

# **Service Robots: Disaster Service Robots: Nuclear Energy Clean-Up**

## **Selected Theme:**

Theme 2: Relation between applications of robots and their performance  
2) Service Use

**Presented By: Group 3, Waialua Robotics Program**

Waialua High & Intermediate School (Waialua, HI)

○ **Jasmin Lacar**

**Student Participants-Research Project:** Maile Andrada, Jennifer Deux, Rhavyn Hirayama, Jasmin Lacar, Jaedyn Malasig, Anthony Miyataki, Aiden Munden, Ala'i Paikai, Toshio Yoshizumi

# Who We Are

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## Waialua Robotics Program (Waialua, Hawaii)

Established in 1999, we are the first FRC program and first robotics-related program in Hawaii. Our focus is to educate students about STEM through robotics and hope that they will continue to use the knowledge they take and use it in their near future.

Waialua, Hawaii is a small rural community known for our diversity due to the agricultural industry that began in the early 1900s. Into the 1990s sugar production decreased causing major producers to move overseas. This left many jobless. However, families from the beginning of the sugar industry remained and many of their generations reside here till this day.



### Glenn Lee

- Robotics Lead Teacher (1999-present) and Coordinator (2003-present)-CTE Industrial Engineering Technology Career Pathway
- STEM Learning Center Coordinator, Career Technical Education Coordinator, former Extended Learning Opportunity (ELO) Project Director, School Technology Cadre and Leadership Team, Fine Arts/PE/AV/CTE dept. head.
- Degree in Electrical Engineering, minor in Math, M.B.A., Teaching Certificate in Secondary Education (Mathematics, Science, and Industrial Engineering & Technology)

# iREX 2017

In attendance of iREX 2017 we were given various topics to present. The topic we decided to present is service robots specializing in disaster areas.

# Email Template

In preparation for our presentation we contacted vendors that will be present at iREX 2017 under the Service Robot Zone. We sent out emails to 86 vendors. We asked if they specified in disaster aiding robots and if they would be present at iREX.

2017年10月6日  
ロボティクスチーム359  
67-160 Farrington Hwy, Waialua, HI 96791

こんにちは、

私たちはハワイのノースショアにあるロボティックチーム359ハワイアンキッズの生徒です。私たちは東京の全国ロボット展に出席しており、貴社のサービスロボット、具体的には災害支援ロボットの仕事についてお問い合わせしています。私たちのチームは現在、サービスロボットの研究を行っており、彼らと協力してきた会社からのインプットを期待していました。なぜあなたの会社が探しているのか、今後サービスロボットがどのように使用されるのか、災害技術が必要なのかなどの情報を求めています。あなたの会社がiREXでサービスロボット技術を展示するかどうかも知りたいです。どんな反応や情報も私どものチームから高く評価されます。

ありがとう、チーム359

October 06, 2017

Robotics Team 359  
67-160 Farrington Hwy, Waialua, HI 96791

Hello,

We are students from the robotics Team 359 The Hawaiian Kids, located on the North Shore of Hawaii. We are attending the national robot exhibition in Tokyo, and are emailing you inquiring about your company's work in service robots, more specifically disaster aiding robots. Our team is currently doing research on service robots, and was hoping on input from a company that has been working with them. We are kindly asking for any information such as why your company is looking into them, how you see service robots being used in the future, or why disaster technology would be needed. We would also like to know if your company will be showcasing service robot technology at the iREX. Any response or information would be greatly appreciated by our team.

Thank you,  
Team 359

# Service Robots

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The two main umbrella topics include industrial and domestic service robots.

## **Industrial:**

- Complete small and repetitive tasks company use
- Agricultural uses(planting and harvesting), organization, factor use, etc.

## **Domestic:**

- Takes place of a human in a non-industrial environment
- "Life Bots" that help us in everyday lives (waitress robots, medical assistant etc.)



