

Environmental Management using Robotics and AI Based Systems: Towards Healthy Environmental Development

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Abstract

Environment is not only an important concern for all of us but also a field of study viz. Environment Studies, Environmental Systems and Engineering, Environmental System and Management, etc. Apart from these few other nomenclatures are Environmental Statistics, Environmental Informatics, etc. As far as Environmental Informatics is concerned it is composed of the Environment including allied branches and also Informatics including other allied branches. Environmental Informatics is used different means for environmental management, monitoring and development using technologies. Different tools, techniques and technologies of Computing and Information Technology are very much important in developing healthy Environmental Informatics practices. Among the emerging technologies, few important are Cloud Computing, Big Data, Artificial Intelligence and Robotics are very important in healthy Environmental practices. Robotics is an emerging technology gaining rapidly for various development of the environment related aspects and process. Robotics is the aspect of the involvement of the designing, development, and operation of robots; which comes with intelligent systems and human like assistance using technologies. Robotics in the recent past become a field of study and contributed from branches like Information Technology, Computer Engineering, Mechanical Engineering, Electrical Engineering, etc. As far as Environmental Informatics is concerned, it is applicable in diverse and emerging areas and all such are depicted here in this paper.

Keywords: Environmental Informatics, Geo Informatics, Emerging Technologies, Robotics, Artificial Intelligence, Ecology.

1. Introduction

Environmental Informatics is actually broader than Geo Informatics and responsible for complete and healthy environmental solutions not only directly associated areas of environment and ecology but also in agriculture, oceanography, climatology, forestry, anthropology, etc. Further here various types of Information Technological tools and components are widely used viz. Database Technology, Web Technology, Network and Communication Technology and others for the promotion of the environment and ecology. Due to the significance of the subjects many universities and educational institutes have started Certificate, Bachelors, Masters programs in the areas of Environmental Informatics internationally [1], [7]. There are different emerging technologies from the domain of IT and Computing have been emerged and among these few important are as follows—

- ❖ Cloud Computing.
- ❖ Virtualization Technology.
- ❖ Big Data.
- ❖ Human Computer Interaction.
- ❖ Data Science and Analytics.
- ❖ Artificial Intelligence.
- ❖ Robotics etc.

Gradually the applications of Robotics have increased rapidly in Environmental Management and to monitor smart environmental monitoring. Robotics is meant for the designing and development of the Robots and Intelligent Systems including operation, uses, and respect of assisting humans and individuals. Robots are useful in many situations and affairs, context and in the environment also this is increasing. In the general inspection of the radioactive materials, bomb detection, manufacturing process in which general human involvement becomes difficult, then robots and Artificial Intelligence uses are important and needy. In the environmental activities viz. space, underwater, in high heat, and clean up, hazardous materials management including in radiation management this becomes important and valuable.

2. Objective

As the paper entitled ‘Environmental Management using Robotics and AI Based Systems: *Towards Healthy Environmental Development*, so this paper intends with the following aim and objective—

- ❖ To learn the overview of Environmental Informatics such as its foundation, features, characteristics.
- ❖ To dig out the general and potential advantages of Environmental Informatics in respect of environmental and social development and management.

- ❖ To get the knowledge on technologies helps in Environmental Informatics i.e. Environmental Management and activities.
- ❖ To get the knowledge on Robotics and basic applications with reference to the applications in environment, ecology, and other allied areas.

3. Environmental Informatics: The fusion of Environment and Information Science

Environmental Informatics is an important and advanced interdisciplinary area of practice and field of studies. This is a combination of two important fields i.e. Environment and Informatics. The *Environment* field is composed of Environmental Science, Environmental Management, Environmental Studies, Environmental Statistics whereas *Informatics* area is composed of the subjects viz. Information Systems, Computer Science, Information Technology, Computing, and so on. Initially, Environmental Informatics is only considered as an area of practice and gradually this is a field of study. Internationally many universities have started an academic program on the area with Bachelors, Masters, and Doctoral Degrees [3], [12], [16]. Environmental Informatics is also called with following—

- ❖ Environmental Information Science
- ❖ Environmental Information Technology
- ❖ Environmental Information Systems
- ❖ Ecological Informatics etc.

Environmental Informatics is also can be considered as a broader area that some of the allied subjects viz. Agricultural Informatics, Forest Informatics, Irrigation Informatics, and even Social Informatics combines with the Urban and Rural Informatics are also considered as important and valuable.

