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INTAKE -36

SYNDICATE GROUP – P

<u>ROBOTICS ON DISASTER SITUATION</u>

DS COMMENT

DECLARATION

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The aim of this script is to study, analyze and discuss the importance and application of robotics in disaster situation to save lives.

CONTENTS

ABSTRACT

1. Natural and man-made disasters are serious problems in every country. Robotics, intelligent machines, systems and devices are highly expected as effective solutions in the future. Special project on development of advanced robots for disaster response (DDT Project) is focused on R&D of robotic solutions for reconnaissance of victim bodies, structural damage and environmental conditions to assist rescue parties in large-scale urban earthquake disasters. This paper introduces an overview of this project and the problem domain of earthquake disasters, search-and-rescue processes and rubble pile characteristics.

2. From the first deployment to the 9/11 World Trade Center collapse, rescue robots have been used in at least 28 disasters in six countries. All types of robots (land, sea and air) and for all stages of a disaster have been used (prevention, response, and recovery). This chapter will cover the basic characteristics of disasters and their effect on robotic design and describe the robots that have been used to date in disasters, with a specific emphasis on Fukushima Daiichi, which provides a rich professional.

3. The rescue of victims is the first priority when such disasters happen.With the advancement of robotics in many areas, rescue robots are currently a research subject along with human search and rescue teams.Robots are used for a range of purposes in rescue operations, from mapping the disaster area to supplying first responders with critical information to assisting search and rescue personnel by carrying the necessary equipment and so on.The use of salvage robots for a rescue robot is another potential use.

4. This paper introduces an overview of this project and the problem domain of earthquake disasters, search-and-rescue processes and rubble pile characteristics. chapter concludes with a discussion of the fundamental problems and open issues facing rescue robotics, and their evolution from an interesting idea to widespread adoption.

CHAPTER 01

INTRODUCTION

WHAT IS ROBOTICS

5. Robots are the design, development and use of machines (robots) for the regular performance of human tasks. In industries such as vehicles, robots are commonly used to perform basic, repetitive tasks and in industries where work is needed in an environment that is dangerous to humans. Artificial intelligence is used in many areas of robotics; robots may have abilities that correspond to human senses, such as awareness of sight, touch and temperature. Some are also capable of simple decision-making, and current research in robotics focuses on developing robots that are self-sufficient in a disorganized environment to allow mobility and decision-making. Today's manufacturing robots don't look like humans, the robot is called android in human form.

WHAT IS A DISASTER SITUATION

6. A catastrophe is a sudden catastrophic occurrence that disrupts a community or society's functioning and causes human, material, economic or environmental harm that exceeds the capacity of society or society to cope with the use of its own resources. They may have their causes, while disasters are always natural.

SCOPE OF STUDY

7. The essence of this study is to primarily study the Robotics on Disaster Situations.

STATEMENT OF THE PROBLEM

8. The major challenges associated with disaster response planning include:

a. The failure in strictly applying the law
b. The lack of public and staff education about disaster risks
c. Poor urban planning
d. Unstable security situation
e. Citizen intervention
f. Endowment of equipment
g. Tools and infrastructure and lack of financial resources.

CHALLENGERS IN ROBOTICS

a. Power and energy
b. Robot Swarms
c. AI for Robotics
d. Brain Computer Interfaces
e. Robot Ethics and Security
f. Social Interaction

APPLICATION OF ROBOTICS IN DISASTER SITUATION TO SAVE LIVES

9. Robots are now used to find buried accident victims, defuse bombs and uninstall decommissioned nuclear power plants as remote-controlled tools. The future objective is to rescue robots that to a certain amount, can act autonomously and perform more complex tasks. Researchers would have to equip them with artificial intelligence to accomplish that.