# Types of Service Robots

## Industrial

### **Agriculture • Forestry • Fishery • Food**

- Work assist, Automated harvesting, Quality control, Weeding, Food(Wrapping & Packaging), Other

### **Infrastructure • Disaster • Construction**

- Inspection, Maintenance, Search, Particular environment(Nuclear Energy, Electric, Gas, Outer space, Construction), Research and development, UAV(Drone), Other

## Domestic

### **Nursing Care • Welfare • Medical Care**

- Mobile assist, Transferring assist, Excretion assist, Rehabilitation assist, Watch services, Surgery assist, Surgery simulations, Communication, Other

### **Life**

- Security, Reception, Guide, Customer service, Cooking assist, Cleaning, Telepresence, Communication, Entertainment, Logistics, Automated vehicles, UAV(Drone), Other

### **Education**

- Education, Educational materials(Programming, etc.), Generic applications, Publication, Entertainment, Other



# Why are Disaster Service Robots Important?

Every year natural disasters cause fatalities to occur needing:

- Assessment
- Rescue
- Clean Up

These tasks are completed:

- Survey Robots
- Rescue Robots
- Extraction Robots.

# Disaster Aiding Service Robots

Disaster aiding robotics is a branch of service robotics that assists with resolving the many problems in the world. There are many types of disaster aiding robots, but their main purpose is to respond and recover when disaster strikes

## **Nuclear Detection Robot:**

- Robots sent into zones to detect radiation levels so they won't hurt humans
- Engineers in Japan have already developed swimming and flying robots to go into Fukushima to test soil radiation levels

Another example of disaster aiding robot is probably the most well known, natural disaster aiding robots. These are many types of robots that serve different purposes in the event of natural disasters. One example includes a drone that will transport supplies to people in need or "CHIMP" a tank-like robot that'll find missing people through rubble so they can be rescued.







# Nuclear Cleanup Service Robots

In response to nuclear mishaps, service robotics have expanded into nuclear cleanup. With past events, such as the Fukushima Daiichi nuclear disaster, nuclear cleanup service robots have since then been developed to resolve the issue.

## What Exactly Happened?

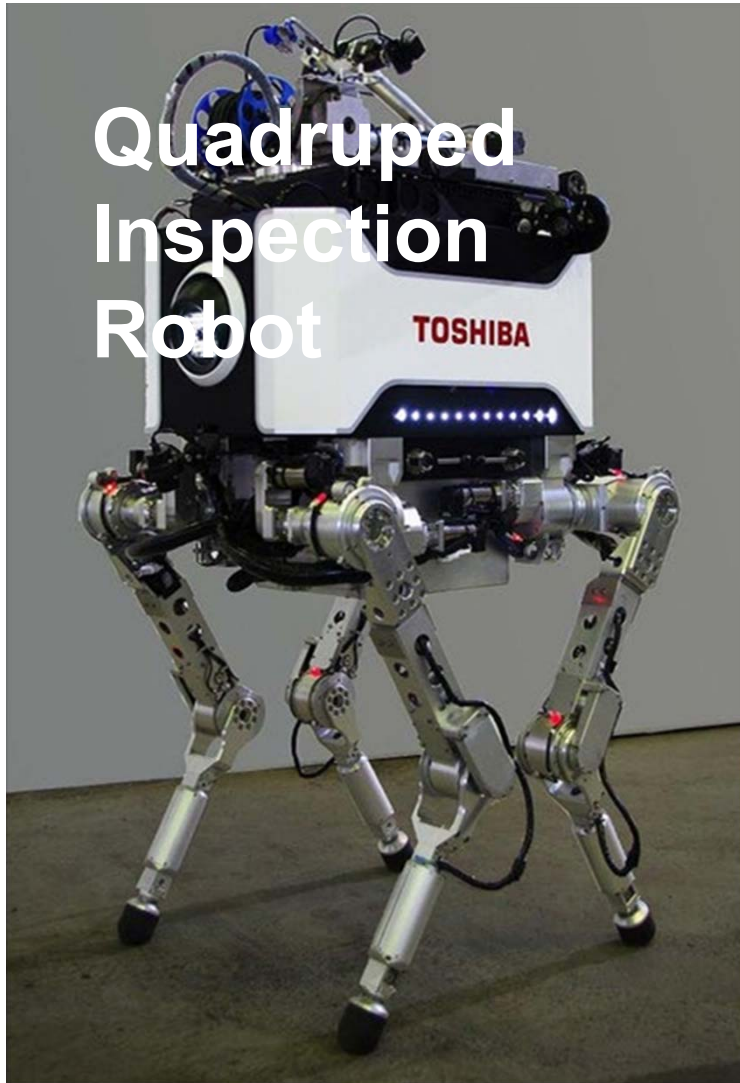
- On March 11, 2011 after a major earthquake, a 15 meter tsunami cut off the power supply and cooling of three Fukushima Daiichi reactors, causing a nuclear accident
- This accident resulted in radiation contamination affecting all surrounding areas
- In response to this specific accident, nuclear disaster robots were then designed to clean up/recover the section and also test the radiation levels without harming anyone

