The communication approach of the 'UvA Rescue C2003'-team

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Abstract. The 'UvA Rescue C2003'-team has been participating in the 'Rescue Simulation League' in the RoboCup competition in Padova. In this article we will explain our approach to cope with the limited communication between the centers and the agents in the disaster area. Our approach has two components. On the one hand, we introduce high-level communication: the agents will update the center with summaries of the current situation, the center aggregates the summaries to a global picture, synchronizes this picture with other centers, and redistributes this information back to the agents. On the other hand, each agent will build a common knowledge model together with the agents in its neighborhood. Based on the common knowledge, the agents are able to predict the behavior of their teammates, which enables the possibility to cooperate without explicit communicating their intentions. ...

1 Introduction

The RoboCup Rescue Project is built upon the success of the Soccer Competition. Both projects provide a testing ground for research and advances in robotics and artificial intelligence. The University of Amsterdam is participating in the Soccer Competition since Paris, 1998 [1]. This year we extend our interest in 'Rescue Simulation League'. This area fosters interesting research questions. Compared to the Soccer Competition, the teams of agents that have to be coordinated are more heterogeneous of nature. Further, the situation awareness is more difficult, because there are never enough rescue agents in the field to get a complete overview of the situation.

2 Communication Model

The first goal is to create operational agents that can operate decently with limited coordination by the centers. Unfortunately, real large catastrophes lead not only to thousands of deaths or injured people, but also hit the communication infrastructure. To cope with the scarce communication between the center and the agents in the field, we introduce two levels of communication. This is illustrated by figure 1.

For the high level of communication we focus on information that describes the current situation in the simulated city. This information has to be precise and recent enough to coordinate the distribution of agents in the field. We call this information the situation awareness.

For the low level of communication we focus on the information needed to be able to coordinate the work of a few agents that are in each other's proximity. This has to be detailed and up-to-date information to be usable. This information will not place a heavy burden on the available communication bandwidth because only local information is required. We call this information the common knowledge.

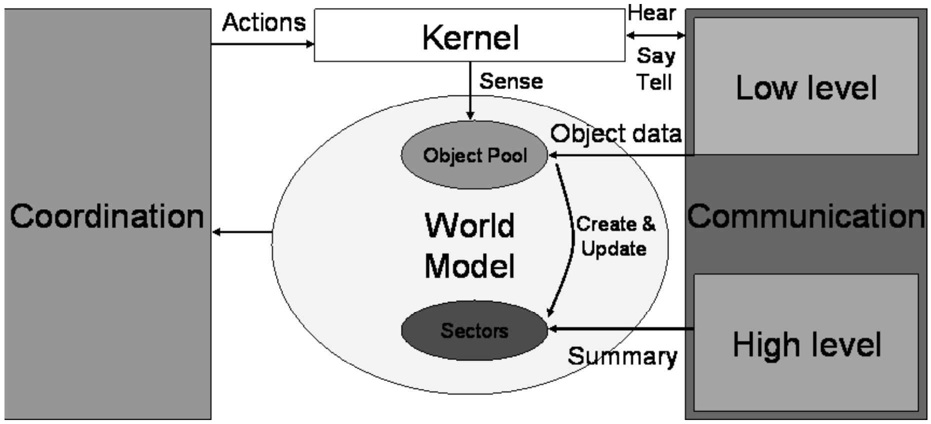

Fig. 1. The Communication model is split in a high level and low level part.

3 Situation Awareness

The high level information is used to assign agents in the field to problem areas. For this task we split up the map of the simulated city into sections, as described in [2]. Each section can be seen as a possible problem area.

For each section we aggregate all observation into four factors:

Dmg	the percentage of buildings that is damaged
Roads	the percentage of roads that are blocked
Fire	the percentage of buildings that is burning
Intel	the percentage of the sector that is recently explored

Every five cycles this information is synchronized between all agents, together with the current positions of all agents, and based on this information new teams can be formed.

