Topics

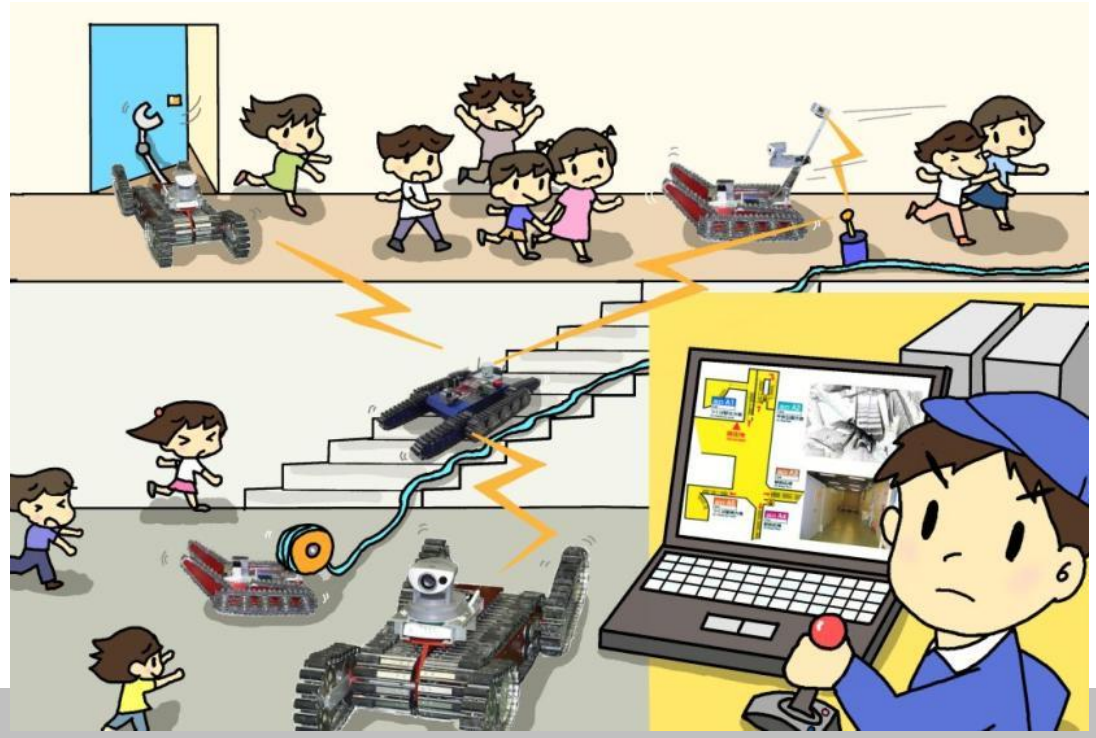
- Introducing Rescue Robots “Quince”
- Operations of Quince at Fukushima NPS
- Lessons learned from the operations

Objective of Quince Project (2005-2011)

- Indoor surveillance of damaged buildings
  - Debris, Stairs, Other obstacles
- Requirements
  - Mobility
  - Remote Control
  - Sensors

Chiba Institute of Technology
Tohoku University
AIST
NICT
Tsukuba University
Okayama University
IRS

