it offers the nobleman challenge of rescuing victims inspired in the myth of the Minotaur [2]. MR-Minos will be developed over the Mixed Reality environment and its main goal is to support an easier translation for students from RCJ to senior leagues.

MR-Minos: a rescue game. The game MR-Minos is based on the Greek myth of the Minotaur presenting a match between two teams that should program two robots: Theseus and Minotaur. The map of the game is a maze with two exits. The game establishes a rescue challenge, in which the robot Theseus should rescue the virtual Athenians lost in the maze as fast as possible to prevent their capture by Minotaur. The robot Minotaur should capture the Athenians. The Athenians are static graphic representations in the map of the game and they can have one of three status: lost, rescued and captured. The lost status is the initial status for all Athenians when the game begins. When rescued, the Athenian is teleported out of the maze. When in the captured status, the Athenian appears in the center of the maze. Figure 3 illustrates the map schema proposed for this game.

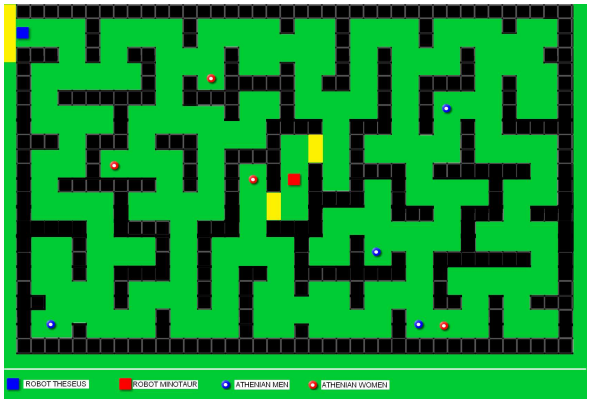

Fig. 3. MR-Minos map schema

MR-Chess. After many years being the standard challenge for the development of artificial intelligence science, chess was replaced by soccer as a new challenge for AI and robotics. However, the game of chess is still been practiced at the schools as a stimulus to learning, reasoning and attention. Getting micro-robots moving as well as chess pieces on a virtual board can be attractive to young students. For that reason, our next project focused on teaching students from high school will be MR-Chess.

The idea is that young chess players can play a match against the robots. The pieces of human player will be avatars that will be manipulated with his finger. For that, a glove will be used so that the camera can capture the movement of the change in the game, making the chess player interact with the mixed reality environment.

4.2 Artificial Intelligence Research

As described in [5], we intend to use successful strategies already implemented by our 2D simulated soccer team, like fuzzy logic[6]. Fuzzy logic is an interesting approach to soccer because it handles with uncertain and vague situations. In the previous BahiaMR team that got the results described in 2, we have used simple production rules [4] to build a simple strategy due the lack of development time.

The main schema was composed by fixed positions to both robots. One robot was the goalkeeper and the other was the striker. The goalkeeper had analyzed the distance between the ball and its own goal and decided to run in the ball direction and kick it to opponent goal or stay in its own goal trying to close the angle between him and the ball. The striker always tried to run towards the ball and kick it to the center of opponent goal.

The main idea is to use fuzzy logic to enhance this simple behavior. At a first glance, we will try to get a better kick to opponent goal to get a better goals scored rate. Then we will use it to make controllers for postioning and decision

making for both goalkeeper and striker. We will also use potential fields [1] to make dribble routine and ball marking strategy.

And a third research focus is on using neural networks [4] to build robots swarms based on a retroactive learning approach proposed by our ressearchers. In this proporsal, we can get advanced learning capability using low processor and memory demand. We can get more adaptative robots that can change and enhance their performance in a match in a autonomous fashion.

5 Conclusions

Bahia Robotics Team is a robotics competitions team that represent the results and work in progress from ACSO/UNEB and its partners research groups. At this work we have described the group structure and our previous Robocup experience specially on Mixed Reality league. BRT is one of the co-developers of Mixed Reality league platform and our contributions for this activity are described on section 3.

We are finishing the new Soccer Application Server that will be used on Robocup 2008 and a Simulation Server that will turn easier for developers to build and test clients for MR environment even if they do not have easy access to all resources, such as camera and large screen, to build MR environment. This will turn possible to use MR tools for education purposes meeting the goals of MR organizers and trustees.

We are also using MR as a testbed for our artificial intelligence researches. The projects described in section 4 will be part of the activities of International Autonomous Robotics Institute that will be created by ACSO and other researchers at Salvador town in the Technological Park Tecnovia. This institute has a goal to be an excellence reference for researches in this area in the next few years. The partnership between BRT and MR organizers and trustees is becoming closer and more productive as we still working with MR environment.

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