Rescue Robots at Earthquake-hit Mirandola, Italy: A Field Report

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Europe, Northern Italy
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May to June 2012: >250 major seismic events
Widespread, severe damage:
27 dead, >50 injured, >45000 homeless
Official request VdF: Please help
Overview

• NIFTi
• Deployment
• Overview of missions
• Lessons learnt
• A few conclusions
Natural Human-Robot Cooperation in Dynamic Environments
Human-Robot Teaming in USAR

• EU-funded project
  • Large-Scale Collaborative Project:
    Jan. 2010- Dec. 2103 (48 months), 6.7M EUR
  • Coordinated by DFKI GmbH (Saarbrücken);
    TNO Soesterberg, Fraunhofer IAIS, CVUT, ETH
    Zürich, Roma La Sapienza, BlueBotics; Fire
    Department of Dortmund, Vigili del Fuoco
  • Reviewers: Dr. Robin Murphy, Dr. Candy Sidner,
    and Dr. Jan-Olof Eklundh

• “Natural human-robot teaming in
  complex, dynamic environments”
  • Think about the entire socio-technical system
Seeing humans and robots as one team.
User-centric development

user-centric requirements analysis

user-centric integrated design

component technology development

system-level technology integration

user-centric experimental evaluation
Realistic use cases
Teaming up with UGV, UAV
Distributed 3D situation awareness
Deployment
Deployment

• Location
  • Mirandola, Emilia-Romagna, Italy
  • Ch. San Francesco *(church)*, Duomo *(cathedral)*
  • End of July 2012
  • Very sunny. 40 degrees centigrade. Very dusty, too.

• Equipment
  • 2 NIFTi UGVs
  • 2 Microcopters
  • Multi-screen setup to support operation by UGV operator, Mission Spc, Infrastructure Spc
  • WiFi network
Ch. San Francesco
Duomo
ROSMAKE --PRE-CLEAN
ROS.org

Infrastructure
Command post
Configurable UAVs
(1 per mission)
UGVs
(1 per mission)
Missions
Missions

• Goal
  • Structural damage assessment
  • Assessment of damage to cultural artifacts
  • How? Videos of objects, ceilings, ...

• Ch. San Francesco
  • Tuesday July 25 - Wednesday July 26
  • Western aisle (UGV, UAV), main aisle (UAV)
  • 5 UAV flights (27 mins), 2 UGV runs (1:05h)

• Duomo
  • Thursday July 27
  • Eastern aisle (UGV, UAV), top of western aisle (UGV), main aisle (UAV), bell tower (UAV)
  • 4 UAV flights (15 mins), 3 UGV runs (1:20h)
UGV: 3D reconstruction from laser
UAV: 3D reconstructions from high-resolution video using structure from motion
UAV: Bell tower of the Duomo
UAV: Bell tower of the Duomo
Lessons learnt
Human-robot teaming

• Team effort
  • Interdependence between humans, robots
  • Complex logistical operation
  • Diplomacy

• Multiple sorties for one mission
  • Gradual development of SA over time
  • Observed need for integration of SA over sorties, within team

• Insights in autonomy
  • Humans and robots are both problem holders, but humans are the stake-holders
  • Autonomy is to support humans, handle cognitive load; not “look ma, no hands”

• Mutual support between UAV, UGV
UGV

- Autonomous navigation
  - None: Tele-operation

- Observation
  - 3D mapping using laser range finder
  - Mission Spc operated PTU, cameras
  - 3D point cloud “map” and camera output support UGV operator

- Lack of direct access to UAV SA
  - Example of need for integrating SA across missions

- No hardware problems
• Autonomous navigation
  • Not much: Tele-operation
  • Limited success of flight-control

• Observation
  • Wide variety of high-res 2D video
  • Post-processing for 3D reconstruction

• High cognitive load

• No hardware problems
In conclusion

• First active deployment of robots in Europe
  • Active deployment of multiple platforms, within a team,
  • Multiple missions, multiple sites

• Hardware is “ready”
  • ... and “we” (NIFTi) has a stable enough system & infrastructure to deploy

• The real issue is: What do you do with the information?
  • Global SA needed for gradual mission (progress) planning
  • Global SA needs integration / fusion over multiple sorties
  • Involvement of end users in information use, distribution

• Human-robot teaming is key
  • Geographically distributed teams
  • Multiple sorties by multiple robots to achieve a mission
  • Close involvement of end user stakeholders is crucial (and helps to show usefulness)

• More about NIFTi: http://www.nifti.eu