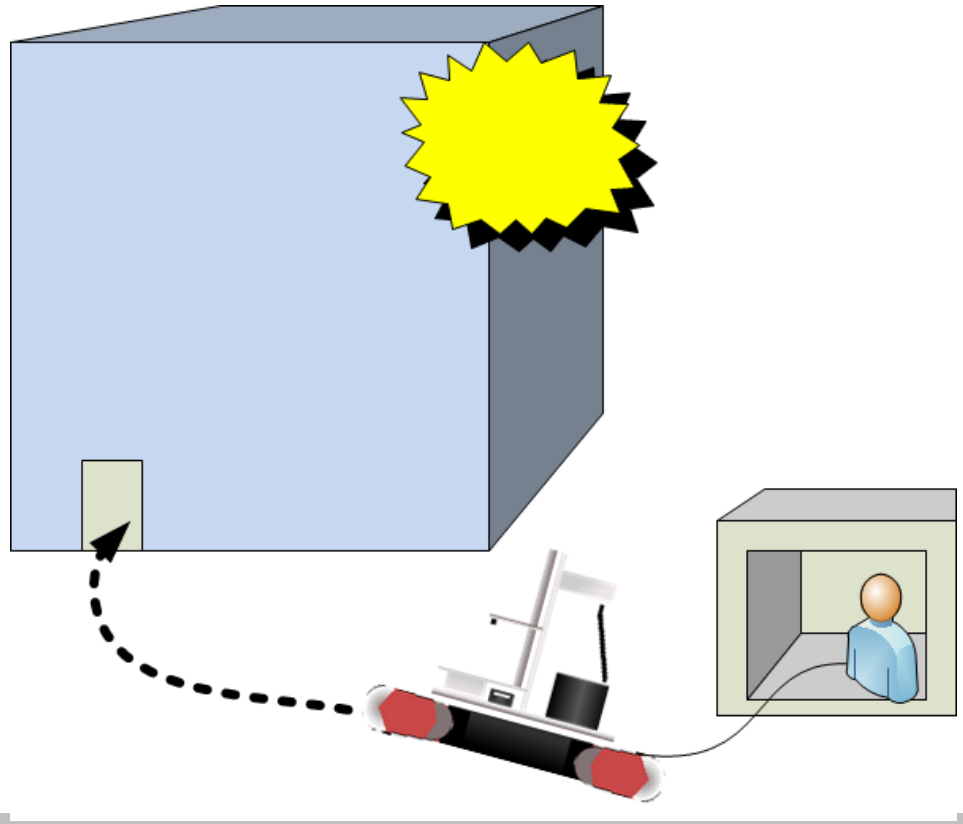
Supported by NEDO



Refining Quince for Fukushima

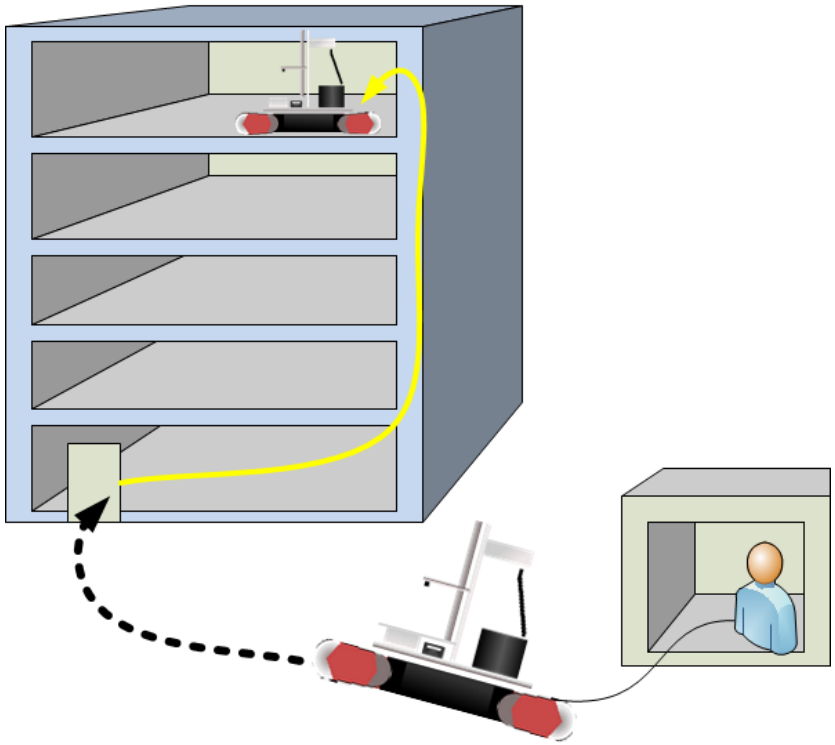
Refining Quince for Fukushima

- The situation is unknown in the building
- Requests for the robot were…
  - Measuring radiation level
  - Taking photos
  - Climb up/down the stairs to reach upper floors
  - Remote control from the safe place



