Sharif Rescue Robots: Robots for Challenging Environment

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Abstract. The Sharif Rescue Robot, EMDAD I, was the winner of Technical Award in Advanced Mobility from 2001 RoboCup/AAAI Competition in Seattle, USA. The new generation of this robot, EMDAD II, participates in 2002 RoboCup Competitions in Japan, in company of some co-operative robots, such as Magellan Pro® (the above-mentioned award) and Twins. In this paper, the software, hardware and mechanical system of designed robots will be presented. Its focus will be held on EMDAD II, the most intricate robot of the team.

1 Introduction

Obviously, in recent years there has been a great motivation to automate rescue procedures in order to discover more victims. Iran is a country where many earthquakes occur regularly and rescuers must face unexpected disasters efficiently. Consequently, the first solution is to use robots. The CE Dept. of Sharif University of Technology has commenced to work on this topic since 2000. The rescue workspace comprises three arenas each with its own specifications, so there is a demand for a variety of robots for each section. Magellan Pro®, Twins and EMDAD II are the robots that are used in yellow, orange and red arenas respectively. The “agents” (“intelligent robots”) of this team are supervised by a central system. Each of robots searches lonely and when encounters a suspected object, an alarm is sent to the central system. In this case, depending on what is received, the central system will realize whether a victim is present or not, and the process will be kept on till the end of allowed period. In this paper, each arena and its suitable robot will be introduced. Ultimately, the tasks of the central system will be presented.

2 Design Strategy

2.1 Yellow Arena

In this arena a commercial robot, Magellan Pro®, is used. The main challenge is to work on control software, which consists of motion planning, visual navigation and thermal detection. For path planning two groups of algorithms have been used:

- The first group lets the robot search autonomously in the arena, so it doesn't need any human operator. Specifically, the *Generalized Voronoi Graph* algorithm [1] is used to achieve the goal.
- The second group are algorithms in which robot will move from point A to B by using local information. Such algorithms are considered for the more complicated arenas in which the automatic motion of robot is more difficult. The D^* algorithm is used to solve this problem.

In visual navigation, the images captured by robot cameras are sent to the central system, and the operator can directly navigate robot from the watching screen. In addition, by using thermal sensors, robots will be able to detect victims according to their bodies' temperatures.

2.2 Orange Arena

For this arena, two robots, named Twins, are considered. A four-wheeled platform has been used for each of them. An industrial PC namely Mity Mite®, does the information processing. The control software for Twins is the same as what was previously discussed for yellow arena. Twins' sensors include ultrasonic sensors, IR sensors and IR cameras.

2.3 Red Arena

This arena is the most difficult of all, and it needs an all-terrain robot to be able to move around a rough land. Consequently, a special robot is designed for this section named EMDAD II. A robot of this kind must have the ability to traverse the different levels of roughness such as ramps and steps. There exist many mechanisms for a mobile platform, among which a tracked mechanism was selected for this design (see Fig. 1). Simplicity, large interaction surface, high traction force and easy control in rough and unknown terrains are some advantages of this mechanism. In spite of the above-mentioned benefits, some problems are noticed for tracked platforms, such as low efficiency, high weight, bad positioning and rigidity. In this design it is endeavored to eliminate these problems. The optimal design includes strengthened polymeric materials, a unique suspension system and a dual body track to enable the robot to pass through different obstacles. Fortunately, the required experience for this optimization came from EMDAD I.

The center of mass has an unavoidable influence on traction and stability of robot, because of this, selecting a suitable position is the most important factor in the final design. As mentioned above, the encountered workspace is rough and firm so the robot must have a high strength against probable impacts. For this purpose, materials used are both strengthened and light. Taking into the account the probability that some parts of the robot could fail during the competition, the solution was to build the robot as modular as possible. By this way, the components can be easily replaced or repaired.

The hardware platform of EMDAD II, is a reliable industrial system based on industrial IBM PC104® boards. This hardware system is capable of sustaining in noisy and industrial environments.

For energy supply, rechargeable Ni-Cd batteries have been used. These batteries entirely have reasonable features in comparison with other kinds of batteries.