CHAPTER 02

BACKGROUND

11. Events such as earthquakes, eruptions of volcanoes, tsunamis, Storms and flooding, ruining lives and disrupting economies around the world Pandemics have the ability to bring death and death to the world. Suffering on an unparalleled scale; although it is likely for climate change to Rising the severity of health and natural disasters. In 2010, disasters affected 263 million people—110 million people. Millions higher than in 2004, the year of the tsunami in Asia. It is possible that more individuals, particularly in developed countries, In the coming years, humanitarian emergencies will impact them. Uh, decades. For this, there are many explanations, including: rapid population growth, especially in areas vulnerable to disasters; Continued, largely unplanned, mass urbanization And insecure Climate change and its effect on sea levels, global precipitation, rainfall**.**

12. Society faces worldwide problems impacting our wellbeing, Wellbeing and lifestyle. This whitepaper discusses the potential for robots and self-contained devices, to: Help us deal with natural disasters and catastrophes Boost our vital systems 'resilience On a variety of spatial and temporal scales, disasters work. Any can occur abruptly, be localized, and involve a quick reply. However such catastrophes, such as sea level rise or sea level rise, There could be very long-term shifts in weather conditions in both Inception and effects. The avoidance of disasters and the forecast of Shift through large regions and over long periods of time is a significant improvement Part of RAS analysis problems for extreme conditions.

13. Industrial civilization is either reluctant or incapable of devoting enough to it.Tools for these problems. For eg, £ 13bn in 2015Globally, the response to humanitarian relief has been spent on Disaster aid, though, is just a third of the world's number. For e.g., he spends on yogurt and is dwarfed by the £ 2 unit was invested on guns. There is also a pressing need to Ensuring the production of more cost-effective innovations To strive globally for disaster relief and reconstruction. It is clear that Autonomous Systems and Robotics will The role of future disaster management plays an increasingly important role.

14. This revolution is still happening and there are aerial robots Saving lives now. At the very least, according to a recent article, In 18 cases, 59 lives were directly saved by drone programs. Various accidents in 20161. These consisted of storms, explosions, Snow, rising seas and occurrences with other emergencies. Vision for the protection of the planet and vital infrastructure Monitoring is part of a network of related observational networks, Properties, which penetrate deep into the most inhospitable Disaster Management and Community Environments With durability. The EPSRC-RAS (Engineering) in recent years has Except Robots and Automated Systems in Physical Sciences)In terms of growth, the network has made considerable strides Activating Channels.

CHAPTER 03

MAN MADE DISASTERS AND INFLUENCE TO HUMAN

15. Catastrophes are heartbreaking occasions that quite often end in the death toll and demolition of property. They happen arbitrarily and unexpectedly, and have been happening since before recorded time well in any event catastrophic events like quakes, floods, avalanches, typhoons and twisters. It was a few hundred years prior with the innovation of industry that individuals achieved unnatural man-made fiascos.

16. Cataclysmic events are directed by regular powers that individuals have practically zero impact over. These are the fiascos individuals figure out how to get ready for and endure on the grounds that almost no should be possible to forestall them. Man-made fiascos are hard to anticipate, anyway they are preventable. With a little cautiousness, they shouldn't happen in any case. Occasions, for example, gas spills, oil slicks, atomic emergencies, and mechanical flames come to pass through human mistake and convey grave results. Despite the fact that the world has seen numerous catastrophic events over the long run, man-made debacles keep on developing, with similarly appalling outcomes.

GAS LEAKS

17. Gas releases will in general be probably the most hazardous catastrophes, since they appear to be harmless until it's past the point of no return. Gas can straightforwardly and by implication poison individuals and the climate spreading quickly, being imperceptibly, possibly lighting, causing passing. Lamentably, gas spills are preventable man-made debacles that originate from the world's extending dependence on gas. These debacles have brought about an unfortunate measure of passings.