4. Robotics in Environment and Ecological Management: Healthy Environmental Informatics Practice

Robotic bases tools, systems are increasing day by day and fundamentally it is for the gathering of data-gathering for better and healthy allowing of new perspectives and also for greater understanding of the help of the environmental processes. The advanced and intelligent robots can able to involvement in the deep oceans and also for the tracking of harmful algal blooms. Robot based systems are also useful in the understanding of the pollution spread, which helps in monitoring climate variables, monitoring of the remote volcanoes [6], [15], [23].

The applications of robots are significantly increased in the marine, terrestrial, and airborne systems. As far as the latest trend is concerned achieving large-scale environmental monitoring is also becoming normal by the robots and robot-based systems including by the wireless sensor network (WSN) interaction.

Environmental monitoring is needed over management of the natural and artificial disaster management and accidents. Environmental health becomes easily possible to manage using robotic integrated technologies viz. remote-sensing satellites, automated sampling systems. Marine-based robotic systems are useful in vehicle design including atmospheric observation. In environmental robotics sensor network interaction, adaptive sampling, etc., are very much useful and required. Though some of the things are important to consider in respect of vehicle control, reliability and safety, real-time with respect to robotic bases environmental monitoring [5], [14], [22].

Climate change is an important concern and it is become more dramatic every year due to changes in temperature and climate across the world and by this plants and animals are become victims and affected by the changing climate; and here robotics become important and valuable in many contexts. Internationally robot development and research become important in the environment (refer Fig. 1 in this context and Fig. for robot uses in different areas).

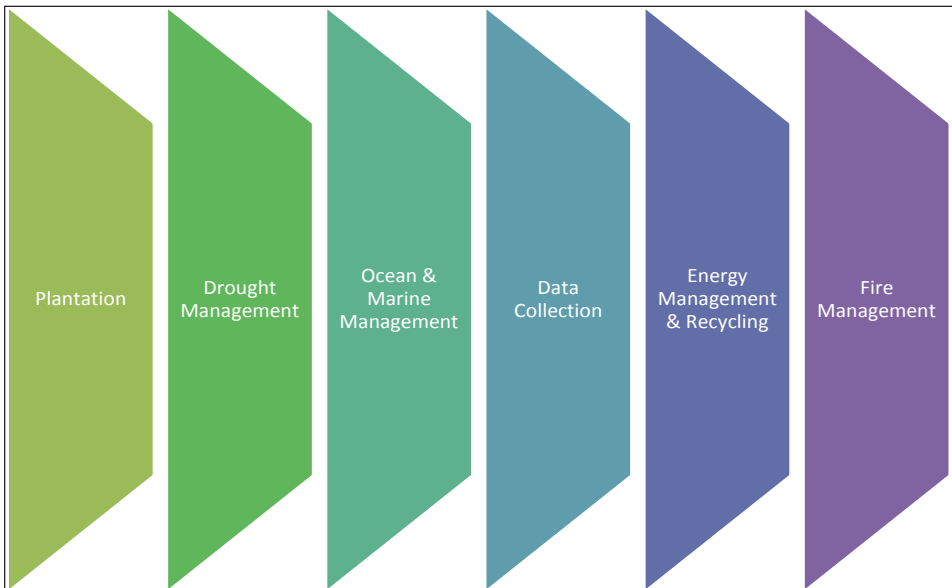


Fig. 1: Basic Robotics and Robot based Environmental Application

4.1 Robot Based Tree Plantation

The Robots, Robot based technologies play an important role in automated and smarter tree plantation. Worldwide many companies are growing which are offering automated and robot based tree planting facilities viz. Sky Grow. Here automated and intelligent vehicles also engaged in planting trees which is about 10 times faster than others. Here instead of seed trees are directed get planted or transform from one place to another place; which ultimately reduced tree cutting.

4.2 In Drought Management for the Farmers

Farmers are faces various kind of challenges and issues and among them, drought is an emerging issue. Climate change affects our food sources and this is a majorly important concern in the poor nations and with the integrated robots and robotics enables systems the drought management can be solved easily. The AI sensors can predict the plants having more chances in survival and growth in harsh conditions. And here farmers can choose the plants with good chances to survive and can help accordingly.

4.3 Ocean and Marine Management

In Ocean and Marine Management also Robotics and Robot based systems can be useful in a healthy manner. There are various devices and tools are used in Ocean and Marine Management viz. Ocean One is used for the monitoring of the coral reefs in the Red Sea. Since coral are important in healthy sea life therefore which such systems the diversity becomes positively possible. Similarly, the oil and gas industry is affecting the ocean in different ways and here also robots are useful. Due to human activities, it is growing therefore proper technological uses are very much important and required. Further robots are also useful to ingest microbes of the ocean and converts into energy [4], [13], [20]. Therefore in this context robots are not only helpful for the energy generation but also in reducing the impact of the oil leakages. Further another simple use of the robot is collection of the waste from the sea and other water bodies. Among the waste, plastic can be one important example however with such practices the depth can be increased of the sea. Robots are useful in cost saving and time management than human efforts. Though the cost of the robots, Human and skilled manpower, and the material (since robots are not biodegradable) of the robots can be an issue.

