Applying Biological Paradigms to Emerge Behaviour in RoboCup Rescue Team

Francisco Reinaldo[1,2], Joao Certo[1], Nuno Cordeiro[1], Luis P. Reis[1], Rui Camacho[1], and Nuno Lau[3]

[1] LIACC-NIAD&R, Faculty of Engineering, University of Porto,
R. Dr. Roberto Frias, 4200-465 Porto, Portugal
reinaldo.opus@gmail.com, nuno_cordeiro@hotmail.com,
{joao.certo, lpreis, rcamacho}@fe.up.pt
[2] GIC, Dept. of Computer Science, UnilesteMG,
Av. Pres. Tancredo Neves, nº3500, 35170-056 Cel. Fabriciano - MG, Brasil
[3] IEETA/DET, University of Aveiro, 3810-193 Aveiro, Portugal
lau@det.ua.pt

Abstract. This paper presents a hybrid behaviour process for performing collaborative tasks and coordination capabilities in a rescue team. RoboCup Rescue simulator and its associated international competition are used as the testbed for our proposal. Unlike other published work in this field one of our main concerns is having good results on RoboCup Rescue championships by emerging behaviour in agents using a biological paradigm. The benefit comes from the hierarchic and parallel organisation of the mammalian brain. In our behaviour process, Artificial Neural Networks are used in order to make agents capable of learning information from the environment. This allows agents to improve several algorithms like their Path Finding Algorithm to find the shortest path between two points. Also, we aim to filter the most important messages that arise from the environment, to make the right choice on the best path planning among many alternatives, in a short time. A policy action was implemented using Kohonen's network, Dijkstra's and D* algorithm. This policy has achieved good results in our tests, getting our team classified for RoboCup Rescue Simulation League 2005.

1 Introduction

Search and rescue of victims in large-scale disaster are serious and very difficult tasks presenting several challenges from a scientific point of view. Unprepared cities can suffer tremendous consequences in a natural catastrophe as was reported in Kobe's earthquake [8]. Every city needs an emergency plan, to reduce the loss of human life in a natural disaster. In recent years, staggering technological breakthroughs brought some science fiction dreams closer to us. The innovations in robotics and artificial intelligence have opened doors and allowed for a complete new use of rescue agents and emergency plans.

RoboCup Rescue international project was started in 1999 to solve disaster and rescue problems by integration of disaster information, prediction, planning and

C. Bento, A. Cardoso, and G. Dias (Eds.): EPIA 2005, LNAI 3808, pp. 422 – 434, 2005.

training for rescue actions. Built upon the success of RoboCup Soccer project, it aims to offer a comprehensive urban disaster simulator, forums of technical discussions and competitive evaluation for researchers and practitioners.

This paper presents our team and its decision system to support planning/control of tasks. The system uses learning modules and path finding algorithms. The use of Kohonen's network [10], Feedforward network, Dijkstra's algorithm [4] and the D* (Dynamic A*) algorithm [14] are discussed, to provide an understanding of how they are applied in agents. Consequently, collaborative actions are emerged and optimal strategies are achieved with high performance for path-finding and other related tasks.

The rest of the paper is as follow. Section 2 presents an overview of RoboCup Rescue Simulation System. Section 3 shows rescue teams and rescue behaviours. Section 4 provides an overview of Artificial Neural Networks, showing the similarity between rescue team and human brain to validate the choice of Kohonen's network for emergent reasoning and Feedforward for producing simple behaviours. Section 5 introduces our team, giving contributions in: functionalities, structure and layer learning building. In Section 6 we present some results and conclude the paper.

2 RoboCup Rescue Simulation System

RoboCup Rescue Simulation League is a rescue project that simulates an urban disaster, heterogeneous team agents and human behaviours [24]. Proposed by Kitano et al. [7], it looks after autonomous agents, complex high-level plans and adjustment of heterogeneous behaviours to save citizens in disasters and to preserve the town (Figure 1). Every year a competition is organized where researchers meet, compare approaches and exchange ideas.

Some emergent methodologies and/or behaviour architectures try to offer suitable solutions for providing emergency decision support. But an unconcern with the requirements of disaster simulation or the topologic structure of the system can suggest an arduous policy of solution elaboration process in the simulation phase.

Challenges and requirements are the guidelines of the rescue simulation system and competition. The challenges are: limited time for rescuing injured citizens; simulation of rescue behaviours, centre agents and team agents; best route planning for moving vehicles allowing detours around blocked ways; distribution of water to extinguish burning buildings; and others. In order to solve this, it is necessary to develop useful reasoning/reactive modules to deliberate/perform secure actions. These modules offer strategies for saving lives and preserving buildings. In addition, Takahashi [24] has presented and categorized, according to their usage, three main classes of requirements in a disaster simulation:

- **Before disasters:** Prevention plans for disasters and how to supply provisions to refuges. This phase is considered in some way as the agents may have a set of adjustable parameters according to the map of the City in which they act.
- **During disasters:** Rescue operations at the field are done to save lives, prevent the destruction of households and so on. These operations are estimated to last for the 72 hours immediately after the disaster.
- **After disasters:** Disasters in urban cities may have effects for a long time.