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RoboCupRescue - Robot League Team SPQR, Italy

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Abstract. In this Team Description paper we describe the characteristics of SPQR-Real Rescue for the Lisbon 2004 Real Rescue competition.

Introduction

SPQR-Rescue Robot team comprises two wheeled robots: ActivMedia Pioneer AT and Pioneer III. Our main objective for RoboCup 2004 competition is to perform the rescue mission by controlling the robots through high level commands. In particular our robots have some autonomy in mapping the environment, localizing themselves, navigating inside the arena, recognizing and locating the position of the victims. By using the high level commands one operator should be able to control both robots using a simple graphical interface. Due to the characteristics of the robots, for this competition we intend to participate only in the Yellow and Orange arenas focusing on the robot semi-autonomy in the mission executions.

Team Members and Their Contributions

Shahram Bahadori	Human body detection
Giorgio Grisetti	Human Interface Development/Localization and Mapping
Alessandro Farinelli	Robots Coordination/Path Planning
Luca Marchionni	Mapping
Daniele Calisi	Path Planning
Censi Andrea	Localization and Mapping
Luca Iocchi	Team Coordinator
Massimo Ferri	Robots Coordination.
Daniele Nardi	Advisor

Operator Station Set-up and Break-Down

The robots we use for the rescue mission are two wheeled robots (50x60x20 cm for 10 kg) that are easily transported by operators or normal trolley.
For robots control the operator will be equipped with a laptop with a wireless card (therefore easily transported).

- **Communications**

We are currently using 802.11b wireless connection between robots and with the laptop of the operator.

- **Sensors for Navigation and Localization**

We use the following sensors:

- Stereo Cameras, located in front of the robot, that provide a visual feedback to the operator;
- Laser/Infrared Range Finder and Ultrasonic, Sensors that identify the free space in front of the robot, and are used by the mapping process.
- Dead Reckoning (encoder based), for locally tracking the robot pose.

- **Sensors for Victim Identification**

The main sensor used for victim identification is the stereo vision system, this system is based on "shape based" human body detection, and the other sensors that we use for additional information about the victims are, thermal IR sensors, gas sensors, and acoustic.

Our human body detection and localization system uses the stereo information to find the place of the victims using a shape based Human Body Detection system based on three phases, the first phase includes the segmentation of the Right image of the stereo couple and in parallel the stereo calculation of the images couple and merging of the segmented objects into stereo blobs, in the second phase the segmented objects will divide to basic parts using a Maximum-Minimum curvatures, and the final phase includes the matching of extracted parts with knowledge base of the system to rebuild the model of the victim body.

- **Robot Locomotion**

Both the robots are based on wheels, with a unicycle like cinematic model. However, one of the two robots has 4 independent driving wheels, so it can navigate and pass over small obstacles (see Figure below). Our plan is to enter the yellow and part of the orange arena, exploiting semi autonomous behaviors for the robots.

- ## Control Method and Human-Robot Interface

As human interface, we use a remote graphical console that is able to represent data coming from robots in a structured way via a low band-width wireless connection.
The console is able both to send high level commands to the robot (such as go to a specified position) through a graphical interface and to graphically represent the robot state and sensor readings. A compressed video streaming can be exported from the robot and visualized on the graphical console.

As for control strategies, we are working on an implementation of a "localization and mapping" method that allows the robots to navigate in the environment to the desired positions given by the operator while avoiding obstacles and finding their way through the arena.

We control only one robot at time while the other robot will be able to continue its activities.

- ## Map generation/printing

The map building process is fully passive and autonomous, while the victim locations in the map are added by the human body detection system, and the final metric map is provided in an electronic form.

Our approach for map building uses data provided by the laser range finder and the ultrasonic sensors, and integrates them by using dead reckoning.

The sonar data are also used to discard the wrong laser readings (like the ones produced by mirrors or glasses) by validating a perception region around the robot.

The overall mapping algorithm works by collecting the last laser readings, and aligning them, through a scan match procedure, in order to improve the dead reckoning estimate. From such an estimate some statistical parameters are extracted and are used by a Rao-Blackwellized particle filter for tracking both the robot pose and the map estimates. Each particle in the filter represents a candidate robot pose and the resulting metric map is obtained by accumulating the laser readings in an occupancy grid. Each particle is then re-sampled according to the evidence provided the laser readings and the knowledge contained in the related maps, while to the operator is shown only the most feasible map hypotheses.

- ## Robot Information Sharing

We are working on an experimental setup that includes a navigator teleoperated robot equipped with laser scanner and sonar for mapping the arena and the second explorer robot equipped with the necessary sensors to do the victim detection autonomously.
For information communication between them we use two different Wireless LAN channels in two sub networks, in this way the navigator can send the map to explorer and both of them can be controlled by the control station.

- ## Team Training for Operation (Human Factors)

Our interface comprises only a remote GUI visualize information coming from robots and send command back.

- **Possibility for Practical Application to Real Disaster Site**

We collaborate with Italian Fire Department at ISA (Instituto Superiore Anti-incendio) of Rome to evaluate the possibility of using robotic agents in real rescue scenarios, to this end we have build Rescue Arenas in the main site of ISA. And we are performing experiments in this direction.

- **System Cost**

We use two mobile bases 10 K Euros and 8 K Euros for sensors and computational units.

- **Bibliography**

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