RoboCup Rescue 2027 Team Description Paper Team Name

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Info

Team Name:	Team
Team Institution:	University
Team Country:	Country
Team Leader:	Name
Team URL:	
Competition:	RRL or SPARC

RoboCup TDP collection: https://tdp.robocup.org/tdp/

***Abstract*—The abstract goes here. Do not describe RoboCup Rescue in detail - concentrate on your robots, their main capabilities and what sets them apart from the competitors.**

***Index Terms*—RoboCup Rescue, Team Description Paper, up to 3 others.**

I. Introduction

PLEASE use this Team Description Paper (TDP) template to answer the following questions about your team's approach to designing, fabricating, controlling, and operating your urban search and rescue robot team. We will likely have many more teams interested in participating than we can accommodate, so we will use this paper to initially qualify your team for final registration. We are looking for teams showing solid progress toward a functioning system, particularly innovative approaches, and well formulated (and well described) team strategies. Timely submittal of this and other documents is also appreciated.

The https://rrl.robocup.org/sparc/ Standard Platform for Autonomous Rescue Competition (SPARC) is staring in 2027. In the info field above please indicate if this TDP is for competing in the Real Rescue League (RRL) - which is the normal rescue competition - or for SPARC. Each team can only participate in one of those. If your team wants to compete in both you'd need to submit two TDPs with two different team names and, if accepted, also register and pay for two teams at RoboCup. Due to the fast pace of the competitions it is also not possible to use the same physical robot for both (i.e. you would need two robots).

For SPARC you can skip the hardware parts and tables, unless you have some custom modifications.

It is very important that you follow this particular template regarding formatting. TDPs of all teams are publicly available. TDPs between 2015 and 2018 are available on this webpage https://robocup-rescue.github.io/team_description_papers/ , later TDPs should be available here: https://tdp.robocup.org/ . We understand that at this early date your system is likely not fully realized, so we expect this document to be incomplete in parts. However, we expect you to articulate at least some ideas in each area outlined below. The more comprehensive your approach appears, the more favorably it will be reviewed. If you have hardware implemented, please add lots of pictures as you describe your system, and give details regarding the parts themselves (sensors, motors, computers, etc). If you have drawings of your system, please include them. If you have particular team strategies, please describe them. Otherwise, please attempt to describe at least the direction you are going in any given section and what we can expect to see at the competition. Please also describe how your operator(s) plan to interact with your system.

Robo Hero is with the Department of Robotics Gurus, Moon University, Moon, e-mail: .

J. Doe and J. Doe are with Anonymous University.



Fig. 1. Photo of your robot. Should ideally be located in a corner with lines 10cm apart (at least on the ground). Take the photo from an angle such that front, side and top are visible. This photo should appear on the first page of your document exactly where it is placed in the template! If you have other robots or an unusual operator station add those in extra figures.

The TDP is not the place to describe your awesome new approach in all details with experiments that proof the performance, etc. This should go into an extra paper. Anyways be sure to cite all your relevant publications and also the according publications of other researchers. The TDP is an overview paper to show how the system performs as a whole. The introduction should give an overview of your systems and your approach to RoboCup Rescue.

A. Submission

If you are a) accepted for the RoboCup Rescue competition, b) payed the registration fees AND c) participated in the event we will to publish your TDP on the webpage.

Please do not include any of the TDP template preparation instructions in your TDP ;)

B. Improvements over Previous Contributions

If you have previously participated at RoboCup Rescue, describe how your system differs and improves from your previous entry.

C. Scientific Publications

In this section, please list all scientific publications related to your RoboCup Rescue team. Please introduce the papers you published in the last year with one or two sentences and list previous publications more briefly. It is important to highlight the role of RoboCup rescue for scientific research, also for the RoboCup Federation.

You can include any paper for which the competition or your rescue robot played a role, for example as inspiration for a problem, as a platform for testing or maybe an application that uses technology developed for rescue.

Example: Our latest research on RGBD-Inertial Trajectory Estimation and Mapping for Ground Robots for rescue robot uses an intel real sense camera to extend VINS-mono to use depth information to generate better maps [1].

In the previous years, we have published the following rescue-related papers: [2], [3], [4], [5], [6], [7], [8], [9], [10].

II. System Description

Use this section to describe your overall system. Depending on the emphasis of your team the different subsections can be of different lengths. Nevertheless please be as detailed as possible. The advantages are:

- Get qualified for RoboCup Rescue by having a detailed system description.
- Document your teams approach.
- Allow a comparison of your team with other teams.
- Allow a comparison between different years of RoboCup and thus (hopefully) a documentation of the improvements through the years.
- Allow other and especially new teams to kick-start their research by copying your system.

A. Hardware

Document the hardware of your system. This can be very brief if you bought the robot (in this case mention the major modifications). The first image of this document (should also appear on the first page) should be a photo of your real robot - see Figure 1.