# Current Nuclear Disaster Cleanup Robots

- Modified earthquake rescue robot
  - **Quince**
    - Explores upper floors of Unit 2 of the reactor building
    - Survey droid
    - Caterpillar treads:
      - Able to climb over debris and stairs
    - Includes:
      - Two cameras
      - Dosimeter
      - Power and communications cable

- **Rosemary:**
  - Communication relay
- **Sakura:**
  - Has U.K development systems→produce 3D radiation maps
    - Includes:
      - Radiation meters
      - fisheye camera
      - laser rangefinder

# Quadruped Inspection Robot



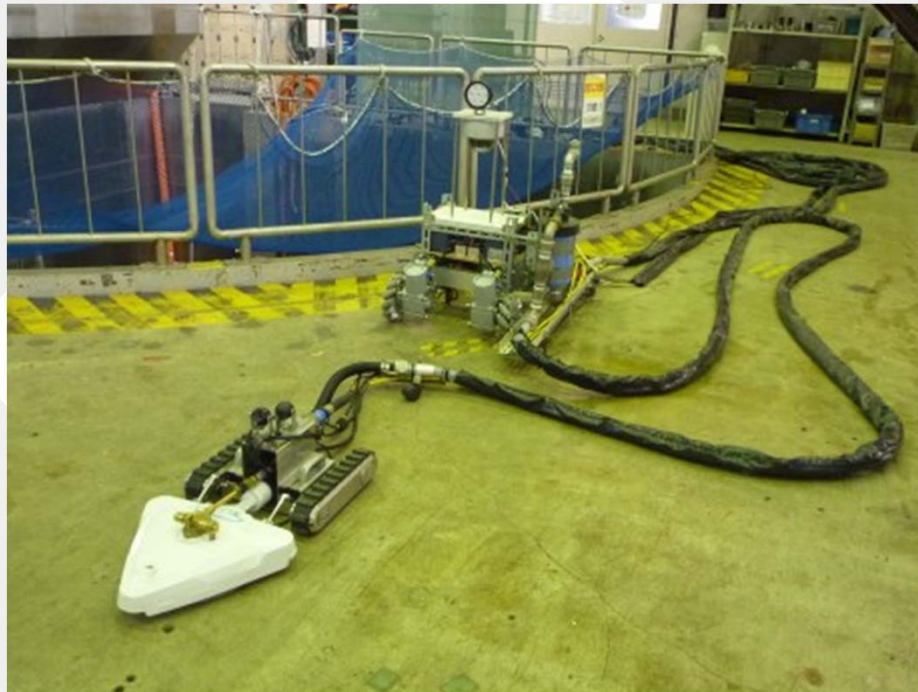
This robot is a four legged inspection robot that goes where humans can't. It avoids low lying obstacles and it's equipped with cameras and radiation dosimeters. It weighs 143 pounds and is three feet by five inches and (106 centimeters) tall and walks up to the speed of one km/h and the battery life lasts up to two hours. This robot was used after the tsunami in Japan because it has radiation shielding and waterproofing.

