



Long-Term Human-Robot Teaming for Robot Assisted Disaster Response

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Robot-Assisted Disaster Response

Human-Robot Teaming



Long-Term

Why Robot-Assisted Disaster Response



What is the situation?

Why Robot-Assisted Disaster Response





Why Robot-Assisted Disaster Response



Complement human abilities and available tools

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Why Human-Robot Teaming















Robot-Assisted Disaster Response



Human-Robot Teaming



Human-Robot Teaming

- What does it take to make a good robot team player
 - what does it need to observe (perception)
 - what should it be able to do (action)
 - when and how should it interact with humans (communication)
 - what robot behaviour do humans expect and trust
 - Driven by human performance factors
 - how do humans see the environment
 - what do humans need to know
 - how do humans communicate
 - how are humans influenced by cognitive load and stress













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User-Centric Design & System Integration







NIFTi Deployment in Mirandola, 2012











Need for Persistence gradually building and transferring situation awareness over time



G.J.M. Kruijff et al. *Rescue Robots at Earthquake-Hit Mirandola, Italy: a Field Report*. In: Proc. of the 10th IEEE International Symposium on Safety, Security, and Rescue Robotics (SSRR). IEEE Press, 11/2012.

Robot-Assisted Disaster Response

Human-Robot Teaming



Long-Term

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http://www.tradr-project.eu

Challenges

- multiple sorties of multiple (different) robots
- situation dynamics
- changing teams
- Objective: create and manage situation awareness over time
 - Persistent environment models (perception)
 - Persistent robot action and collaboration models
 - Persistent human-robot teaming (how to grow as a team)







Multiple asynchronous sorties (1 UGV, 1 UAV) to assess a large-scale static disaster





Multiple asynchronous sorties (1-2 UGVs, 1 UAV) to assess a large-scale **dynamic** disaster





Multiple **synchronous & asynchronous** sorties (2 UGVs, 1-2 UAVs) to assess a large-scale dynamic disaster



TRADR: Long-Term Human-Robot Teaming





May 2015

YouTube: EU FP7 TRADR channel: TRADR Joint Exercise (TJEx) 2015: https://www.youtube.com/watch?v=4z86nUlgEqc

Also in Year 3: TRADR Deployment in Amatrice





Amatrice: Earthquake on August 24 2016







... and after

Before...



- The Vigili del Fuoco asked TRADR to deploy robots to construct 3D textured models of two severely damaged churches in danger of collapse
- 48 hours between request and on-site deployment
- operation 8-19 (incl. material move & setup time)



San Francesco



Sant'Agostino

TRADR Deployment in Amatrice





2x TRADR UGV (BlueBotics, Neovision):







DJI Phantom 4



San Francesco







cf. "EU FP7 TRADR" channel on YouTube: Amatrice

Sant'Agostino









cf. "EU FP7 TRADR" channel on YouTube: Amatrice

3D Models





Summary





I.Kruijff-Korbayová, L. Freda, M. Gianni, V. Ntouskos, V. Hlaváč, V. Kubelka, E. Zimmermann, H. Surmann, K. Dulic; W. Rottner, E. Gissi. Deployment of Ground and Aerial Robots in Earthquake-Struck Amatrice in Italy (brief report) In Proceedings of the 2016 IEEE International Symposium on Safety, Security and Rescue Robotics (SSRR). Lausanne, Switzerland,October 2016.

"EU FP7 TRADR" channel on YouTube: Amatrice



Year 4: Deltalings Training Plant, Rotterdam, NL





http://www.deltalings.nl/programmas/rdm-training-plant

Technical Day Posters & Demonstration



Posters

- Learning for exploration, detection and 3D mapping (UGV)
- Learning and modelling for terrain perception and robot control (UGV)
- Perception and control for manoeuvring and manipulation (UGV)
- Multi-robot localisation and change detection (UGV)
 - Multi-robot autonomous patrolling and exploration (UGV)
 - 3D mapping for UAVs
 - Human-robot teamwork modelling
 - Enhancing human-robot team performance with work agreements
 - Team communication processing
 - User strategy for tactical command

Demonstration

- Command post:
- Tactical mission control
- Robot operation control
 - Teamwork support
- UGVs in the field:
 - Robots in operation
 - Perception capabilities
 - Grasping
- Multirobot collaboration:
 - Mapping
 - Patrolling
- 3D mapping for UAVs:
 - mission planning
 - data collection

UGV: Traversing difficult terrain



Tested in challenging USAR environment The Tremora hospital near Pisa, Italy with Firebrigade of Pisa

https://www.youtube.com/watch?v=s8V6a1yrKkQ&list=PL_nKsIv0htjePXdT0y3s3M0xGU2Ur8ESs&index=1

Merging 3D maps





https://www.youtube.com/watch?v=JJhEkIA1xSE&list=PL_nKsIv0htjePXdT0y3s3M0xGU2Ur8ESs&index=10

Summary



Robot-assisted situation assessment for disaster response Human-robot teamwork Persistence **User-centric design** System integration **Deployment capability**

TRADR Innovation







TRADR Consortium



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