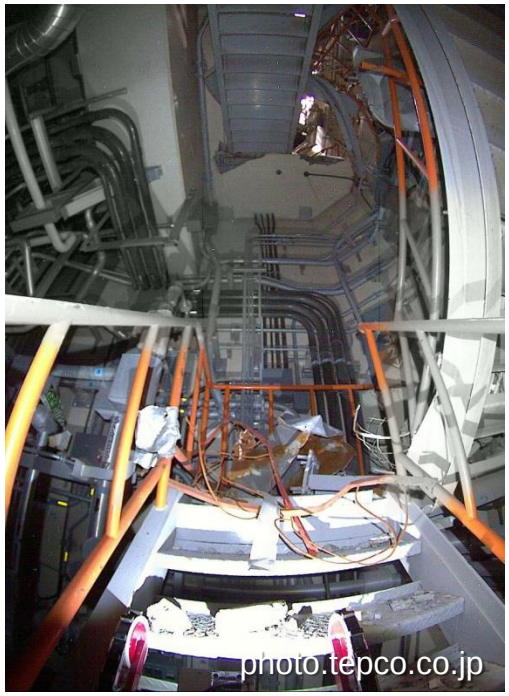
Refining Quince for Fukushima

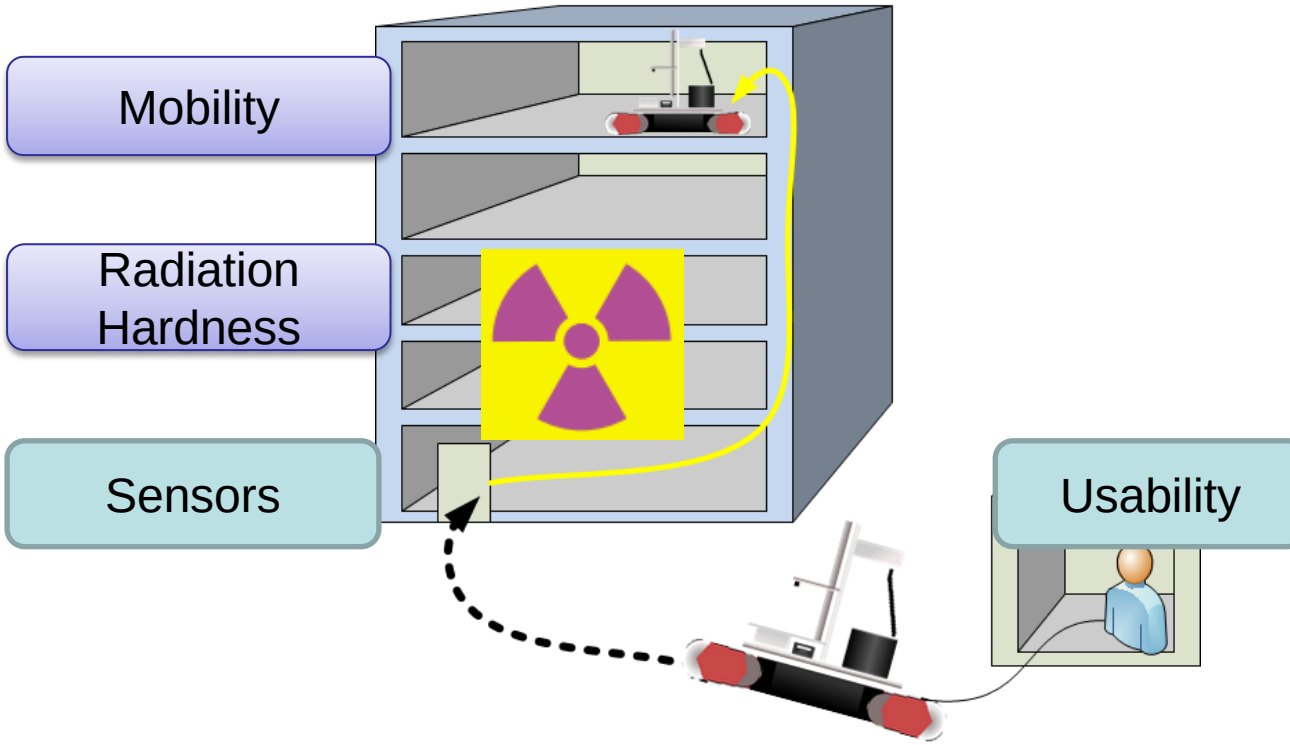
- 5 floors above ground, 2 floors below
- No electricity
- No window
- Some doors
- Thick walls
- Debris