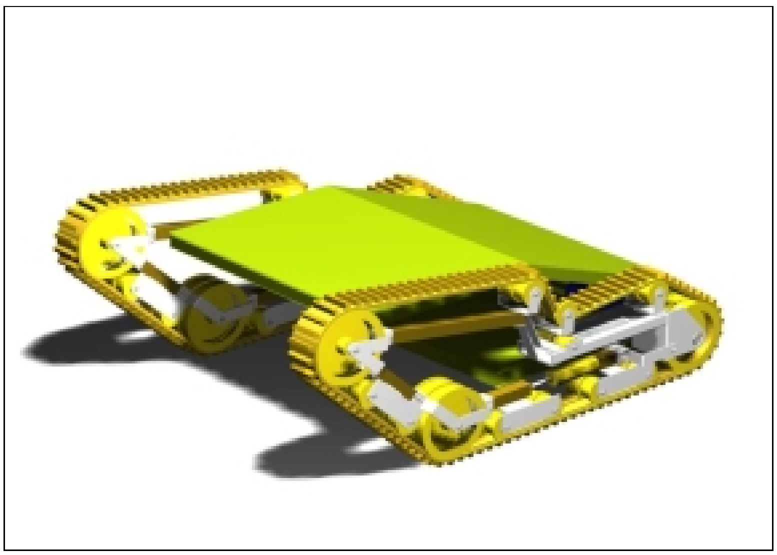

Fig.1. Mechanical platform of EMDAD II.

3 The Task of Central System:

As illustrated in Fig.2, all the robots search separately and communicate with central system using TDM approach. This system enables the operator to switch on each robot and check its current status.

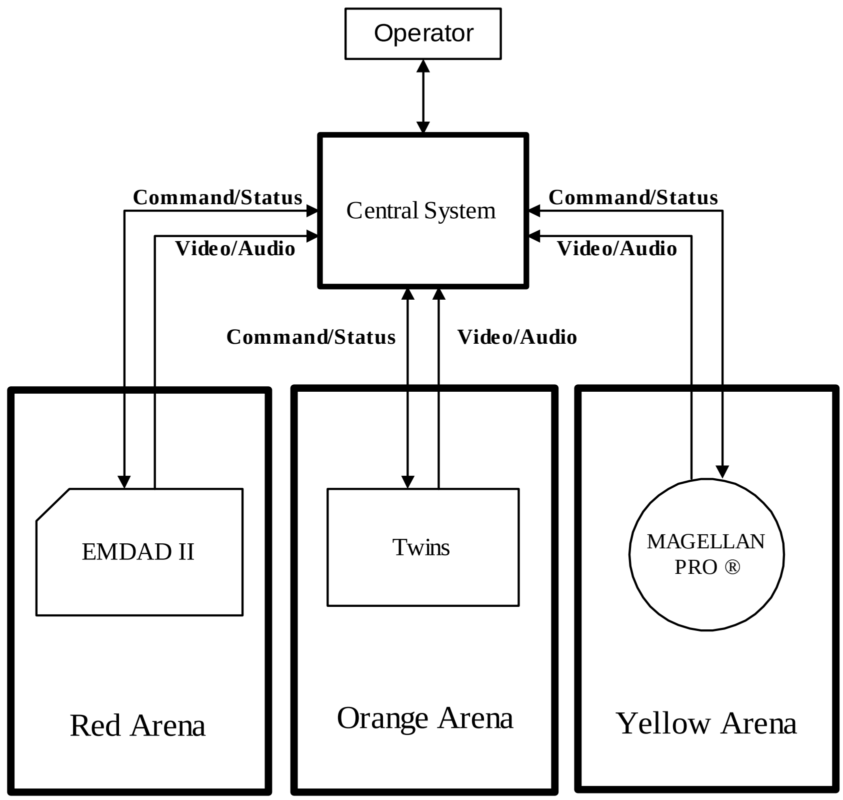

Fig. 2. Distribution of robots in each arena. An operator can switch on each robot and check its status.

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