As a robot with four legs, it easily travels through low and uneven surfaces like stairs and rocky hills. Mainly used as an inspection robot, it is able to detect affected areas and the specific radiation levels

# Raccoon

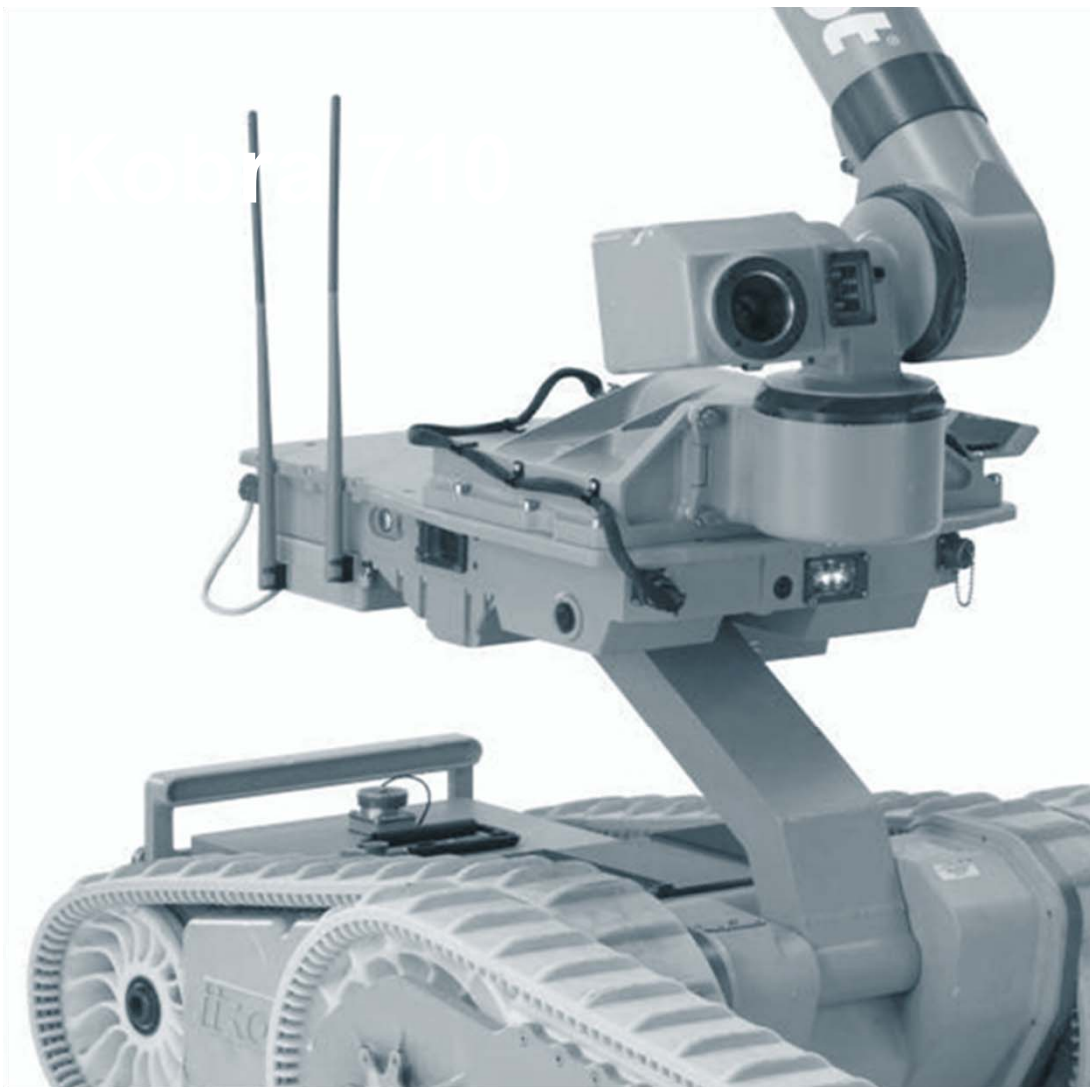
The Raccoon is a vacuum cleaning robot that brings down the amount of radiation in a building. It's controlled by two heavy cables, powered by two mobile relay units, a suction system, and a jet head. This robot has two rotating cameras, moves about 10 meters per minute, and uses a powerful remote controlled washer unit that uses about 13 liters of water per minute at the pressure of 15 MPa. It can survive there harsh conditions because it has water-proofing and a radiation shield.