Key Issues

- The situation is unknown in the building



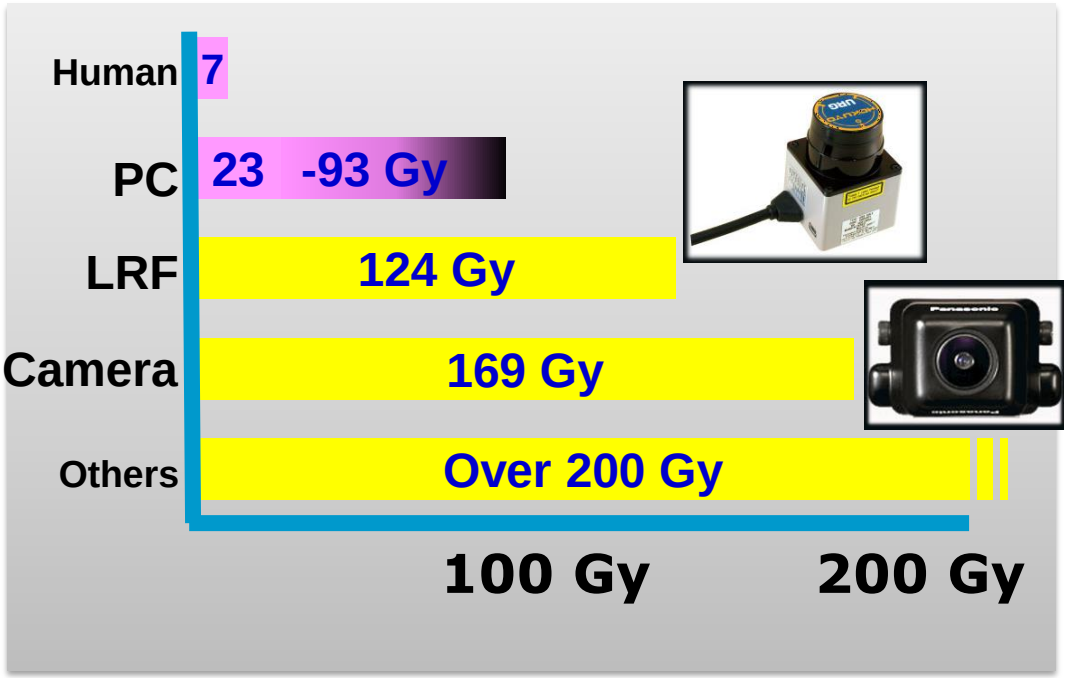


Key Issues

Radiation Hardness

Gamma ray irradiation test

Takasaki Advanced Radiation Research Institute, **J**apan **A**tomic **E**nergy **A**gency (JAEA)



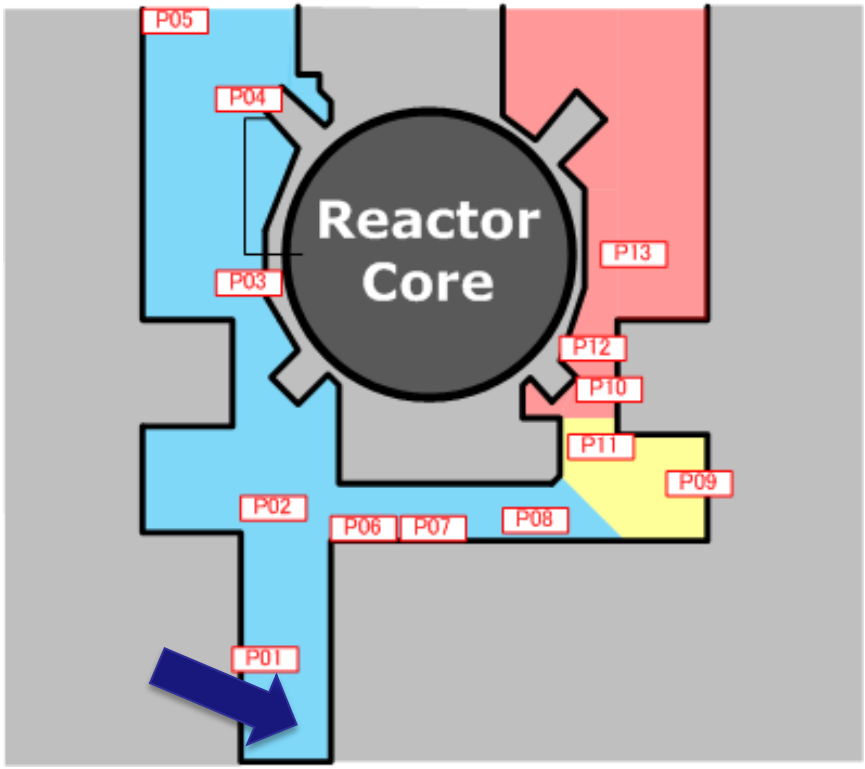
Estimated to be survived over 400h in 40mSv/h environment