4.4 In Data Collection

As far as Data Collection is concerned Robots and Robotic Technologies are very much important and growing rapidly. There are many robots which are important and can get collect the data using sensors. Such data collection can be from the seaside or deep sea or desert or forest. Swarms Robots can be a prime example in this regard; though multiple small robots can also be used. In the field of marine biology also such robots are useful in data collection.

4.5 Wave and Solar Energy Management

Most of the energy we are using is from Fossil fuels and this is reducing day by day. The Engineers are engaged in developing systems, robots and robotic integrated technologies which may be helpful in the use of solar energy and wave energy uses. For managing climate change also use of alternative and renewal energy can be considered as worthy. Wave Gilder is an important example, for the use of the wave and solar energy using robotics. Here solar energy is the core concern and associated.

Robotics is helpful in simplification of the solar energy development process in many contexts. Therefore enhancing solar energy means support to the environment and ecology. In solar cells and devices, dust is an important concern since most of these are located in the desert areas viz. Africa or Desert Areas of Asia etc. and the robots are useful for dust management and cleanliness of the devices. Further here robots in the solar energy sector include a robot with built-in solar panels and here robot can generate their own energy effectively [9], [17], [19].

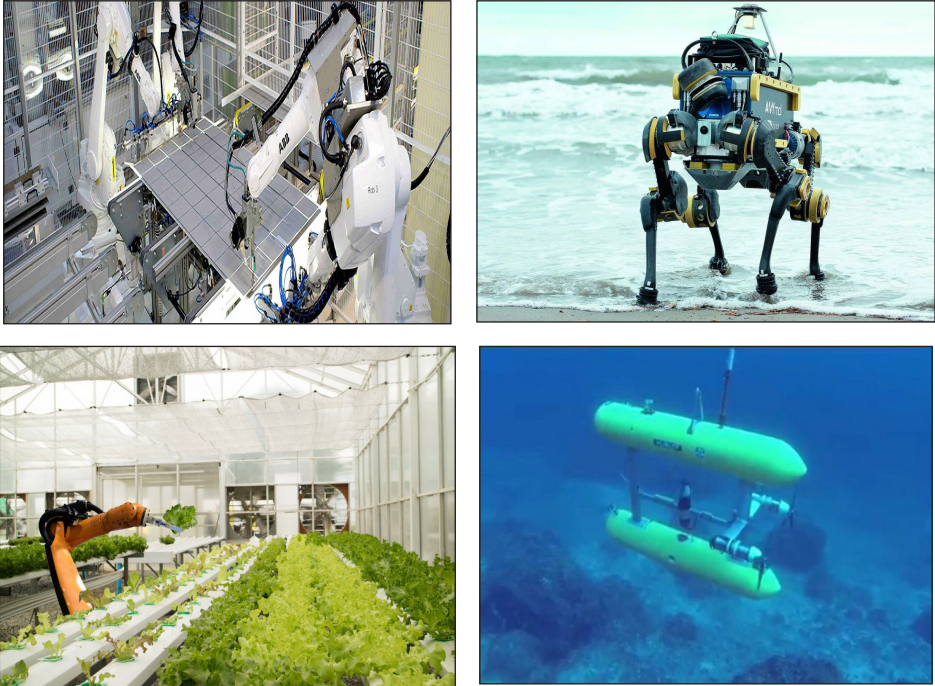


Fig. 2: Uses of Robots in different environmental contexts

4.6 In Water Pollutions

As far as Water Pollution is concerned, robots are useful in controlling the water pollutions as well. There are few devices invented which are helpful in water pollutions management using intelligent sensors and systems and further converting them into energy. Here microbes are used to consider as an item for cleanliness and further these are converted into the energy.

4.7 Easier Recycling

As far as recycling is concerned, Robots and Robotic Technologies can be considered as worthy in respect to the easier recycling. The traditional manual work and human efforts can be reduced using Robots and Similar Systems. AMP Robotics in this context an important example in which Artificial Intelligence are highly deployed.

Here robots can sort out the materials and place all such into a particular bin. Therefore this helps in constructions and establishment related firms and indirectly to the environmental engineering practice with advantages.

