UFCG/ITA/UNESP Rescue Team Rescue Simulation Virtual Robots League RoboCup Brazil/LARC 2008

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***Abstract*—This description paper describes the studies conducted by the UFCG/ITA/UNESP Rescue Team aiming the preparation for the Robocup Brazil/Latin American Robotics Competition 2008. Main studies were conducted on Simultaneous Localization and Mapping. Other aspects from the team's implementation for this year competition are briefly analyzed on this paper.**

***Index Terms*— Virtual Robots, Simultaneous Localization and Mapping, Kalman Filter, Particle Filter, Human Operators**

I. Introduction

The UFCG/ITA/UNESP Rescue Team was established this year, as a fusion of the eRoboticaRescue Team(UFCG) created in 2007, and that has participated on the Robocup Brazil 2007 in Florianópolis, and the traditional team ITA/UNESP whose establishment came on the year of 2006, and is itself a fusion from the ITA-VR and the UNESP Rescue Team. Those fusions emphasize the efforts on the creation of a unique and strong Brazilian National Team for the Virtual Robots League. Those universities are involved on a great cooperation consortium, that is leading the brazilian research on robotics employment on Search and Rescue and are being responsible for the spread of the use of USARSim, among researchers all around the country. On the worldwide competition this year on the Robocup Suzhou 2008, this maturing contributing joint efforts team, was called the "Brasil VR", formed by members from the Instituto Tecnológico de Aeronáutica (ITA), Universidade Estadual Paulista (UNESP), Universidade Federal de Campina Grande (UFCG), with the aid of researchers from the Universidade Federal de Santa Catarina (UFSC). And next year, with the experience gained and a deeper cooperation, on Robocup Graz 2009, hopefully the results presented will be even more exciting. Currently, our main studies are being conducted on SLAM, according to different robots behaviors, autonomous, or semi-autonomous (with the help of a human operator on certain aspects of the robots movement).

II. Usarsim and Virtual Robots League

USARSim is a high fidelity simulation of USAR robots and environments intended as a research tool for the study of HRI and multi-robot coordination. USARSim supports HRI by accurately rendering user interface elements (particularly camera video), accurately representing robot automation and behavior, and accurately representing the remote environment that links the operator's awareness with the robot's behaviors [1].

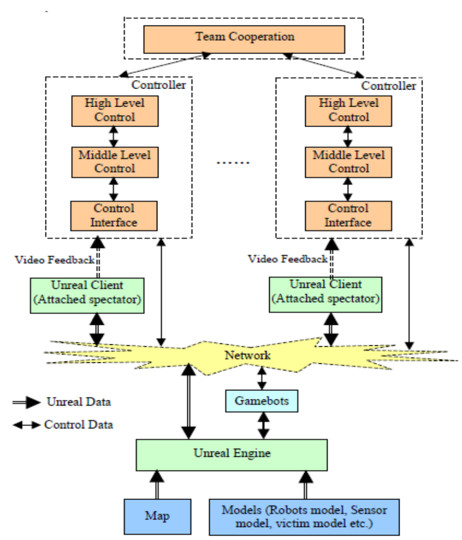

Fig. 1. Usarsim Architecture

In the Simulation League, the problem is addressed from the other side. Large teams of heterogenous agents with high level capabilities have to be developed. Topics like coordination, distributed decision making, multi-objective optimization are some of the crisp matters being addressed. It is part of the overall vision that in the future the two scientific communities will move towards each other, and will eventually meet. The system architecture is shown in Figure 1. Below the dashed boxes is the simulator that provides the interactive virtual environment for the users. The dashed box is the user side where you can use the simulator to aid in your research. The system uses a client/server architecture. Above the network icon in Figure 1, is the client side. It includes the Unreal client and the controller or the user side applications. The Unreal client renders the simulated environment. In the Unreal client, through changing the viewpoint, we can get the view of the robot in the environment. All the clients exchange data with the server through the network. The server side is called the Unreal server. It includes the Unreal engine, Gamebots, the map, and the models (such as robot models, victim models, etc.). The Unreal server maintains the states of all the objects in the simulator, responds to the data from the clients by changing the objects' states and sends back data to both Unreal clients and the user side controllers [1].