Key Issues

Communication

Wireless communication test

High Power Wifi 2.4GHz (1W)
High Power UHF Video (1W)



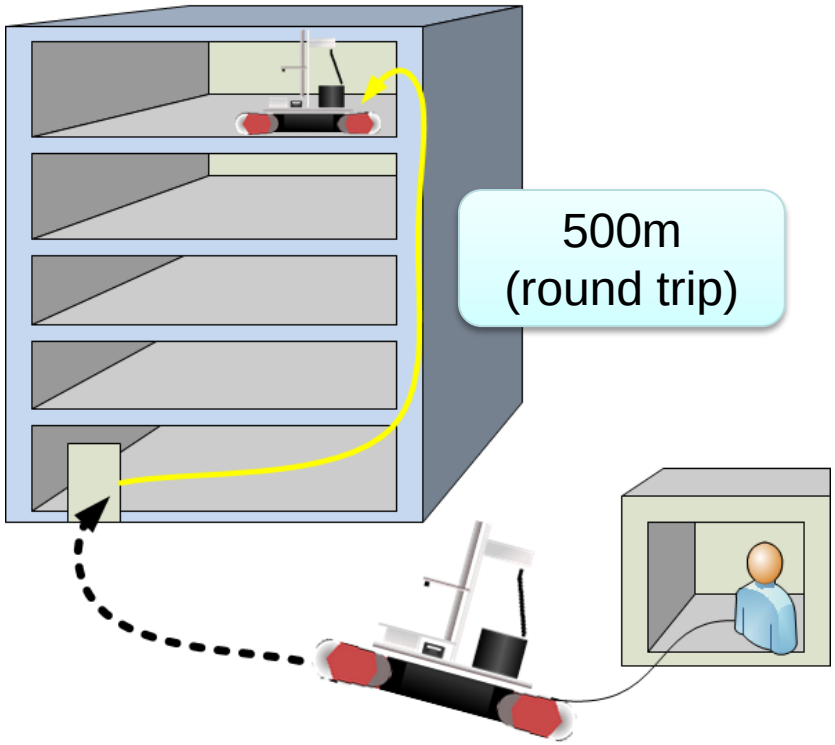
Gave up using wireless system and moved to wired system