Refer to the Tables I and following as well as Table IV in the Appendix - there is no need to document part here in detail if it is sufficient to know that it is used from the tables. Please also share your CAD drawings or electronics plans with the community on your own webpage and link to them in this TDP! Do so by adding a big picture to the appending AND by providing the files in a commonly used format as ancillary files http://arxiv.org/help/ancillary_files.

Explain your approach regarding those topics - create relevant subsubsections as needed:

- Locomotion
- Power (Batteries)
- Electronics, including micro-controllers, etc.
- Manipulation/ directed perception
- Sensors
- Computation (high performance for autonomy, etc.)
- Communication is covered in its own subsection - mention the regarding hardware and software there.
- Others...

B. Software

Refer to Table V in the Appendix.

Explain how your software works. Create relevant subsubsections as needed. You might want to explain:

- low level control
- communication protocol (video, commands, data)
- localization
- mapping
- autonomy
- victim detection
- path planning
- navigation
- arm control
- arm planning
- ...

C. Communication

Please use this section to describe your plan for communicating with your robots (passive tether, active tether, radio, etc.) Double check the rules regarding restrictions and rules for the radio! See https://rrl.robocup.org/rules/.

Report about your wifi hardware in detail. Tell us the vendor and model of your hardware - access point and antennas. Describe which protocol your hardware is working with. Let us know what is the maximum power your hardware supports and what is the power-setting you will be using during the competition. Tell us the gain of your antennas. Tell us the SSID you will be using (typically it should be ”RRL_teamname”).

D. Human-Robot Interface

Explain how your robot is controlled. What does the operator see? In which ways can he interact with the robot? Also describe how a potential user should be trained and how you trained the operator for your team.

III. Application

This section covers the practical aspects of your system...

A. Set-up and Break-Down

Please use this section to describe your plan for set-up and break-down of your the robots and the operator station.

B. Mission Strategy

If not already covered in the Introduction, explain your overall strategy to the RoboCup Rescue Challenge. Also mention what you cannot or don’t want to do.

C. Experiments

Explain how you verify your system. Did you build any standard test methods for testing your robot? What kind of experiments and validations did you do with your hardware/ software/ overall systems? What did you learn?

D. Application in the Field

Discuss how your system is applicable to the field of search and rescue. Where are its strength and weaknesses? What do you think would be possible to improve in the near and medium future towards using it in real scenarios?

IV. Conclusion

The conclusion goes here. Brief summary, outlook to the competition, lessens learned from previous competitions, etc.

Appendix A
Team Members and Their Contributions

Please use this section to recognize all team members and their technical contributions. Also note your advisors and sponsors, if you choose. You may want to include links to homepages.

- Adam Jacoff — Controller development
- Satoshi Tadokoro — Mechanical design
- Robo Hero — SLAM algorithm

Appendix B
CAD Drawings

Put one or two nice views of your CAD drawings (for hardware teams - software teams can delete this section). Keep in mind that you can use *begin{figure**} to display an image in full width.

Appendix C
Lists

A. Systems List

For every system (each robot individually robot incl. support, Operator Station) answer the following items. One table per system. Remove entries that do not make sense. If a number is unknown try to estimate it or put a question mark (do not delete the entry if it might be interesting but you don't know the answer).

B. Hardware Components List

List all interesting components of your Robots and Operator stations. Include a hyperref link to the product page if possible - see the examples.

C. Software List

List all relevant software packages you (actually) use! Include a hyperref link to the software page if possible - see the examples. Include version numbers.

If you are using some advanced algorithms be sure to cite the according papers.

When it is not very obvious explain briefly what the software is used for in usage.

TABLE I
Manipulation System

Attribute	Value
Name	MoonRobbi
Locomotion	tracked
System Weight	23kg
Weight including transportation case	28kg
Transportation size	0.6 x 0.6 x 0.5 m
Typical operation size	0.5 x 0.8 x 0.4 m
Unpack and assembly time	180 min
Startup time (off to full operation)	10 min
Power consumption (idle/ typical/ max)	60 / 200 / 800 W
Battery endurance (idle/ normal/ heavy load)	240 / 120 / 60 min
Maximum speed (flat/ outdoor/ rubble pile)	4 / 1 / - m/s
Payload (typical, maximum)	3/ 10 kg
Arm: maximum operation height	160 cm
Arm: payload at full extend	2kg
Support: set of bat. chargers total weight	2.5kg
Support: set of bat. chargers power	1,200W (100-240V AC)
Support: Charge time batteries (80%/ 100%)	90 / 120 min
Support: Additional set of batteries weight	2kg
Any other interesting attribute	?
Cost	5000 USD

TABLE II
Aerial Vehicle

Attribute	Value
Name	MoonFly
Locomotion	quadcopter
System Weight	3kg
Weight including transportation case	6kg
Transportation size	0.6 x 0.6 x 0.5 m
Typical operation size	0.6 x 0.6 x 0.2 m
Unpack and assembly time	10 min
Startup time (off to full operation)	2 min
Power consumption (idle/ typical/ max)	100 / 150 / 300 W
Battery endurance (idle/ normal/ heavy load)	30 / 20 / 15 min
Maximum speed	12 m/s
Payload	0.15 kg
Any other interesting attribute	?
Cost	2000 USD

Acknowledgment

The authors would like to thank...