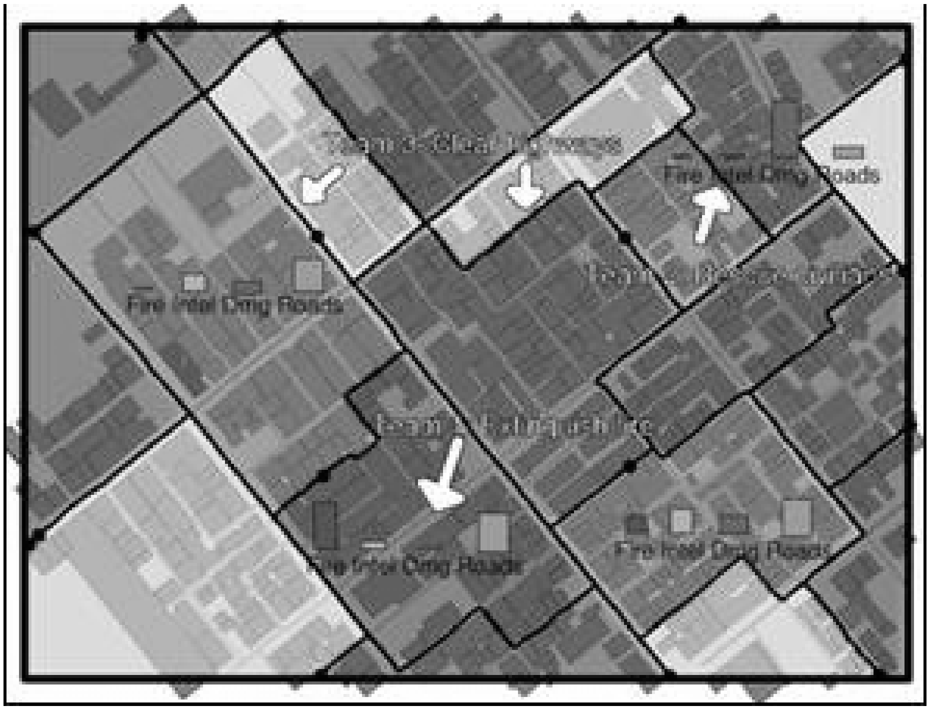

Fig. 2. For each sector the current situation is summarized with four factors: Dmg, Roads, Fire and Intel.

In [3] we compare the combined situation assessments of all agents in the field with the situation known by the simulation-kernel. We see that two agents can already build up a quite accurate situation assessment for the Fire factor.

4 Common Knowledge

When the agents in the field arrive at the intended problem area, they plan their actions on their own observations, suplemented by the observations of other agents that are at hearing distance. Based on these recent observations, the agent not only plans its own behavior, but also estimates the actions taken by agents in the neighborhood. In this way the agents cooperate at a local level to accomplish a task.

The exchange of observations to other agents in the neighborhood is our low-level communication. The cycles that are not used for high-level communication are used for this low-level communication.

The success of this strategy should be visible in the reduction of uncoordinated behavior. We will define uncoordinated behavior as the frequency of failed tasks by the cooperating agents. A police-agent that arrives at a road only to find that it was cleared by someone else, a fire brigade that can not reach the fire, an ambulance that tries to rescue a civilian agent that has already died, those are all signs of disorganization.

5 Conclusion

With an early version of this approach we have competed in the 2003 version of the RoboCup Rescue Simulation League. Unfortunately technical problems and flaws in our situation assessment algorithm prevented us from seeing the effects of our approach reflected in our competition scores. With the extension of this research we intend to continue to contribute to development of the Rescue Simulation League in the coming years.

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Arnoud Visser studied physics at the University of Leiden, The Netherlands, where he performed investigations in the field of non-linear optics. At the University of Amsterdam since 1991, he participated in several international projects (ESPRIT, ESTEC) concerning robotics for the Computer Science Department. He is interested in architectures for collabrative decision making of Intelligent Systems.

Stef Post is a computer science student at the University of Amsterdam. Because of his large experience with programming he documented and verified most of the simulator details. He currently focusses on the communication model of our agents.

Maurits Fassaert is an artificial intelligence student at the University of Amsterdam. He is specialized in neural computing and genetic programming, but has gained knowledge of designing multi-agent systems while making a commercial realtime strategy computer game. He now combines these fields of expertise to design the common knowledge behaviour of our agents.