In the Fukushima nuclear disaster it moved around the floor of the reactor buildings first level, scrubbing and jet washing the concrete surface in attempt to bring down the radiation.



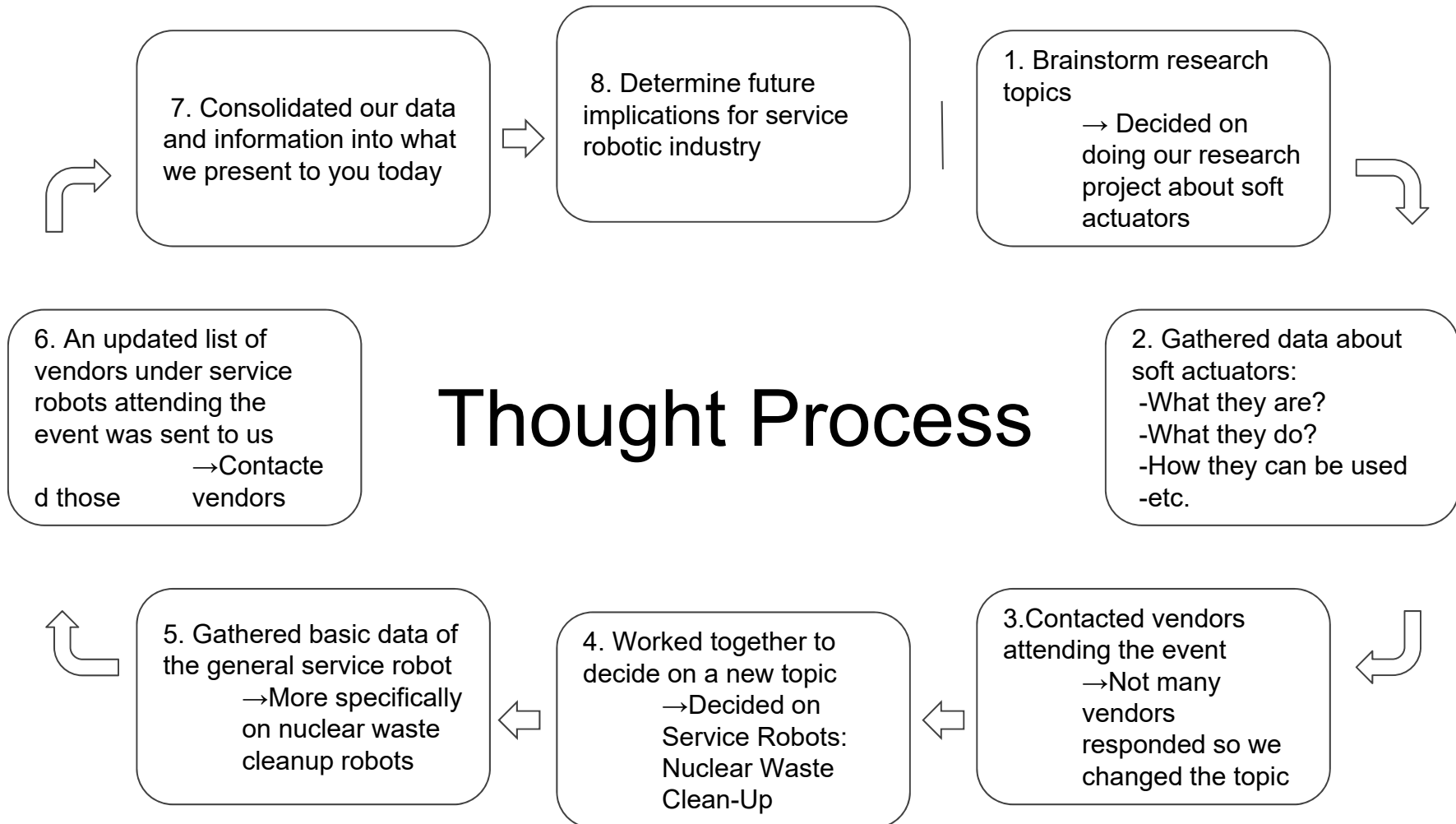
Raccoon was a robot that was designed to help “vacuum” and clean radiation off of the floors after huge amounts of radioactive materials had been released, making it too dangerous for any employee to enter.