4.8 In Reduction of Carbon Emissions

In respect of the reduction of carbon emission also robots and robotics technologies can be worthy. In manual vehicles and trunk, there is huge energy used and dedicated to emission every day. In this context, AI and Technology integrated systems vehicles if more used for transportation of the systems then worthy and indirectly beneficial for the reduction of the carbon and helps in environment and ecology.

4.9 Robots Reduce Personal Transportation Emissions

The self or automated car is rising rapidly throughout the world. This is very perfect in the development of the condition of the environment and ecologies. In such context Robots and Artificial Intelligence based technologies are very important. Worldwide may cars and transportation is coming which are based on automated technologies and robots. Therefore such are helpful in reduction on emissions and helps the environment; directly and indirectly.

4.10 Less Energy and Waste Management

Regarding less energy and waste management also Robotics and Artificial Intelligence based systems are useful and increasing throughout the world and this practice also helps in climate management. Use of the robotics can be a worthy tool for waste management and helps to the following—

- ❖ In Manufacturing and Production Industries
- ❖ In Preventing Pollutions and careful monitoring
- ❖ In promotion of less efficient machines
- ❖ In Promotion of less and fewer human errors, etc. [2], [10], [18].

These benefits alone have impacts beyond the actual manufacturing process. The reduction of energy, and the need for fewer resources will impact all industries that supply materials to manufacturers.

Since humans are consuming many resources and products and thus they are also responsible for developing large amounts of waste and their disposed and management is possible with emerging AI based systems and Robots. Simple robots are already being used viz. vacuuming, cleaning, and mowing and sorting garbage, household waste collection, etc. Here advanced robots are useful in the collection of the data from the sensors, AI based systems, algorithms, etc. Thus the way of garbage collection is needed and for the minimum use of resources to words healthy environmental impact. Waste treatment and recycling can go with modern technologies and automatically these are also helpful in the reduction of CO₂ emissions. Waste materials collection becomes quickly, effectively with AI and Robots than humans with less procedures.

4.11 In Environmental Alerts Management

Robots, Artificial Intelligence and allied technologies can be worthy in environmental systems management towards more sustainability. In many cases, environmental alert management systems can be used and there use of emerging technologies specially Robotics and AI can be considered as worthy and important. In this context important weather, disaster, earthquake, etc. However here allied technologies are also partially useful viz.—

- ❖ Cloud Computing.
- ❖ Big Data and Analytics.
- ❖ Human Computer Interaction, etc.

4.12 In Wildfire Management

As far as Wildfire Management is concerned Robotics, Robots and Artificial Intelligence based system are considered as important and worthy. In many countries, wildfires become very common for example in the US where about 100000 wildfires can be noted each year. And it affects the plant and animal species, human health and also infrastructure, etc. Here Robots and AI based technologies are worthy in control of wildfires quickly. Further, these are also helpful in avoiding risk.

Fire extinguishers and water propelling devices are useful in wildfire management. Here robots can be integrated with the GPS technologies, heat sensors, and artificial intelligence auto control the systems remotely towards efficiently detecting fires. These robots are useful in humans or environmental supports. Robots are integrated with the camera sensors and help in saving and rescue animals during wildfires. Therefore, robots and AI can be replaced with humans in the context of wildfire management.

4.13 In Promotion of Sustainable agriculture

Robots and Artificial Intelligence based systems are also worthy in making of agriculture smarter and more environmentally friendly. Robots and Artificial Intelligence are useful to detect chemical levels in the soil, levels of fertilizers. In planting, sowing, and watering also thus Robots and Artificial Intelligence is worthy. With precision and short time robots can also be used for crop harvesting for the optimum time for picking up fruits and vegetables. In livestock farming or managing a herd of domesticated animals also robotics are useful. In the enhancement of farming and smart agricultural development also robotics are worthy and very important. Similarly in post production of agriculture also Robotics and AI based systems are useful. Therefore such agricultural promotion by the robotics and allied technologies are also important in developing environment and ecology directly and indirectly [8], [11], [21].

5. Conclusion

Environmental Informatics is gaining rapidly internationally due to its wider benefits and various other branches within Environmental Informatics towards societal and anthropological development. Universities, Higher Educational Institutes and Research Centers and researchers around the world doing well in use Robotics and other emerging technologies viz. big data analytics, cloud computing, IoT, converged network and communication in promotion of environmental development. As Robots are able take various forms and resemble humans in appearance therefore robots are worthy deal in the present context. Bio-Inspired Robotics are emerging rapidly which are engaged with intelligent and robot-based activities with the concern of biodiversity and environment.

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