Robocup Graz 2009 – Virtual Robot League

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Abstract. This paper describes the main features of the MRL Virtual Robots team which intends to participate in Robocup Graz 2009 competitions. Virtual Robots is an environments that a combination of state of the art algorithms of Robotics and Artificial Intelligence fields are needed to deal with its challenges. In the following we describe our approach for the main challenges such as Simultaneous Localization and Mapping (SLAM), Image Processing, Exploration and etc.

Keywords: SLAM, Localization, Robocup Graz 2009, Image Processing, Exploration.

1 Introduction

Robotics and Artificial Intelligence are the center of attention of many researchers these days. USARSim provides us with an environment in which the conjunction of these two fields occurs. In this environment, a disaster (usually an earthquake) is being simulated in indoor and outdoor scenarios. The goal is to gather a map of a previously unknown environment which would provide information about the situation, victims, damages and etc. To overcome the goal, a combination of the state of the art algorithms of different fields needs to be implemented. These fields include but are not limited to Localization and Mapping, Machine Vision and Image Processing, Robot Navigation, Robot Communication, Robot Coordination, Modeling and etc. In this paper, we describe our approaches to these different challenges which we would use to participate in Robocup Graz 2009 Virtual Robots Competitions.

Our team members and their contributions in team are:

- M. Sadegh Kordafshari : AI Advisor, Supervisor
- Edris Esmaeili : Coordinator, AI Planner and Developer
- Sanaz Taleghani : SLAM

- Mohammad Shirzadi : Software Developer
- Vahid Azizi : Software Developer
- Amir Panah : Image Processing and SLAM

2 Localization and mapping

2.1 Localization

We have tried many different localization algorithms like using encoder sensors, scan matching algorithms and SLAM algorithms. From those algorithms, we found out that if an accurate localization results is needed, the choice of methods are mostly limited to scan matching algorithms and SLAM algorithms. We found scan matching algorithms so faulty unless there is some kind of memory which would allow robot to correct its localization estimations if the scan matching process fails temporally.

During our researches about different localization and mapping algorithms, we found out that most of the current SLAM methods have different drawbacks i.e. huge memory consumption, heavy computation burden, high costing updates and etc. Therefore, we tried and innovated our own SLAM algorithm named GSLAM.

Like so many other methods, GSLAM works with features (landmarks) of a map and performs simple geometrical rotation and translation searches to match the features of the current observation of time step t+1 and the features of the previous observations of time step 1 to t. Consequently, for the localization matter, the negative of these rotation and translation changes of features are applied to the robot's state.

GSLAM has its own Feature map which does not provide us with a high quality and comprehensive map. Therefore, we use Grid mapping to generate our final desired map of the environment.

This algorithm has a problem, when feature is insufficient it would fail. Therefore we intend to use other algorithms such as Extended Kalman filter-Which was applied on INS data- to cover this problem. We used a new prediction model that is based on the type of the command and the time it takes the robot to perform the command and this prediction is transformed to Δx, Δy, $\Delta\theta$ and is applied in our EKF algorithm.

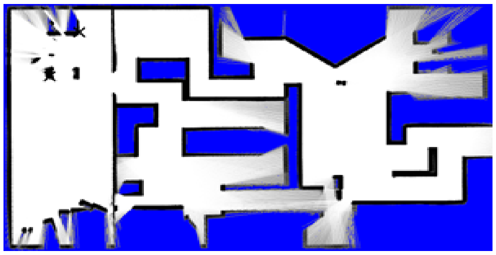

Fig. 1. A Generated map using GSLAM and Grid Mapping

2.2 Mapping

We used to use a Grid Mapping method which was improved by ourselves. This algorithm received the sensor data from each robot in a real time way that had a huge overhead on the center. But it had an advantage : After the disconnection of robots from center we didn't lose the map so far till that time. We are currently using a new algorithm which contains both advantages that is based on line produced by feature extraction methods which are sent to center and we create the map based on these lines.

3 Exploration And Navigation

3.1 Exploration

Last year for driving the robots due to the Potential Field we enjoyed the aid of the Fuzzy Algorithm using the parameters based on the distance from the searching robot, target area potential, the deference between robot's angel and target angel, the distance between the robot and the target point (a point was chosen as target for the robot and was sent to the robot by the center). Currently we have changed our decision making system from Center Based to Distributed and we're using Fuzzy Algorithm with new parameters such as recognition of corridors, rooms and the widest area for searching.

3.2 Navigation

Last year we used a combination of A* and Potential Field to find the optimum way for reaching to the target location. Using A* for first wasted a lot of time in decision making and also wasn't applicable in unknown environments, and for second and it wasn't necessary for the robots to remain still during the decision making process which resulted in less exploration area. Thus we decided to implement an electromagnetic environment based on our strategy that assigned homonymous poles to robots and obstacles and non-homonymous poles to the leader and the target. Then the speed of each wheel is calculated from the resultant of these vectors and it causes the robots to be in motion continuously. We developed a program to test this algorithm that would simulate this environment.