- Measuring 35 inches (89 cm) long, 18 inches (46 cm) high (in stowed configuration) and 30.25 inches (77 cm) wide (or 21.25 inches with its stair-climbing flippers removed), the 710 Warrior weighs 347 pounds (157 kg) with battery and flippers installed.
- It can travel at speeds up to 8 mph (12.9 km/h) thanks to its electric motor that packs enough grunt to allow the robot to pull a car.

# Thought Process



# Email Inquiries

After contacting 86 vendors, 22 responded and of those responses, 2 were relevant, HiBot and Mitsubishi. From our inquiry we were able to learn more about the service robots used during the Fukushima incident.

HiBot shared information with us over email that they are currently working on search and rescue systems and they will be demonstrating during this event. Mitsubishi manufactured robots used in the Fukushima Nuclear Disaster clean-up.

Company	Contact?	Respond? (y/n)	Comments
REVAST	Yes		
Robot Revolution Initiative	No	NA	
Robot Services Initiative	No	NA	
ROBOTEC	Yes		
Robotoron	Yes		
The 8th Robot Award	No	NA	
Rozetta	Yes		
RT	Yes	Yes	<a href="https://mail.google.com/mail/u/2/?ik=ymfifnbox1504x516ee7248">https://mail.google.com/mail/u/2/?ik=ymfifnbox1504x516ee7248</a> "If IREX2017, our answer is "no" for our booth. We'll show our educational kits in the exhibition."
Saitama Prefecture	Yes		
Seibu Electric & Machinery	Yes		
Sharp	No	NA	
Shinano Kenshi	Yes		
Shinko Engineering Research	Yes		
SMFL Rental	Yes		
Softbank Robotics	No	NA	
SunFlare	No	NA	
Taiwan Automation Intelligence and Robotics Association	Yes		

Company	Contact?	Respond? (y/n)	Comments
City of Tsukuba Applied Vision Systems -Colog -TOPS Systems	Yes	Yes	
Cloud Robotics	No	NA	
COEX	No	NA	
Demonstration project for the Introduction of robots (Ministry of Economy, Trade and Industry)	No	NA	
dkdesignlab			
DMM.com	Yes	Yes	
GIJINKKOUGEI	No	NA	
HiBot	Yes	Yes	<a href="https://mail.google.com/mail/u/2/?ik=ymfifnbox15ef78a7f96ac951">https://mail.google.com/mail/u/2/?ik=ymfifnbox15ef78a7f96ac951</a> (related)
I-RooBO Network Forum	No	NA	
Ibaraki Prefectural Government -CYBERDYNE -Hitachi Automotive Systems	Yes		
Inner Magnolia Tiny Beetle Technology	No	NA	
INNOECHO_INNOROBO	No	NA	
Innovation-Matrix Japan	No	NA	
Japan System Development	No	NA	
JEPIICO	Yes		