18. The most genuine gas spill happened in Bhopal, India in 1984. Known as the Bhopal Gas Tragedy, it started with the spillage of methyl isocyanide (MIC), a dry gas utilized in pesticides, from the Union Carbide of India Ltd. The gas framed a dangerous cloud causing serious body aggravation, hacking, lung growing, dying, and even passing from direct thought inward breath. It murdered approximately 5,000 individuals, influenced 50,000 additional individuals, and left in any event 1,000 visually impaired.

19. Another gas spill happened as of late in 2015, at the Aliso Canyon Facility close to Los Angeles. Guaranteed as the biggest single gas release, the office delivered 5 billion cubic feet of methane into the air over a 112-day time span. While there were no quick passings from this abnormal break, it delivered a concerning measure of methane, identical to a year of warmth catching discharges from 600,000 vehicles.

OIL SLICKS

20. Oil slicks are the absolute most recognizable man-made catastrophes, annihilating to individuals, the climate, creatures and worldwide economics.

21. 2010 saw the most exceedingly terrible and biggest oil slick the Deepwater Horizon Oil Spill in the Gulf of Mexico. An abrupt blast on a BP oilrig cracked a line, yet left the well unregulated. The blast executed 11 specialists and harmed 17 others. The submerged all around released 40,000 to 162,000 barrels of oil a day into the Gulf until it was covered an entire 89 days after the fact.

22. A catastrophe of this extent makes it hard to gauge the measure of ecological harm, yet it very well may be thought to be very broad. Inlet fishing has not bounced back, a lot of oil are as yet present, the general conditions have been gagged to death, and in any event 3,500 volunteers experienced liver and kidney harm delayed contact with the oil. Other than the Deepwater spill, there have been 44 other oil slicks worldwide since 1969.

ATOMIC MELTDOWN

22. While atomic energy is perfect and feasible, the outcomes of an emergency can be pulverizing and wide coming to. One of the most well known atomic emergencies happened in Chernobyl, Ukraine in 1986. One of the reactors in the force plant detonated, bringing about more aftermath than the Hiroshima and Nagasaki nuclear bombs consolidated. While 350,000 individuals were emptied from the encompassing region, almost 500,000 specialists toiled to end the emergency, 31 of which passed on during the endeavor.

23. The genuine obliteration is credited to the radiation introduction, which has executed an expected 4,000 individuals and disfigured endless others. America had its own emergency in 1979 known as the 3 Mile Island Nuclear Explosion. The plant encountered a fractional emergency, yet just a limited quantity of radiation was delivered. This was because of the accomplishments of a working control framework, bringing about no prompt results. In any case, over the long run there were passings and birth surrenders in animals from the region.

MECHANICAL FIRES

24. Flames might be common or man-made, contingent upon what initially caused the calamity. Lightning may cause a characteristic fire, however spilled gas or flawed mechanical hardware is viewed as a man-made reason.

25. For instance, in 1944 spilled gas from a Cleveland gas organization discovered its way into a sewer, where it lighted. The blast blew sewer vents into the air and lighted pipes of fire, which set homes ablaze. The calamity finished with 130 dead and a lot more destitute.

26. In 1991, a food chicken preparing plant in North Carolina saw 25 passings because of a fire brought about by a broken pressure driven piece. This fire was especially enlightening as the laborers would have endure were it not for fire entryways that were bolted. The plant had worked for a very long time without submitting to a wellbeing investigation.

27. It is hard to accuse a catastrophic event for anybody since it is an 'demonstration of God,' however disgraceful security and anticipation measures are no reason for the death toll in man-made debacles. Wellbeing is kept up through hardware the executives, operational arranging, steady arrangement and point by point counteraction. Sadly, man-caused catastrophes to have a lot more causes now than any other time. Luckily, there are individuals who submit their lives and vocations to help other people when calamities happen, man-made and characteristic the same.

CHAPTER 04

NATURAL DISASTERS AND INFLUENCE TO HUMANS

28. Disasters can take several different types, and they can vary in length from an hourly disturbanceto days or weeks of sustained devastation.