Key Issues

Communication

Wired communication device

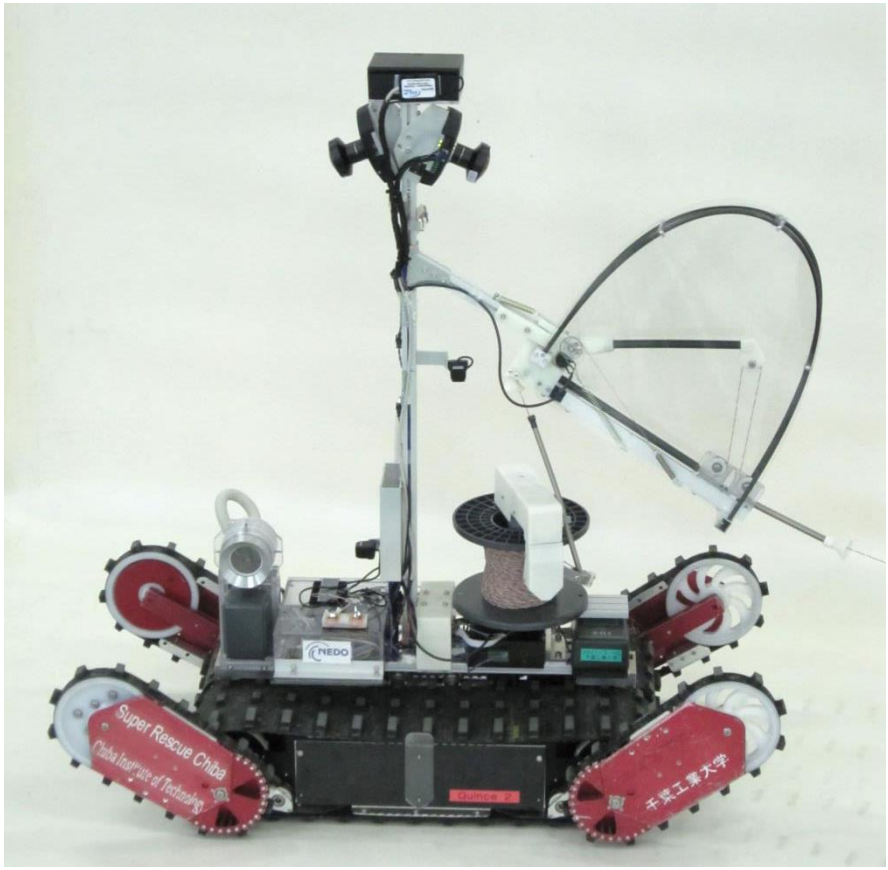
- UTP cable (Fast Ether, PoE)
- Plastic Optical Fiber (Fast Ether)
- Glass Optical Fiber (Fast Ether)
- Coax (Fast Ether?, PoE?)
- Thin Twisted Pair (VDSL)

