Editorial: Special Issue on Safety, Security, and Rescue Robotics (SSRR), Part 1

On land, on water, and in the air, disaster response is always a race against time in order to reach out to as many survivors as possible. Rescue robotics is an emerging technology that can be of great use for accelerating this search, and thus for saving human lives. While there has been a notable increase in the deployment of rescue robots for local incidents and disasters, there remain core problems that need to be solved until this emerging technology is ready to be widely adopted.

This special issue on Safety, Security, and Rescue Robotics (SSRR) appears in two parts, the first in May 2016 (Issue 3) and the second in June 2016 (Issue 4). This part deals with core problems of mobility, communication, and structure recognition on unmanned vehicles operating on rough terrain, under the sea, and in the air. This is the third special issue on SSRR published by the Journal of Field Robotics. Our previous issue in March-May 2011 focused on the overall design as well as crucial components for advanced locomotion, and our previous issue in January-February 2008 focused on lessons learned from field trials in the search and rescue domain.

Several natural disasters that occurred in the past were in connection with the flooding of larger areas. In such situations, unmanned underwater and surface vehicles can be of great use for disaster mitigation. The paper by Ozog *et al.* presents an approach to long-term multi-session mapping on underwater vehicles with a focus on ship hull inspection tasks. The proposed method uses a combination of visual features and locally planar surface patches for registering multiple maps and combining them into a single representation of the ship hull. The authors describe how to use generic linear constraints to iteratively sparsify a map over several sessions, which allows for real-time operation. Results are presented from two long-term datasets collected from two large ships illustrating how the proposed method is robust towards significant changes in the local visual appearance of the hull structure.

In their field report Qi *et al.* describe their solution to collapsed-building detection by integrating low-altitude statistical image processing methods on rotary-wing unmanned aerial vehicles. The system design is based on requirements collected from both literature and experience from search and rescue after earthquakes. In 2013 the system supported the Chinese International Search and Rescue Team to accurately detected collapsed buildings for ground rescue guidance at low altitudes after the earthquake in Lushan, China.

The paper by Rollinson and Choset presents a method of achieving whole-body compliant motions with a snake robot that allows the robot to automatically adapt to the shape of its environment. This allows a snake robot navigating a pipe to adapt to changes in diameter and junctions, even though the robot lacks mechanical compliance or tactile sensing. The compliant controller estimates the overall state of the robot in terms of the parameters of a low-dimensional control function, i.e., a gait. The controller then commands new gait parameters relative to that estimated state. The system enables more sophisticated motions that would previously have been too complex to be controlled manually.

Autonomous navigation is challenging when considering a natural outdoor environment and a robot that has many degrees of freedom. Belter *et al.* propose a navigation system combining robust environment perception with onboard sensors, efficient environment mapping, and real-time motion planning. The key idea of the motion planner is to use a higher-level planner for coarse path planning, considering the terrain cost, on a low-resolution elevation grid, and a lower-level planner to find a sequence of feasible motions on a more precise but smaller map. The system has been thoroughly tested under real-world conditions in experiments with two six-legged walking robots with different perception systems.

The paper by Yamada *et al.* proposes a blade-type crawler vehicle with improved performance over rough terrain. The economical micro unmanned ground vehicle (MUGV) has been designed for observing craters during volcanic eruption. Observing a crater during volcanic eruption is a dangerous task, which is still being performed directly by volcanologists. The vehicle is capable of rapidly capturing arbitrary images and video of volcanic eruptions without being affected by winds or volcanic ash.

Communication is a serious issue during disaster response and mobile robots capable of actively extending communication range are a promising approach. The paper by Min *et al.* presents a networked robotic system design capable of enhancing wireless communication range and bandwidth. The system is composed of active communication nodes implemented as mobile robots equipped with directional antennas. The authors propose a weighted centroid algorithm that facilitates active antenna tracking and direction-of-arrival estimation. The effectiveness of the system has been evaluated under several varying conditions.

The response to the call for this special issue was very strong and following directly after the International Symposium on IEEE International Symposium on Safety, Security, and Rescue Robotics (Linköping, Sweden) in October 2013. We selected 13 articles for the special issue of out of 49 papers that were originally submitted. All articles have undergone the journals rigorous review process and were partially presented at the Symposium.

We wish to thank Sanjiv Singh for his advice during the reviewing process. Our sincere appreciation goes to Sanae Minick for guiding and supporting the overall process while being very assistive at several administrative details. Our reviewers deserve special recognition for their thoroughness and patience.

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