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'A Review Study on Future Applicability of Snake Robots in India'

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Abstract: *In this study we to aim to present an overview of features of snake robots and their application across various fields. Snakes is blessed with a unique feature of moving over or climbing all most all kind of terrains, rough, muddy, watery, narrow cracks, tall trees and this unique mobility feature have inspired the creation of 'Snake Robots'. Snake robots can work as a wonder to reach challenging and cluttered environments where it is impossible or too dangerous or narrow for human beings to operate. Snake robot is an innovation that has a great scope in India. Snake robots, thus, holds a lot in future and great scope for India. Snake robots can be used in various fields like agriculture, sanitation, fire fighting, surveillance and maintenance of complex and possibly dangerous structures or systems such as nuclear plants or pipelines, intelligent services, media, exploration, research, education, military, disaster management, and rescue & search operations. These unique features and degrees of freedom of snake robots make them fascinating topic for research and is worth investment & applicability. With further innovations, the potential of snake robots can be exploited and give way to infinite applications.*

Keywords: *Application, Innovations, Locomotion, Locomotive Robots, Snake Robots*

I. Introduction

Scientific innovations have always helped mankind to explore the extremes and reach to the avenues beyond our imagination from simple agricultural tools to sophisticated spaceships, satellites. With ever growing innovations & inventions man has explored the outer space. From simple tools like knife, pen to advanced computerized systems technology has helped us achieved the so called 'beyond human capabilities'. Many scientific innovations have revolutionized the human life like discovery of fire and invention of wheel, electricity, computers, airplanes, mobiles and satellites ….the list is long and Robotics is one such boon of science.

Robotics is the branch of mechanical engineering, electrical engineering and computer science that deals with the design, construction, operation, and application of robots, as well as computer systems for their control, sensory feedback, and information processing.

Robotics is now being practically used in every field from agriculture to aeronautics, from education to medical, from production to entertainment, from domestic help to advance research. Dedicated specialized robots are being developed for every field and world has already witnessed the successful use of robots in many spheres Industrial robots**,** Domestic or household robots**,** Medical robots**,** Service robots**,** Military robots**,** Entertainment robots**,** Space robots**,** Hobby and competition robots.

Robots which are specially designed and programmed for the purpose of locomotion (moving from one place to another) are referred as *'Locomotive Robots'.* These specialized robots can move on difficult geographical reliefs like mountain or hilly surface, deserts, rough terrains, wild forests underground, under water and in narrow & difficult places like pipes, drains, gaps, holes, sewers and can climb trees, pipes, ladders, etc. They can also face extreme climatic conditions. It seems that nothing is 'unreachable or unapproachable' for these robots. You name it and these robots can reach there. Some of these places are inaccessible or very difficult & life threatening to reach and whereas some of these places like small pipes, holes, cracks are beyond the reach of a normal human being; but thanks to 'locomotive robots' we can now explore such places easily. Due to this unique feature the locomotive robots are been widely used like space missions, military operations, rescue operations, oil refineries, etc.

There are various designs within locomotive robots like wheeled and legged like transport robots, human robots, animal robots, etc. The king of reptiles snake is blessed with a unique feature of moving over or climbing all most all kind of terrains, rough, muddy, watery, narrow cracks, tall trees, and this unique mobility feature have inspired the creation of 'Snake Robots'.

II. Literature Review

Shigeo Hirose, Edwardo F. Fukushima (2003) concludes that due to snake like design of snake robots they can be used in disaster management. Japanese government is taking steps to promote research in the field of snake robots. The researchers describe a new paradigm "snakes and strings" for rescue operations. According to this paradigm snake like technology can be used for developing mobile robots which can walk through narrow spaces under collapsed buildings and hyper tether that will continuously supply energy, accomplish reliable communication link, and also exhibit high traction force.

Timothy Bretl, Teresa Miller, Stephen Rock Jean-Claude Latombe (2003) describe that there are various challenges in designing climbing robots with quasi-static motion. The researchers present a framework is to compute climbing motions of three limbed robot in real vertical natural terrain. The framework of climbing robots handles motion constraints, complicated robot geometries, unknown or partially known environments and three dimensional terrains is analysed in detail.

