Petri Net with RFID Distributed Database for Autonomous Search and Rescue in Trails and Crossings

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Abstract. A modified Petri Net inside RFID database is proposed to assist search and rescue in trails and crossings. The main idea is presented directing rescue agents and trekkers in external areas without the guarantee of satellite communication and with restriction of points with electric power.

Keywords: Search and Rescue · Multiagent systems · PNRD

1 Introduction

According to [1], from 1998 to 2011 the Rocky Mountain Rescue Group assisted 1857 search and rescue (SAR) incidents involving 2198 victims in the USA. From these, 345 were climbing incidents with 428 victims. According to the Brazilian Fire Department, from 2013 to 2014 the occurrences of people lost in forests increases 17,30% in the State of São Paulo and 21.42% in the Baixada Santista [2].

In this way, the SAR community is open to new methodological proposals. Specifically talking, several studies report the use of mobile robotics and Petri nets to aid in the modeling and analysis of SAR operations. For example, a technique to test robot behavior in an urban SAR environment uses elementary Petri nets to model the behavior of system actors [3], and a qualitative analysis of process of triage in disaster rescue operations using stochastic Petri nets [4].

This ongoing work is based on an approach called Petri Net inside RFID Database (PNRD) [5], and proposes to trace the user in external environment with a modified PNRD, with that, to direct the robots' local search in case of any incident.

2 Preliminary Discussion

SAR agents compose the search and rescue team. There is an AerialBot, which is a cartesian robot that can be on Patrol mode, Aid mode or Available mode. There

are two GroundBots, ground mobile robots which can be on Available mode, Local search mode, Aid mode, Approach mode, or Rescue mode. All the SAR agents have a Wi-Fi module, enabling TCP/IP communication. The Walkers, which are the trekkers, are represented by mobile robots that can assume three invariant states: the walker status, the healthy status, and the trek status. The walker status can be on Lost mode, On route mode, or Rescued mode; the healthy status can be on Healthy mode, Injured Mode, or On triage mode; and the trek status can be on Ready to trek mode Ongoing mode, Returning mode, or Full trail mode. Milestones with RFID tags are used at specific points along the trail to facilitate the users' traceability and direct a possible search for injured or missing users.

The RFID readers are embedded on Walker and GroundBots with the modified PNRD Engine, and can read the existing tags along the trail. The equipment records the users' data in the tags, transforming them into a local database of users who traveled there. This equipment will also be able to identify the user's trajectory by storing the possible routes through an incidence matrix. Thus, the PNRD approach is modified so that the reader stores the process (incidence matrix) and trek status (region that the user is in), and the tag starts to store the trigger vector.

This ongoing work presents a new approach to SAR systems without satellite communication using autonomous robots and modified PNRD. The PNRD approach is modified to meet SAR system requirements, storing the incidence matrix and the user's trek status in the RFID reader and using the RFID tag as a repository of the trigger vector and the list of users that have passed through it. The trail was tagged at several points to assist the users' tracking. The models need to be embedded and the tests be performed so the proposal is better discussed. Also, it is intended to expand it to cover colored, timed, hierarchical, and stochastic Petri nets.

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