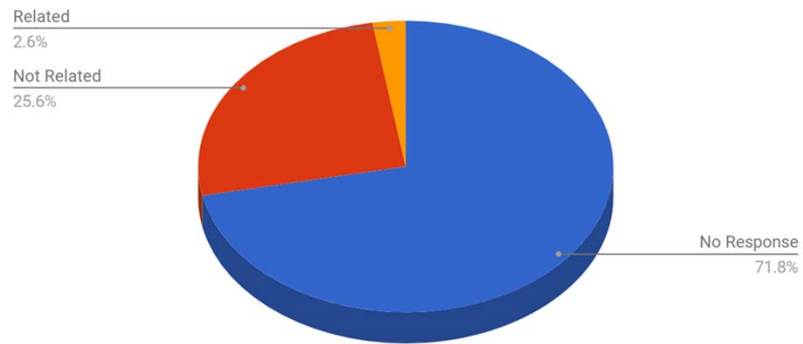
Company	Contact?	Respond? (y/n)	Comments
Aichi Robot Industry Cluster Council -Aichi Center for Industry and Science -technology Industrial Research Center -Matsuda ehiru -Nagoya Institute of Technology Umezaki -Taguchi Laboratory -Shanichi Construction Materials	No	NA	
AMARYLLO INTERNATIONAL	No	NA	
AMED -AIST -CCS-NET -IDEAQUEST -KIND TRUSTERY KOGYO -Kyoko E. estoric -MORISAWA SAFETY -RayTron -RTWORKS -Sarys Homes	Yes	Yes	<a href="https://mail.google.com/mail/u/2/?ik=ymfifnbox15ef78a7f96ac951">https://mail.google.com/mail/u/2/?ik=ymfifnbox15ef78a7f96ac951</a> (unrelated)
Artec	No	NA	
ASAHI KASEI FIBERS	No	NA	
ASAHIDENSHI -enRoute -MITSUBISHI	No	NA	
ATOX	Yes		
BNL(Japan)	No	NA	
British Embassy Tokyo -Bunshun -HIRAGA GENNAI MEMORIAL -MUSEUM -OC Robotics -Science & Technology Facilities Council, -RAL Space -Shadow Robot -Thames	No	NA	

Company	Contact?	Respond? (y/n)	Comments
THK	NA	NA	
Tokyo Metropolitan Industrial Technology Research Institute	No	NA	
Tokyo Sensor	No	NA	
Tokyo University of Science -Asahi sun clean -ANDROPS -KOKUCHISEISAKUSHO	No	NA	
TOMY	No	NA	
TOYOHASHI CITY	No	NA	
TOYOTA MOTOR CORPORATION	No	NA	
Tsukuba Center	Yes	No	
Tsukuba Global Innovation Promotion Agency	No	NA	
UBTECH ROBOTICS	No	NA	
UNIROBOT	No	NA	
Universal Future Society -Promotion -Committee	No	NA	
YAMAGUCHI PREFECTURE	No	NA	
Robot Business Promotion Council -Cuhai House Industry -DOJILLI Research/Development -HiBot -HOKUYO AUTOMATIC -IIT -IIT SYSTEM -Mitsubishi	Yes (HiBot)	Yes (HiBot)	<a href="https://mail.google.com/mail/u/2/?ik=ymfifnbox15ef78a7f96ac951">https://mail.google.com/mail/u/2/?ik=ymfifnbox15ef78a7f96ac951</a> (related)

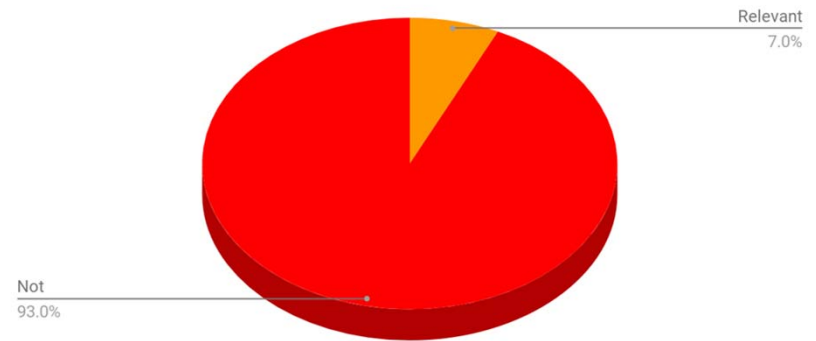


# Results of our research at the exhibition

Number of 2016 Vendors Contacted: 78



Number of 2017 Vendors Contacted: 86







# Future Research and Development

- Components
  - Consideration of various components can be made to substitute, improve, and even replace “key” components. Such as motors and various items.
- Communication
  - Improvement of communication can be made
  - Wireless communication has the limitation of range connection resulting in use of cable connection with even more limitations, more improvement of range can be more of a priority
- Feasibility
  - The convenience of how much more easier and faster the development and construction of disaster service robots is a big future topic



# Future of Service Robots



**Q: Does your company ever plan to extend into the service robot industry besides the Fukushima Daiichi Nuclear Disaster?**