III. Brasil VR - Joint Efforts

The Brazil-VR controller is a cross-platform open-source architecture built by a group of students and researchers from four different Brazilian universities (Instituto Tecnológico de Aeronáutica (ITA), Universidade Estadual Paulista (UNESP), Universidade Federal de Campina Grande (UFCG) and the Universidade Federal de Santa Catarina (UFSC)) that are part of the Brazil-VR project. The goal of the project is to spread the use of the USARSim simulator in the country as a research platform on Artificial Intelligence and Robotics through the use of the controller built over the simulator [2]. The conceived architecture is shown on Figure 2. The communication is based on the TCP/IP protocol, where multiple clients(robots), are connected with the USARSim and have a full-duplex with the Base Station of the Wireless Server, that is represented on the USARSim simulator as a robot called CommStation. Our System consists of modules of communication, parser, behavior, controller, slam, and GUI(see, figure 3). The classes diagram may be seen of figure 4. An initial map generated using our Controller, may be seen on the 5.

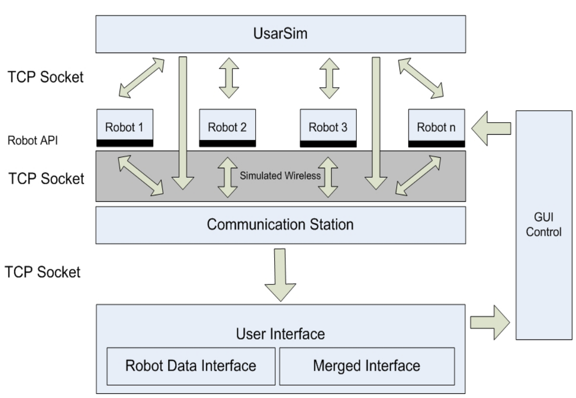

Fig. 2. Architecture

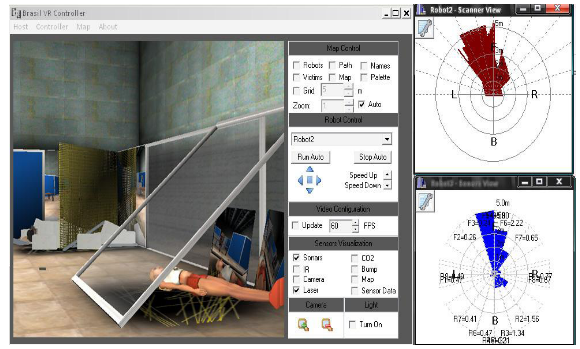

Fig. 3. Brasil-VR GUI

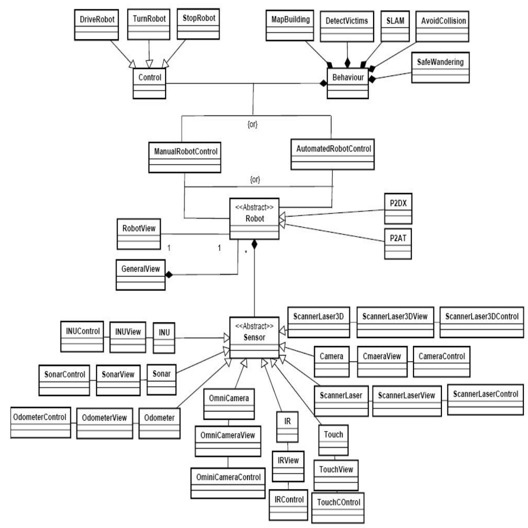

Fig. 4. Classes diagram

Fig. 5. Sample Generated Map

IV. Robots

Different robot configurations could be used to explore the situations that may be imposed as challenge by the competition this year. However, because of past experiences with wheeled mobile robots, this year , our team focused on only two robot platforms to the competition, the p2dx(figure 6(b)), a 4 wheeled mobile robot from Mobile Robots Inc. and a p2at(figure /reffig:p2at), from the same manufacturer. Both were equipped with Sonar, Laser , GPS, Odometer, INS, Camera, as defined on the Usarsim Manual [1], and allowed on the competitions' rules.