29. Are disasters caused by people or by nature? A disaster takes place when the following three conditions occur at the same time: When people live in hazardous places like, for example, close to an active volcano, on unstable slopes where landslides are likely to happen, or close to rivers which could flood.

30. When a hazardous phenomenon occurs, be it natural or human-made. When the phenomenon also causes a lot of damage, especially where no preventive measures have been taken. Natural phenomena can sometimes strike very hard and cause disasters if preventive measures have not been taken or if some human activities have harmed the natural environment or upset the balance of the ecosystem.

31. For instance, too much water that the soil is unable to absorb can cause floods, while too little water in some regions can lead to drought. But people can make the situation worse, for example when trees are chopped down and no new ones are planted.

32. This makes the soil very dry and dusty, which can lead to erosion. When the rains come, there are not enough roots and vegetation to bind the soil together, and a landslide can occur. Most wildfires are caused directly or indirectly by people. Farmers, for example, sometimes burn their fields to get rid of weeds before planting, and the fire can get out of control. Sometimes people are careless with cigarettes or forget to put out bonfires when they go camping.

33. A little spark is sometimes all it takes to start a fire. If we destroy parts of nature such as coral reefs, forests, or fragile mountain plants, we are destroying the natural barriers that protect us from tsunamis, drought, landslides, floods and other hazards.

34. Natural disasters are large-scale geological or meteorological events that have the potential to cause loss of life or property. Below is a list of the various types of natural disasters.

GEOLOGICAL DISASTERS

a. Avalanches and landslides
b. Earthquakes
c. Sinkholes
d. Volcanic eruptions

HYDROLOGICAL DISASTERS

a. Floods
b. Tsunami

METEOROLOGICAL DISASTERS

a. Tropical cyclone
b. Blizzards
c. Hailstorms
d. Ice storms
e. Cold waves
f. Heat waves
g. Droughts
h. Thunderstorms

Space disasters

a. Impact events and airburst
b. Solar flare

35. The UN defines a natural disaster as the results of events caused by natural disasters that overwhelm local response capability and have a significant impact on the social and economic growth of a country.The effect of natural disasters should be minimized by countries with high levels of human development in terms of the overall number of people killed, affected and harmed.

36. There are two additional aspects of natural disasters that need to be explored before engaging in discussion of human rights and natural disasters.First how 'natural' are 'natural catastrophes'? The distinction between natural disasters such as floods and manmade disasters such as an oil spill or chemical accident is often made. But the effects of natural disasters are also greater because of human presence.

37. A second aspect of natural disasters concerns the speed at which they occur. A rapid-onset disaster includes earthquakes, flooding, hurricanes, cyclones, etc. Slow-onset disasters, particularly droughts, develop over a period of time. This gives more time for precautions to be undertaken and for governments and the international community to mitigate the effects of a change in climate.

THE HUMAN IMPACT OF NATURAL DISASTERS

38. **Displaced Populations**. One of the most immediate effects of natural disasters is population displacement. When countries are ravaged by earthquakes or other powerful forces of nature, many people have to abandon their homes and seek shelter in other regions. A large influx of refugees can disrupt accessibility of health care and education, as well as food supplies and clean water.

39. **Health Risks**. Aside from the obvious immediate danger that natural disasters present, the secondary effects can be just as damaging. Severe flooding can result in stagnant water that allows breeding of waterborne bacteria and malaria-carrying mosquitos. Without emergency relief from international aid organizations and others, death tolls can rise even after the immediate danger has passed.

40. **Food Scarcity**. After natural disasters, food often becomes scarce. Thousands of people around the world go hungry as a result of destroyed crops and loss of agricultural supplies, whether it happens suddenly in a storm or gradually in a drought. As a result, food prices rise, reducing families' purchasing power and increasing the risk of severe malnutrition or worse. The impacts of hunger following an earthquake, typhoon or hurricane can be tremendous, causing lifelong damage to children's development.