Aksel Andreas Transeth, K.Y. Pettersen (2006) the researchers reviewed the mathematical modeling and locomotion of snake robot. Due to some unique characteristics of snake robots like they can go through narrow paths, walk over rough surfaces they are being extensively used in rescue operations and firefighting where it is difficult for human being to reach .The researchers discussed different approaches to biological inspired robots in their study.

KonstantinosKarakasiliotis, Michail G. Lagoudakis, et.al.(2007) the researchers during their study found that mostly robots used for rescue & search operations try to copy mobility biological inspirations like snakes, inch worms, etc. The researchers analysed the feasibility of such robotic mechanisms. The researchers came up with a model named the ChlorochlamysChloroleucaria which is a multi-segment manipulator having grippers at both ends and studied the motion planning problem for loop-like locomotion under physical and environmental constraints which is to be tested in the real time situation.

JunyaoGao, XueshanGao, Wei Zhu, Jianguo Zhu (2008) conclude that snake inspired robots can play crucial roles in disaster management activities. to site an example of earthquake, responding quickly while rescue operations is key to save lives, most of time due to large amount of debris it takes time to locate people buried under debris. Snake inspired robots can become useful tool to perform such rescue operations quickly.

James K. Hopkins, Brent W. Spranklin, Satyandra K. Gupta (2009) the researchers introduced a new type of robotic design and showed how using existing technology and robotic design new forms of robotic designs can be structured. This paper also addresses various practical challenges in the field of snake inspired robots.

Maity , S. K. Mandal, S. Mazumder, Sukamal Ghosh (2009) conclude that wheel based robots have several limitations like they cannot climb, cannot walk over rough surface, difficult to walk over terrains. So engineers have worked in this direction and designed serpentine robots which can climb, can crawl over rough surfaces.in this paper researchers explained the biological aspects of snakes and the research work done inthis direction they also explained locomotion and its type.

Pal Liljeback, Oyvind Stavdahl, Kristin Y. Pettersen, et.al. (2010) conclude that there is need of intelligent snake robot locomotion in unstructured environment and suggest two approaches for this. First design approach is based on measuring the joint constraint forces at the connection between the links of the snake robot. Second, allowing the cylindrical surface of each link of a snake robot to rotate by a motor inside the link in order to induce propulsive forces on the robot from its environments. The researchers describe about benefits of proposed design approaches over previous designs.

Blessy Mariam Markose , Harshitha Loke (2014) the researchers analysed the adoptability of snake robots in search & rescue operations and how these robots can reach place like narrow cracks, rough terrains and extreme environments where other search mechanisms or human beings cannot reach. But snake robots do have certain limitations like poor power efficiency and lesser control but the researchers conclude that innovation can overcome these limitations and snake robots can be a very successful mechanism.

Pal Liljeback, Oyvind Stavdahl, Kristin Y. Pettersen, et. al (2014) the researchers describe about a snake robot named, Mamba that provides platform that can help in snake robot locomotion research. A unique feature of snake robot is that it can measure environment contact forces acting along its body, including underwater

locomotion that can be achieved by separating the actuator inside each joint module with a custom-designed force/torque sensor. In this paper authors described the designing of the sensor and demonstrate its performance.

Objectives of the study

- To study snake robots as a near future technology.
- To analyse whether snake robots can revolutionise the human life.
- To examine the applicability of snake robots across various fields.
- To analyse the scope of snake robots in India.

III. Observations

Research on snake robots has been conducted for several decades. The world's first snake robot was developed by Professor Shigeo Hirose at Tokyo Institute of Technology in Japan in 1972 (Hirose, 1993). The Many countries like Japan, Israel, USA, etc are already using snake robots successfully for search and rescue operations and military operations, where it may be too dangerous or narrow to operate for human beings. Snake robot is an innovation that has a great scope in India and we should look forward to use snake robots in a wide range of applications.

Wheel is a great invention, but it cannot go everywhere. Wheeled mechanisms constitute the backbone of most ground-based means of transportation. On relatively smooth surfaces, such mechanisms can achieve high speeds and have good steering ability. Unfortunately, rougher terrain makes it harder, if not impossible, for such mechanisms to move.