((a)) Simulated p2at Robot ((b)) Simulated p2dx Robot

Fig. 6. Used Robots

V. Simultaneous Localization and Mapping

In the Virtual Robots competition, one of the main problems to be solved is the Simultaneous Localization and Mapping(SLAM). Historically what has motivated the research on SLAM is for the robot to keep track of its position by maintaining a map of the environment and an estimate of its pose on this map [3]. Based on the generated map, we can increase the performance on control and behavior and find more victims, and provide a robot, that can be a more powerful tool to the society on the research and rescue field, as it will be able to be deployed on a wide range of situations. On this team description paper, we applied the FastSlam method that is based on the Extended Kalman Filter and the on Particle Filters.

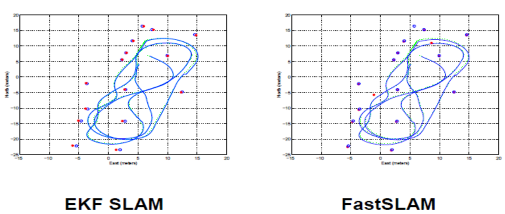

Fig. 7. Fast Slam and Extended Kalman filter Based Slam,comparison.

VI. Victims Detection

One of the key challenges on the Robocup Virtual Robots Rescue Simulation League is to detect victims on the environment. Many approaches were evaluated. Among them are a multi-layer perceptron trained by the backpropagation algorithm [4], the threshold method, the neurofuzzy technique proposed in [5]; the spiking neural network with radial basis function used by [6]. The obtained results from each technique were compared to define the best compromise between execution time and classification efficiency. Tests involving environment lighting differences, victims skin colors, victims skin exposition and victims positions were carried out. On Figure 8 the results may be seen, as (a) shows the simulated victim, and (b) shows the successful classification.

((a)) Victim screenshot ((b)) Victim resultant identification

Fig. 8. Victim Identification

VII. Strategy

This year we are going to test a semi-autonomous approach to the Simultaneous Localization and Mapping problem. The robot interacts with the environment with limited autonomy and an human operator collaborates with its behavior and takes some decisions to optimize the covered area. With this interaction, less time is spent on Victims search, collision avoidance, unwanted closed loops. The Strategy consists on using data gathered by both robots to take decisions based on its autonomous behavior and the operator's intervention. As starting point, we compute all the characteristics around the robot's start pose and then we choose the "best path"trying to avoid collisions and trying to avoid to stay away of the base stations' communication range. Another main aspect to be exploited is the communication strategy between the robots and the base station where we try to enter restrict communication places and the distance communication limits of the Wireless Simulation Server (WSS). Also, all the data is checked to guarantee that no data is being corrupted, and treating the communication among the operator and the simulated Robot.

VIII. Conclusion

In this paper , we described the main aspects of our Team for the Robocup Brazil 2008, Virtual Robots Rescue Simulation competition. Especially, on specific topics like SLAM, there are lots of aspects to evolve, however , with the universities consortium we are being able to evolve much faster, and the solution of some tasks on the League are being accomplished on a really satisfactorily way.

IX. Future works

As future work we may list:

- *SLAM:* More consistent study on SLAM, and incorporation of state-of-art techniques;
- *Victim Detection:* To enhance the Visual Victim Detection system;
- *Behavior:* Create a more robust behavior module;
- *Robot Platforms:* Test new robot platforms, as humanoids, the airRobot, etc...;
- *Strategy:* To develop more adaptable strategies, such that our strategy may be chosen according to each a priori map given;

- *Communication:* Development of a more efficient communication module;

X. Acknowledgments

The authors would like to thank the financial support and the award fellowship provided by the Electrical Engineering Department (DEE UFCG) and the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), respectively.

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