41. **Emotional Aftershocks**. Natural disasters can be particularly traumatic for young children. Confronted with scenes of destruction and the deaths of friends and loved ones, many children develop post-traumatic stress disorder (PTSD), a serious psychological condition resulting from extreme trauma. Left untreated, children suffering from PTSD can be prone to lasting psychological damage and emotional distress.

42. We can't stop natural phenomena from happening. But we can make them less damaging if we understand better why they happen, and what we can do to prevent or mitigate them. Since people are partly responsible for disasters happening, we have to change what we are doing wrong, in order to avoid or reduce the impact of natural phenomena.

43. Every community must get to know its own features and surroundings: the natural environment as well as environment built by human beings. This is the only way for a community to manage the hazards that surround it and to reduce its own vulnerability to these hazards.

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CHAPTER 05

ROBOT CONCEPT AND ARTIFICAL INTELLIGENCE

39. The principal thing to explain is that mechanical technology and man-made brainpower are not very similar things by any stretch of the imagination. Truth be told, the two fields are on the whole separate.Robotics is a part of innovation that manages actual robots. Robots are programmable machines that are typically ready to do a progression of activities self-governingly, or semi-self-rulingly.

40. As I would see it, there are three significant elements which establish a robot: Robots interface with the actual world through sensors and actuators. Robots are programmable. Robots are typically self-sufficient or semi-independent.

41. I state that robots are "typically" self-sufficient in light of the fact that a few robots aren't. Telerobots, for instance, are completely constrained by a human administrator however telerobotics is as yet classed as a part of advanced mechanics. This is one model where the meaning of mechanical technology isn't clear.

42. It is shockingly hard to get specialists to concede to precisely what establishes a "robot." Some individuals state that a robot must have the option to "think" and decide. In any case, there is no standard meaning of "robot thinking." Requiring a robot to "think" recommends that it has some degree of computerized reasoning however the numerous non-clever robots that exist show that reasoning can't be a prerequisite for a robot.

43. Anyway you decide to characterize a robot, mechanical technology includes planning, building and programming actual robots which can associate with the actual world. Just a little piece of mechanical technology includes man-made brainpower.

ILLUSTRATION OF A ROBOT: BASIC COBOT

44. A straightforward collective robot (cobot) is an ideal illustration of a non-wise robot. For instance, you can undoubtedly program a cobot to get an article and spot it somewhere else. The cobot will at that point proceed to pick and place protests in the very same manner until you turn it off. This is a self-ruling capacity in light of the fact that the robot doesn't need any human contribution after it has been modified. The errand doesn't need any insight on the grounds that the cobot will never change what it is doing.

45. Most modern robots are non-savvy. Man-made reasoning (AI) is a part of software engineering. It includes creating PC projects to finish assignments that would somehow or another require human insight. Computer based intelligence calculations can handle learning, observation, critical thinking, language-understanding or potentially coherent thinking.

46. Artificial intelligence is utilized from numerous points of view inside the advanced world. For instance, AI calculations are utilized in Google look, Amazon's suggestion motor, and GPS course locaters. Most AI programs are not used to control robots.

47. In any event, when AI is utilized to control robots, the AI calculations are just essential for the bigger mechanical framework, which additionally incorporates sensors, actuators, and non-AI programming.

48. Regularly yet not generally AI includes some degree of AI, where a calculation is "prepared" to react to a specific contribution to a specific path by utilizing known information sources and yields. We talk about AI in our article Robot Vision versus Computer Vision: What's the Difference? The key angle that separates AI from more customary writing computer programs is "insight." Non-AI programs just complete a characterized arrangement of directions. Artificial intelligence programs imitate some degree of human knowledge.

ILLUSTRATION OF AN UNADULTERATED AI: ALPHAGO

49. One of the most widely recognized instances of unadulterated AI can be found in games. The exemplary illustration of this is chess, where the AI Deep Blue beat title holder, Gary Kasparov, in 1997.