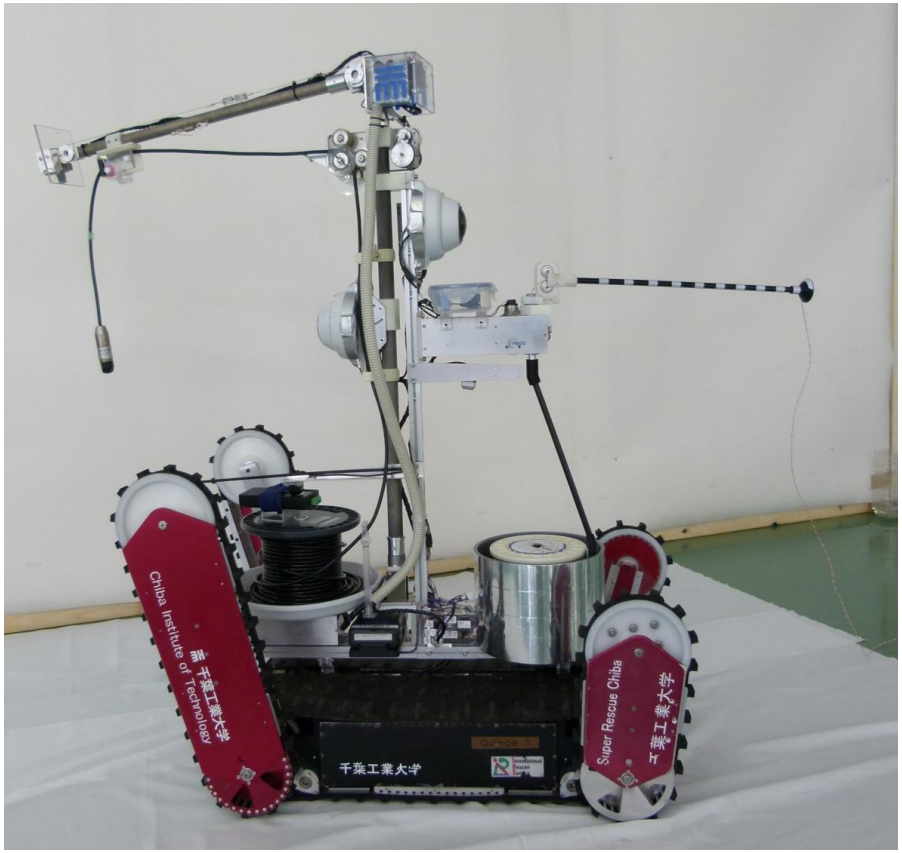


Key Issues

Communication

Wired communication device



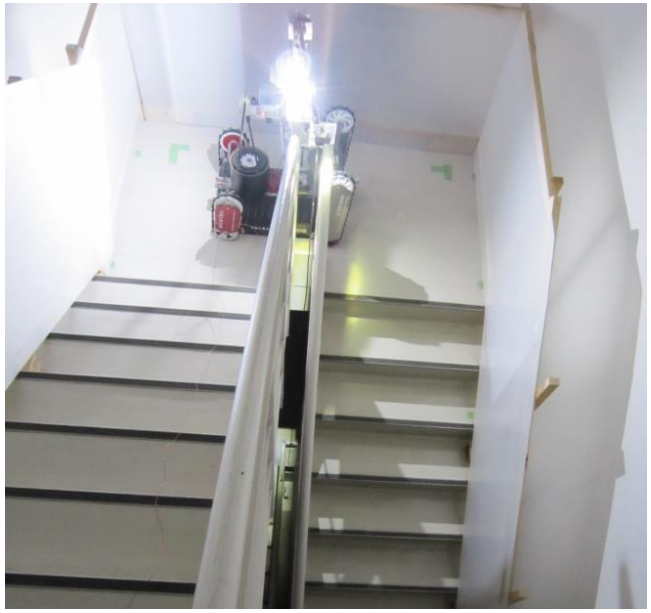


Key Issues

Mobility

Steep, Slippery

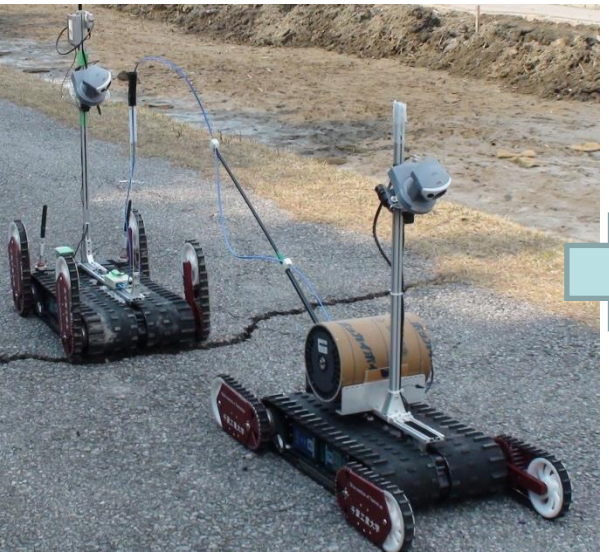
Narrow

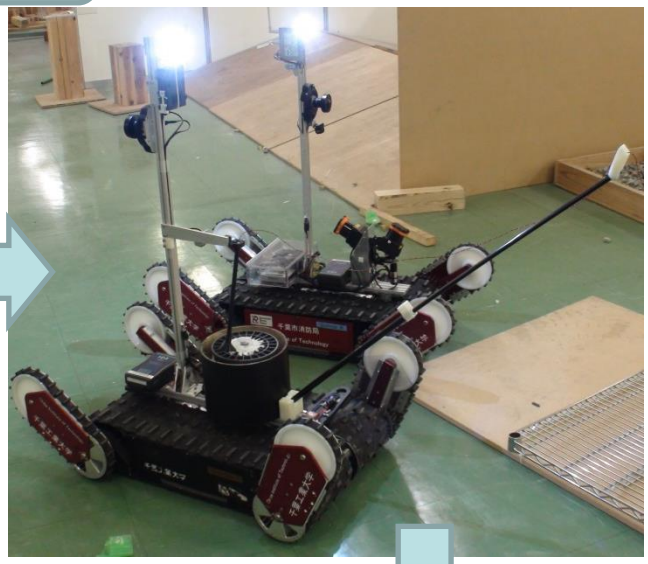


Verified with mock up Environment

Key Issues Adopting to Fukushima

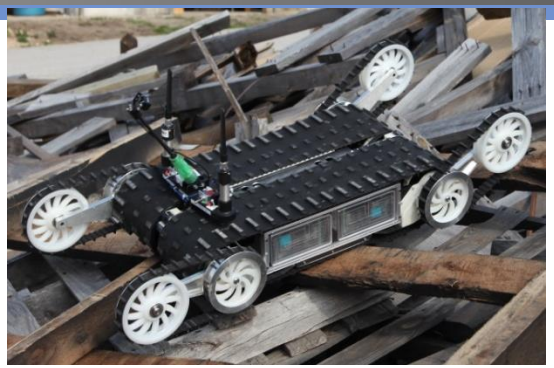
Sensors





Usability

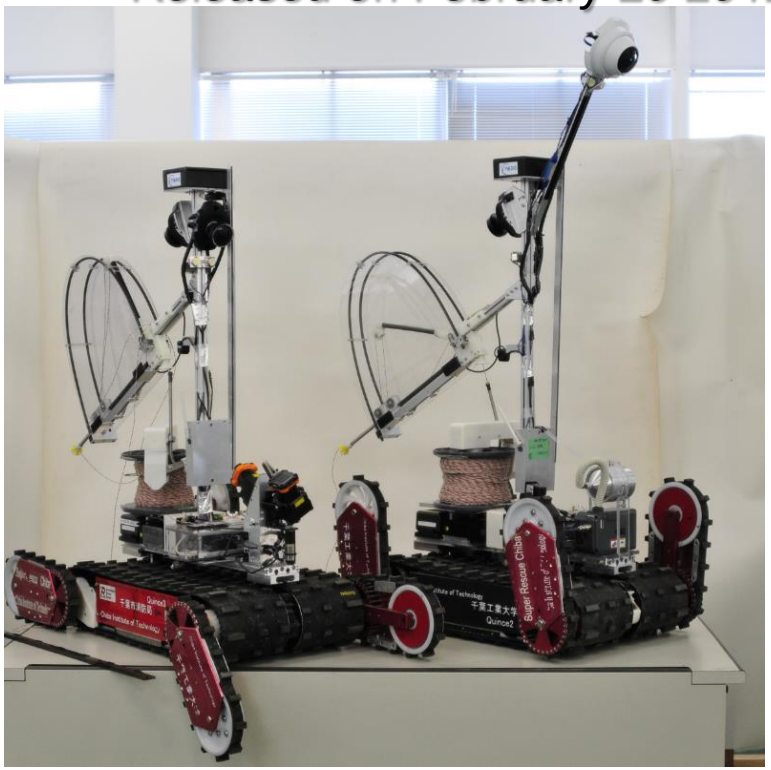
Quince Robots for Fukushima



Quince（May 2011）

Quince 1
Released on June 20 2011

Quince 2, 3
Released on February 20 2012



Activities in Fukushima NPP

	Date	Target
1	2011/ 6/24	Unit 2 1F, B1
2	2011/ 7/ 8	Unit 2 2F, 3F
3	2011/ 7/26	Unit 3 2F
4	2011/ 9/22	Unit 2 1F
5	2011/ 9/24	Unit 3 1F
6	2011/10/20	Unit 2 3F, 5F
7	2012/ 2/27	Unit 2 5F
8	2012/ 3/21	Unit 2 1F
9	2012/ 5/24	Unit 3 1F
10	2012/ 6/13	Unit 2 3F to 5F
11	2012/ 7/ 4	Unit 1 1F
12	2012/11/27	Unit 3 1F
13	2013/4/16	Unit 2 1F

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10	2012/ 6/13	Unit 2 3F to 5
11	2012/ 7/ 4	Unit 1 1F
12	2012/11/27	Unit 3 1F
13	2013/4/16	Unit 2 1F

Lessons learned

- Quince worked well
  - better than we expected
  - as expected for the other people
- Close relationship with the end user was very important
  - 2 people came to our lab and worked together
  - Very quick update cycle was established

Lessons Learned

- Issues
  - We have underestimated the environmental conditions
    - Too narrow, too hot, too bright, slippery, etc.
  - Cables are hard to handle
  - Operation time was limited due to battery capacity

2012/2/27 Unit 2, 5F

Approach 58min, Exit 46min

Surveillance 76min

10:33 Entry

11:20 Arrived to 4F

11:31 Arrived to 5F

12:47 Left 5F

13:33 End

Recent work

- Smaller Robot “Sakura”
  - Width 420 Length 530
  - (Quince: 490 x 700)