References

[1] Z. Shan, R. Li, and S. Schwertfeger, "Rgbd-inertial trajectory estimation and mapping for ground robots," *Sensors*, vol. 19, no. 10, p. 2251, 2019.
[2] R. Sheh, S. Schwertfeger, and A. Visser, "16 years of robocup rescue," *KI-Künstliche Intelligenz*, vol. 30, p. 267–277, 2016.

TABLE III
Operator Station

Attribute	Value
Name	MoonOp
System Weight	3.2kg
Weight including transportation case	4.5kg
Transportation size	0.4 x 0.4 x 0.2 m
Typical operation size	0.4 x 0.4 x 0.4 m
Unpack and assembly time	1 min
Startup time (off to full operation)	1 min
Power consumption (idle/ typical/ max)	60 / 80 / 90 W
Battery endurance (idle/ normal/ heavy load)	10 / 5 / 4 h
Any other interesting attribute	?
Cost	2000 USD

TABLE IV
HARDWARE COMPONENTS LIST

Part	Brand & Model	Unit Price	Num.
Drive motors	Maxon RE 50 200 W	CHF 870	2
Drive gears	Planetary Gearhead GP 52		2
Drive encoder	Encoder HEDS 5540		2
Motor drivers		?	2
DC/DC		?	1
Battery Management		?	1
Batteries		?	1
Micro controller		?	1
Computing Unit		?	1
WiFi Adapter		?	1
IMU		?	4
Cameras		?	4
PTZ Camera		?	1
Infrared Camera		?	1
LRF		?	2
CO_2 Sensor		?	1
Battery Chargers		?	4
6-axis Robot Arm		?	1
Aerial Vehicle		?	1
Rugged Operator Laptop		?	1

TABLE V
SOFTWARE LIST

Name	Version	License	Usage
Ubuntu	14.04	open	
ROS	jade	BSD	
PCL [11]	1.7	BSD	ICP
OpenCV [12], [13]	2.4.8	BSD	Haar: Victim detection
OpenCV [14]	2.4.8	BSD	LBP: Hazmat detection
Hector SLAM [15]	0.3.4	BSD	2D SLAM
Moon 3D Mapping	0.8	GPL	3D Mapping
Proprietary GUI from Moon U.	0.7	closed source	Operator Station

[3] R. Sheh, T. Kimura, E. Mihankhah, J. Pellenz, S. Schwertfeger, and J. Suthakorn, "The robocuprescue robot league: Guiding robots towards fieldable capabilities," in *Advanced Robotics and its Social Impacts (ARSO), 2011 IEEE Workshop on*. IEEE, 2011, pp. 31–34.

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[5] S. Kohlbrecher, K. Petersen, G. Steinbauer, J. Maurer, P. Lepej, S. Uran, R. Ventura, C. Dornhege, A. Hertle, R. Sheh, and J. Pellenz, "Community-driven development of standard software modules for search and rescue robots," in *Proceedings of the 10th IEEE International Symposium on Safety Security and Rescue Robotics (SSRR 2012)*, 2012.

[6] J. Pellenz and D. Paulus, "Mapping and Map Scoring at the RoboCupRescue Competition," Quantitative Performance Evaluation of Navigation Solutions for Mobile Robots (RSS 2008, Workshop CD), 2008.

[7] R. Sheh, A. Jacoff, A.-M. Virts, T. Kimura, J. Pellenz, S. Schwertfeger, and J. Suthakorn, "Advancing the state of urban search and rescue robotics through the robocuprescue robot league competition," *8th International Conference on Field and Service Robotics*, 2012.

[8] A. Jacoff, R. Sheh, A.-M. Virts, T. Kimura, J. Pellenz, S. Schwertfeger, and J. Suthakorn, "Using competitions to advance the development of standard test methods for response robots," in *Proceedings of the Workshop on Performance Metrics for Intelligent Systems*. ACM, 2012, pp. 182–189.

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[12] P. Viola and M. Jones, "Rapid object detection using a boosted cascade of simple features," in *Computer Vision and Pattern Recognition, 2001. CVPR 2001. Proceedings of the 2001 IEEE Computer Society Conference on*, vol. 1, 2001, pp. I–511–I–518 vol.1.

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[15] S. Kohlbrecher, J. Meyer, O. von Stryk, and U. Klingauf, "A flexible and scalable slam system with full 3d motion estimation," in *Proc. IEEE International Symposium on Safety, Security and Rescue Robotics (SSRR)*. IEEE, November 2011.