50. A later model is AlphaGo, an AI which beat Lee Sedol the title holder Go player, in 2016. There were no mechanical components to AlphaGo. The playing pieces were moved by a human who viewed the robot's proceeds onward a screen.

51. Misleadingly astute robots are the scaffold among advanced mechanics and AI. These are robots that are constrained by AI programs. Most robots are not misleadingly astute. Up until as of late, all modern robots must be customized to complete a dreary arrangement of developments which, as we have talked about, don't need man-made reasoning. Nonetheless, non-keen robots are very restricted in their usefulness.

52. Man-made intelligence calculations are important when you need to permit the robot to perform more perplexing errands. A warehousing robot may utilize a way discovering calculation to explore around the distribution center. A robot may utilize self-ruling route to get back when it is going to run out of battery. A self-driving vehicle may utilize a blend of AI calculations to recognize and evade expected risks out and about. These are for the most part instances of misleadingly canny robots.

MODEL: ARTIFICIALLY KEEN COBOT

53. You could expand the abilities of a collective robot by utilizing AI. Envision you needed to add a camera to your cobot. Robot vision goes under the classification of "observation" and as a rule requires AI calculations.

54. State that you needed the cobot to distinguish the item it was getting and place it in an alternate area relying upon the kind of article. This would include preparing a particular vision program to perceive the various kinds of articles. One approach to do this is by utilizing an AI calculation called Template Matching, which we talk about in our article How Template Matching Works in Robot Vision.

55. All in all, most misleadingly smart robots just use AI in one specific part of their activity. In our model, AI is just utilized in item location. The robot's developments are not generally constrained by AI (however the yield of the article indicator impacts its developments). As should be obvious, mechanical technology and man-made consciousness are truly two separate things.

56. Mechanical technology includes building robots physical while AI includes programming insight. Notwithstanding, there is one territory where everything has somewhat confounding since I previously composed this article: programming robots. The expression "programming robot" alludes to a kind of PC program which independently works to finish a virtual errand. Models include:

57. Web index "bots" otherwise known as "web crawlers." These wander the web, filtering sites and arranging them for search. Mechanical Process Automation (RPA) These have to some degree commandeered "robot" in the previous few years, as I clarified in this article.

CHATBOTS

58. These are the projects that spring up on sites converse with you with a bunch of pre-composed reactions. Programming bots are not actual robots they just exist inside a PC. Along these lines, they are not genuine robots.

59. Some serious programming robots may even incorporate AI calculations. Nonetheless, programming robots are not piece of advanced mechanics.

CHAPTER 06

ROBOTS RESPONDING IN EMERGENCY SITUATIONS

60. Recent dramatic incidents, such as the earthquakes in Nepal and Tohoku, the Haiyan typhoon or the many floods in Europe, have shown that it is difficult for local civil authorities and emergency services to handle emergencies adequately. The implication is that these crises lead to a massive disturbance of local society as a whole. These crises, in addition to the loss of human life, often have financial implications that are often highly difficult for the affected countries to resolve.

61. In the case of major crises, the search for human survivors at the crash scene is a primary activity of the fire and rescue services. This is a complex and dangerous job that leads too often to the loss of life among the managers of the human crisis themselves. The deployment of unmanned search and rescue (SAR) systems will provide a valuable tool for saving human lives and speeding up the process of search and rescue.

62. More and more robotic tools, in reality, are now leaving the safe laboratory environment and are being deployed and incorporated into citizens' daily lives. The automated manufacturing plants in industry, but also the widespread use of consumer drones and the emergence of autonomous cars in public space, are notable examples. These robotic tools can also play a valuable role in the field of search and rescue.

