International Journal of Disaster Response and Emergency Management
Volume 2 • Issue 1 • January-June 2019

A Novel Concept of Biomorphic Hyper-Redundant Snake Robot:
An Approach for Rescue Operation During Earthquake and Landslide

Yash Dinesh Shethwala, G.H. Patel College of Engineering and Technology, Gujarat, India
Ravi Pravinbhai Patel, G. H. Patel College of Engineering and Technology, Gujarat, India
Darshankumar Rajendrakumar Shah, G. H. Patel College of Engineering and Technology, Gujarat, India
Saurin M. Sheth, G. H. Patel College of Engineering and Technology, Gujarat, India

ABSTRACT

Disaster is a sudden accident or a natural calamity that causes great damage or loss of life and property. In any disastrous conditions, a lot of manpower is wasted and still unable to save some lives. A biomorphic hyper-redundant snake-like robot may help in such situations. Its excellent property of getting into small spaces and ability to traverse along any surface can be very helpful in search and rescue operations. These robots can help to locate humans in a disaster and provide precise information about its condition to rescuers. It can also be used in other domains like military, underwater, aerospace, and nuclear. In this research, the mechanical modelling and simulation of snake robot body have been carried out. Different speeds have been achieved on various surfaces where the snake robot has to traverse. An algorithm is proposed for human detection based on a YOLO algorithm. PCB design for the power supply is carried out and two types of gait motion (lateral undulation and side winding) have been achieved by the snake robot.

KEYWORDS

Biomimic, Biomorphic Hyper-Redundant, Earthquake, Landslide, Robot Operating System, Search And Rescue Operations, Snake Robot

DOI: 10.4018/IJDREM.2019010103

INTRODUCTION

A natural disaster is a catastrophic event that is caused by natural processes. Each year, natural disasters affect different parts of the world in various forms. Natural disasters often disrupt the functioning of the community or society and cause human, material, economic and environmental loss. Floods, earthquakes, hurricanes, volcanic eruptions, landslides, tsunamis, wildfires, tornados, blizzards, avalanches, etc., are examples of natural disasters. Despite being so technologically advanced, humans have had trouble facing natural calamities. Natural calamities result in mounting death tolls. People also get displaced and missing during such an adverse event. This makes many families lose their family members if emergency aid is not provided on time.

In such cases, a snake robot can be very much helpful in search operations. The snake robot is a biomorphic robot which mimics a biological snake. A biological snake can go through very small holes and can traverse on many different uneven terrains. This nature of a biological snake can be very helpful in the disastrous situation. The snake can perform various gait motions which help them to traverse on different terrains. The caliber of a biological snake body is petite which helps it to pass through small holes. The other advantage of the robotic snake over others is that it can run without wheels. Hence, it perfectly suits the situation where the normal wheeled robot cannot run. Thus, taking inspiration from a biological snake, the authors designed such a snake robot which is very similar in operation to a biological snake.

Motion patterns of snakes, inchworms, and caterpillars are used as an inspiration for how the snake robot should move [1]. The hyper-redundant quality of snake helps it to locomote through irregular and challenging environments which becomes difficult for wheeled, tracked and legged robots. The first qualitative research on snake locomotion was done by J. Gray in 1946. The first working biologically inspired serpentine robot was made by Shigeo Hirose in 1972. He presented a 2m long serpentine robot with 20 revolute 1 DOF joints. A huge snake robot has been developed in 1992 at Caltech. Miller developed several prototypes of snake robots; among them, the last one, S5, has a very realistic lateral undulatory gait motion. The joints are mostly revolute, but extensible (prismatic) joints are also employed.

This snake robot has got many applications in different fields like military, Underwater and Medical. These are listed below

- Military Application: In military snake robot can be used for spying and surveillance.
- Underwater Application: To study the behavior of aquatic animals this type of robots can be used. Snake robots can also be used other underwater applications like to search submerged objects, to study pollution level in seawater and underwater machining processes like welding.
- Medical Application: small size snake robots can be used as small surgical manipulators.