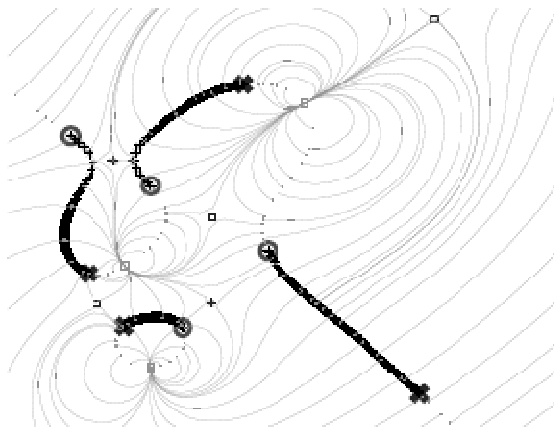

Fig. 2. Visualization of our Navigation approach

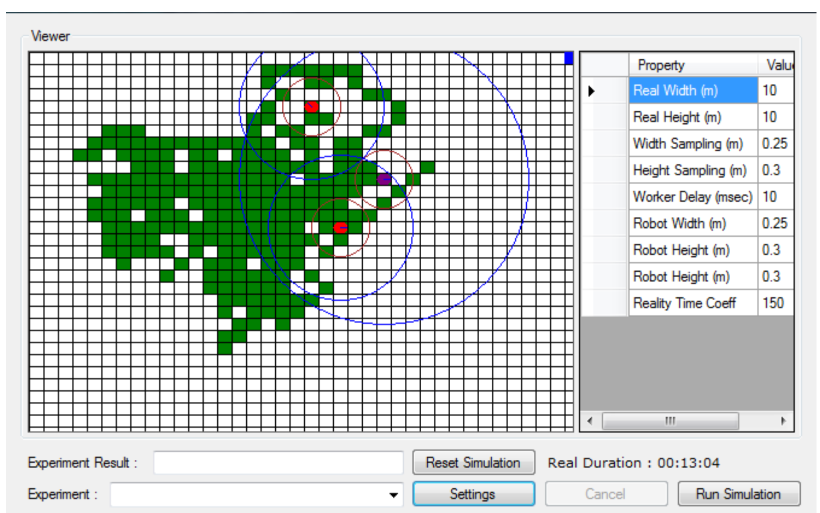

Fig. 3. Multiagent Simulation Program

4 Image Processing

Last year Neural Network was used for detecting the victims. This year an optimized version of this algorithm is applied and besides it helped us in detecting other objects such as obstacles, cars, street kerbs and so forth that was also effective in determining the direction our robots moving along.

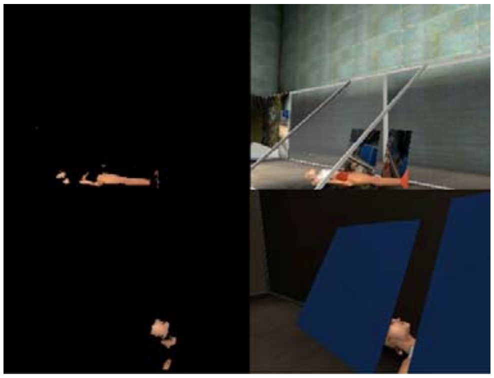

Fig. 4. Result of our Image Processing Algorithm

5 Cooperation

For optimizing the cooperation of robots we tried that each robot performs according to the location of other robots and also forming and developing the area of a graph. A robot's own new location is chosen based on this graph and other parameters that was mentioned in section 3-1. In this part optimization algorithms such as Genetic were used.

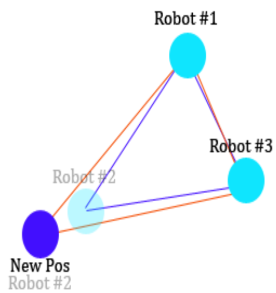

Fig. 2. Generated Graph

5.1 Communication

We use simple messaging protocols for communication between robots and operator. WSS is utilized to deliver our messages to their intended target. Unfortunately, we still have not managed to implement a communication strategy which would reasonably overcome the limiting features of wireless communication systems such as distance limitations.

5.2 Coordination

For coordinating the robots in decision making in Distributed model we decided to broadcast the locations of the robots to them in some particular frequent intervals that the robots would realize the presence of other robots around them in the electromagnetic field so they won't face any trouble in finding their direction.

6 Sensors and Robots

We have used these sensors mounted mainly on the P2AT robot.

Table 1. The sensors we use

Sensor	Count
INS	1
Odometry	1
RFID	1
Sick LMS	1
Sonar	4
Victim RFID	1
PTZ Camera	1

7 Conclusion

Our 2.5 years experience of working in Virtual Robots field lead us to an innovation about the SLAM problem and some other different method gradually. These methods are still in progress, but the promising results which we got from these methods encourage us to continue our work.

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