63. This does not assume, of course, that the implementation of robotic tools is straightforward in the search and rescue world. On the contrary, the context of search and rescue is extremely unfriendly to technology, as comprehensive solutions are needed that can be implemented extremely quickly. As suggested by human users of these devices, Chapter 2 of the book will include a more in-depth analysis of the criteria for search and rescue robotics. Indeed, one significant factor must not be overlooked:

64. As mentioned before, robotic search and rescue tools are there to support human rescue personnel. One of their key strong points is that they will improve the situational awareness of the rescue workers by giving them a clearer and higher quality perspective on the essence of the crisis. Indeed by looking at disaster scenes from a point of view that is almost impossible or impractical or rather unsafe to obtain by humans, robotic tools are able to provide better insights.

65. Video cameras, thermal cameras, 2D and 3D laser range detectors, chemical, biological and radiological pollution measurement sensors, enabling accurate and fast cartography. These robotic assets, undisturbed by cloud cover, are therefore becoming a very good complementary instrument for space-based remote sensing, which remains important for wide areas to be covered. The incorporation of these advanced sensors on autonomous robots for search and rescue opens up the possibility of damage assessment.

66. As data collectors during a crisis, unmanned assets fitted with powerful sensors have an important role to play, not only in support of immediate relief operations. Indeed in the aftermath of a disaster, a legal dispute sometimes takes place between individuals causing injury, the authorities and the insurance companies. Accurate time-stamped and geo-referenced data gathered during the crisis by unmanned systems will serve as proof to resolve these disputes.

67. From an economic point of view, using unmanned assets can also make more sense. Indeed the deployment of staffed rescue helicopters and/or patrol boats, each costing thousands of dollars an hour to run, is a standard search and rescue operation on land or sea. Unmanned assets will reduce these running costs significantly and free up manned assets for high-priority tasks.

68. Time is a crucial parameter in a search and rescue context, as the probability of victims' survival decreases rapidly. Therefore it is necessary to deploy as quickly as possible all the search and rescue assets. However, it is often the case that conventional search and rescue assets (rescue helicopters, rescue vessels, etc are highly overwhelmed during a major disaster, e.g. for evacuating victims. The rapid deployment of omnipresent unmanned rescue instruments will greatly speed up the rescue option.

69. A key advantage of mainly unmanned aerial instruments is that they allow human rescue workers to gain a global overview of the situation and hazards in the crisis area very quickly. As a result, search and rescue personnel can now coordinate their efforts more efficiently, without having to wait until satellite imagery is available or a ground-based survey is conducted

70. Compared to their manned counterparts, an apparent benefit of using robotic systems is that the autonomous systems keep the human rescue workers from damage. In earthquake response situations, where search and rescue personnel now also have to reach semi-demolished structurally unstable buildings to look for survivors, this is extremely important, scared by the risk of aftershocks taking down the entire structure. For these ta ta ta, indoor drones and ground robots are especially suited.

71. As demonstrated by the tragic events in Fukushima, where a tsunami triggered the meltdown of three nuclear reactor cores, exposing the world to nuclear radiation, a crisis where there is a chemical, biological, or radiological aspect poses a huge problem for human relief workers. Robotic assets can be the only weapons in such situations to cope properly with the crisis, without endangering further human lives.

72. At sea, it is actually the case that rescue operations need to be stopped at night or when the sea gets too hard, otherwise human search and rescue personnel will find it too risky. With robust environmental conditions such as night-time operations, heavy wind, rain or rough sea conditions, robotic assets undoubtedly have issues, but in a risk-assessment sense, it would be reasonable to deploy these unmanned systems for risky operations instead of manned assets.

CHAPTER 07

CONCLUSION

73. Special project on development of advanced robots for disaster response (DDT Project) focused on R&D of robotic solutions for reconnaissance of victim bodies, structural damage and environmental conditions.

74. From the first deployment to the 9/11 World Trade Center collapse, rescue robots have been used in at least 28 disasters in six countries. All types of robots and for all stages of a disaster have been

75. The rescue of victims is the first priority when such disasters happen. Rescue robots are currently a research subject along with human search and rescue teams chapter concludes with a discussion of the fundamental problems and open issues facing rescue robotics

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