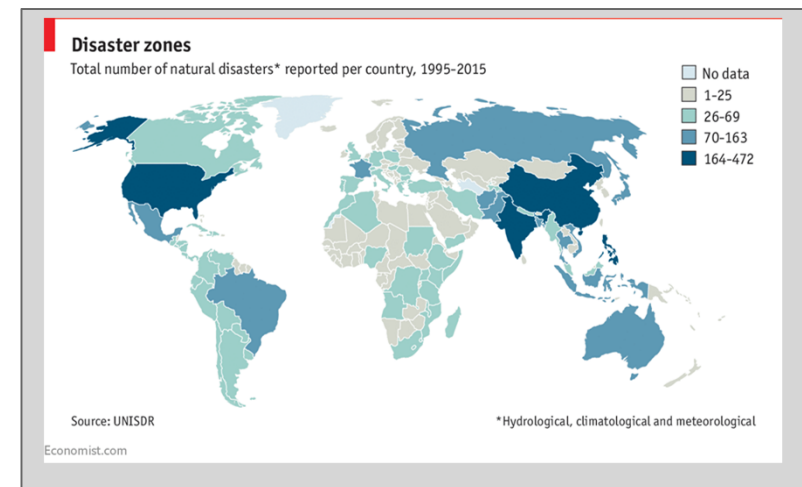
A: Japan Atomic Energy plans to expand upon their already developed disaster robot technology through continuing research on the field and similar fields.

**Q: Because of the number of various limitations (money, time, etc.), do you have plans to address any of your own concerns?**

A: The problem for Japan Atomic Energy, was finding a balance between the robot's weight and functionality

**Q: Being in a situation with a disaster that is assisted by service robots, will you ever go around the world and help with disasters other than nuclear clean-up?**

A: Their mission is to research breakthrough ideas to benefit the world through the use of technology. They plan on using the next 30 years to gather data and test products to advance the field.



# Materials

- “What do companies use to create these robots and why?”

## Japan Atomic Energy:

- Use **thick layers of lead** to prevent radiation related damage to robots that test levels of radiation

## Mitsubishi:

- Use **aluminium and steel** to ensure robot's stability, but still conserving money by using those metals



In general, we found that the companies show preference to using lighter materials and metals. This makes the robot move more quickly and freely, in response to the necessary stimulant.

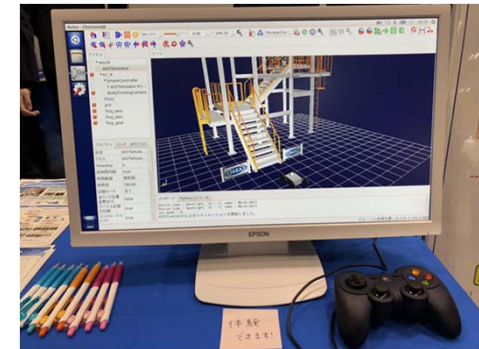
# Controlling

- “How do companies control these robots, and why?”

## Japan Atomic Energy:

- **Human Controlled**

When talking to the people at JAE, they felt very strongly that human controlled robots were the most effective. “Humans will know the environment, they can perform the task without error.”



In general, we found that most companies (in the service robotics field) used human controlled robots. The main reason was they found it to be more precise than a programmed, autonomous robot.

# Durability

- “How do companies protect their robot from radiation damage?”

## Mitsubishi:

- Installed radiation sensors in robot to prevent it from entering areas that are highly concentrated with radiation.



In general, we found that the most effective way of protecting a robot from radiation is thick layers of lead. But, this leads to the robot exceeding weight requirements, and the need for a stronger (more expensive) motor and computer to control it.

# Improvements

- Make lighter (improve speed and reaction time)
- Increase power and longevity
- Improve/develop prototype
- “Cable more resistant from disconnection”

## **In Conclusion...**

- Natural disasters are a recurring event.
  - Service robots aid and minimize direct human involvement.
  - Service robots supplement human limitations.
  - Robots survey, rescue and extract in disasters.
  - Robots replace physical human contact with a virtual presence.
- 
-

**Mahalo!**

**Team 359**

**Hawaiian**

**Kids**

**Waialua, HI**

