Chapter 56
Overview of Search and Rescue From Robotics to Wireless Sensors and Robots Networks

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ABSTRACT

In the recent years, many researchers have shown interest in developing search and rescue system composed of one or multiple robots, which have the mission of finding victims and identifying the potential hazards. To enhance the robotic systems there is a growing trend of integrating wireless sensor networks (WSNs) to robots and multi-robot systems, which gives more awareness of the environments. In the first part of this article, the authors present a review of robotic system and their environments in search and rescue systems. Additionally, they explain challenges related to these systems and tasks that a robot or a multi-robot system should execute to fulfil the search and rescue activities. As a second part, the authors expose the system that integrates WSNs with robots and the advantages that brings this latter. In addition, they cite tasks and missions that are achieved in a better way with a cooperation of WSN and robots. Furthermore, the authors expose and discuss the remarkable research, challenges and the open research challenges that includes this cooperation.

1. INTRODUCTION

Search is the activity of finding survivors, victims or a searched object; while rescue is the activity of extricating survivors, victims or a searched object. The search and rescue activities start when the rescue center sends a team of rescuers to inspect the disaster area. In this step, the team search for victims via a systematic or a random search and collects other information about the disaster area that may affect the rescue operations for example: obstacles, falling debris, toxic gases…etc. After this step, the rescue center plans the rescue activity by creating a map of the disaster area that contains the location of victims.

This helps them to excavate rubbles and rescue victims. Finally, victims are transferred to hospitals and the disaster area is put under surveillance for any changes.

To execute these tasks, researchers proposed to add robot to help in the search and rescue activities. Then, to achieve this mission quickly, efficiently and accurately a cooperation between robots was proposed. This way of search and rescue activities will fulfil in a team mission. This team cooperation could replace the need for human presence in the disaster site for almost all the steps of search and rescue operation cited previously. However, there are some challenges that this system faces, these challenges are related to the mobility, communication, control, robot's sensors, power and the human robot interaction (HRI). Also, there are some challenges related to the reliability of the system such as: optimizing mission times, robot localization, creating the disaster area map, decision making, improving robots reliability, finding the maximum number of victims, sending the maximum of information to the rescuers (see Murphy, 2008).

To overcome some of these challenges, an inclusion of stationary sensors in the system was proposed; those sensors help to coordinate between robots and make them more aware of the surrounding environment. These sensors do several tasks to help robots in their missions. They could be relays that send the information collected from robots to the operator. They could be also coordinators that transmit the data between robots to extend robots coverage. They could help to have a distributed tasks allocation (For example, one sensor chooses the robot that moves to a destination). The use of sensor network could help to solve the problem of resource conflicts by routing data in different paths. Additionally, having a wireless sensor network is the best way to monitor the whole disaster area and to detect the different events that might happen at any time. Furthermore, the WSNs track victims and robots to communicate their location in real time to the rescuers. However, this wireless sensor network has several challenges related to the hardware of sensors used, to the energy consumption, to routing protocols, to the degree of autonomy and to the quality of services.

Figure 1 shows the architecture of a search and rescue system, which is divided into two parts: the rescue center and the disaster area network. These are related via a wired or wireless network dependent to the architecture of the application. Rescuers provided with powerful servers supervise the rescue center. The second part of the system, which is the disaster network, was composed in the beginning by single powerful robot only. After that, the rescue application moved from the use of one robot to the use of

Figure 1. Architecture of a search and rescue system
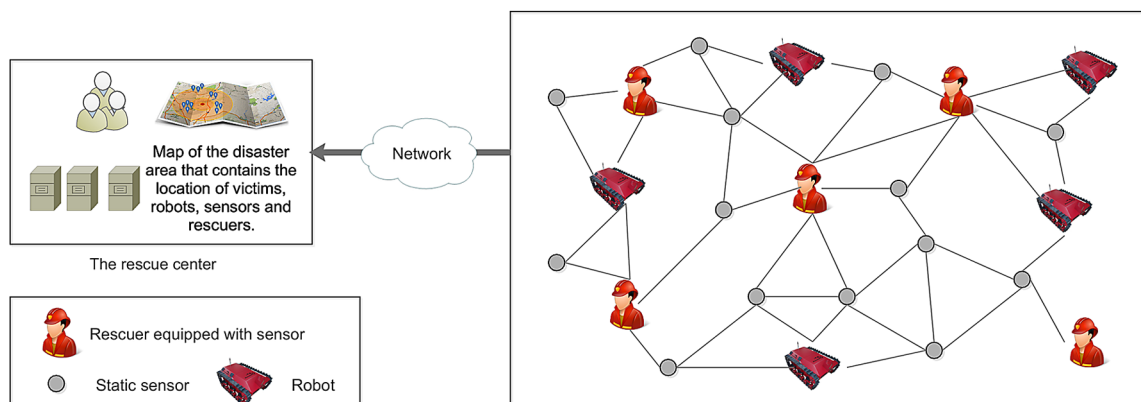
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