Snake is one of the creatures that exhibit excellent mobility in various terrains. It is able to move through narrow passages and climb on rough ground. This property of mobility is attempted recreated in robots that look and move like snakes. Snake robots most often have a high number of degrees of freedom (DOF) and they are able to locomote without using active wheels or legs. Snake robots suit a wide range of applications. One of many examples is rescue missions in earthquake areas. The snake robot could crawl through destroyed buildings looking for people. It could also carry small amounts of food or water to people trapped by the building prior to the arrival of rescue personnel. The snake robot can also be used for surveillance and maintenance of complex and possibly dangerous structures such as nuclear plants or pipelines. In a city, it could inspect the sewer system looking for leaks or aiding fire-fighters. Also, snake robots with one end fixed to a base may be used as a robot manipulator which can reach hard-to-get-to places. In comparison to wheeled and legged mobile robots, the snake robots have high stability and good terrainability. The exterior can be completely sealed to keep dust and fluids out.

The world; so is India especially given the vast geographical diversity, has been suffering from many natural and man caused catastrophic disasters during the last decades, like massive earthquakes, fire break outs, floods, airplane crash, Tsunami 2011, Uttrakhand floods 2013, , military operations in cases like 26/11 Mumbai attack (2008) or recent terrorist attacks in Punjab (India).

After earthquake, many people are buried under ruins, as witnessed in recent Nepal earthquakes. Rescue is very important in the first 48 hours. Snake robot is a very useful tool in climbing into ruins to detect people. In such events, collapsing of houses and buildings in large areas is almost inevitable. Hence, searching for victims and subsequent rescue operations from the rubble of collapsed buildings are major problems that must be faced and planned well ahead from the actual disasters. However, these operations are very dangerous for human workers and even for trained police dogs. Furthermore, the places where most of the victims are trapped are in most cases inaccessible using traditional methods and existing technologies. These are important reasons, which may motivate researchers to direct efforts for the research and development of practical and useful search-and-rescue robot systems like snake robots.

Snakes acquire many advanced motion capabilities: their body can function as "legs" when moving; as "arms" when traversing branches; and as "fingers" when grasping objects. However it is their long, slender and smooth articulated body shape that makes them especially suited to enter and move inside small cracks and gaps, such as encountered in the disaster sites. The same performance can be expected from mechanical snakes that inherit these physical characteristics. Snake robot knows all force it touching and know environment. Force feedback control is used to cross obstacle.In order to inspect narrow and unstructured environments such as disaster sites, snake-like robots should have rugged construction, but at the same time be sufficiently sensitive to detect contact with their environments. In addition, control which allows the robot to adapt to its environment is also essential.Future applications of snake robots include agriculture, sanitation, fire fighting, surveillance and maintenance of complex and possibly dangerous structures or systems such as nuclear plants or pipelines, intelligent services, media (for investigative reporting), exploration, research, education, military, disaster management, and rescue & search operations, inspection and maintenance in industrial process plants, archaeological exploration and subsea operations. Snake robots; thus, holds a lot in future (in terms of applicability) and great scope for India.

IV. Conclusion

Snake robot is an innovation that has a great scope in India and we should look forward to use snake robots in a wide range of applications. Snake robots, thus, holds a lot in future and great scope for India. Snake robots can be used in various fields like agriculture, sanitation, fire fighting, surveillance and maintenance of complex and possibly dangerous structures or systems such as nuclear plants or pipelines, intelligent services, media, exploration, research, education, military, disaster management, and rescue & search operations. These unique features and degrees of freedom of snake robots make them fascinating topic for research and is worth investment & applicability.

V. Recommendations

Further innovations on snake robots can help to overcome their limitations of poor power efficiency and hence snake robots are not future technology rather a near future technology soon to become present technology and holds lot of scope in India.

Many research challenges still remain before we will see useful applications of snake robots, and much remains to be understood about the dynamics of these fascinating mechanisms. An important topic which the researchers are currently investigating concerns new models and control strategies to support intelligent and adaptive snake robot locomotion in challenging and cluttered environments which are otherwise difficult, life threatening or inaccessible for human beings. With further innovations, the potential of snake robots can be exploited and give way to infinite applications.

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