

Pleurobot

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Abstract

A pleurobot is a biomorphic hyper-redundant robot that resembles a snake. Snake robots come in all shapes and sizes, from the four stories long, earth quake snakebot developed by SINTEF, ^[1] to a medical snakerobot developed at Carnegie Mellon University that is thin enough to manoeuvre around organs inside a human chest cavity. Though snake robots can vary greatly in size and design. A snake robot can traverse cluttered and irregular environments by using irregularities around its body as push-points to aid the propulsion. This is denoted obstacle-aided locomotion and requires the snake robot to have two features: (1) a smooth exterior surface combined with Head and Tail with linkage joints these two features are characteristic of biological snakes, but have received limited attention in snake robot designs so far. This paper presents a joint mechanism for a snake robot aimed at meeting both these requirements.

Keywords: Pleurobot, snakerobot

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'. In this project we worked in the development of a PLEUROBOT which can move in a two and fro motion with the help of two wheels and balanced by castor wheel. It is capable of many capabilities like it is fully remote controlled and also it is used in surveillance, obstacle detecting, fire sensing agent, inspection. It only works on 12V A.C. supply.

Literature review

Shigeo Hirose, Edwardo F. Fukushima (2003) ^[1] 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) ^[2] 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 analyzed in detail.

Aksel Andreas Transeth, K.Y. Pettersen (2006) [3] 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.

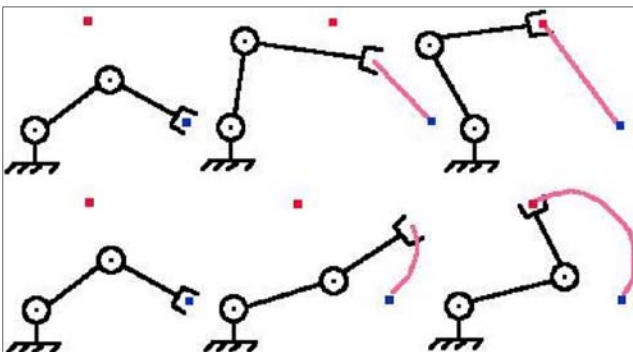
Konstantinos Karakasiliotis, Michail G. Lagoudakis, *et al.* (2007) [3] the researchers during their study found that mostly robots used for rescue & search operations try to copy mobility biological inspirations like snakes, inch worms, etc. The researchers analysed the feasibility of such robotic mechanisms. The researchers came up with a model named the *Chlorochlamys Chloroleucaria* 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) [1] 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.

Working

Degree of freedom

The degrees of freedom, or DOF, are a very important term to understand. Each degree of freedom is a joint on the arm, a place where it can bend or rotate or translate. We can typically identify the number of degrees of freedom by the number of actuators on the robot arm. Now this is very important - when building a robot arm we want as few degrees of freedom allowed for our application, because each degree requires a motor, often an encoder, and exponentially complicated algorithms and cost. In this robot it has 2 degree of freedom which are for head and tail movement



Robot Movement

▪ **Straight – Forwards**

Both wheels rotate at the same speed, but the right wheel rotates forward and the left wheel rotates backward, so the robot turns to its left around its centre.

This makes a sharp turn in place.

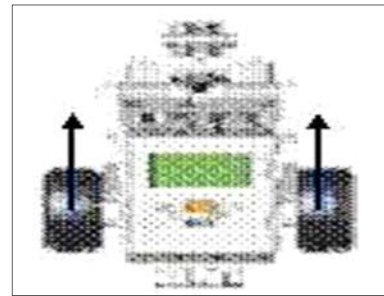


Fig 1: Straight – Forward

▪ **Straight - Backwards**

Both wheels rotate forward at the same speed and the robot moves straight backward.



Fig 2: Straight - Backwards

▪ **Swing Turn – Forward Right**

The left wheel rotates forward and the right wheel does not move, so the robot pivots around the right wheel as it turns forward. This makes a wider turn.

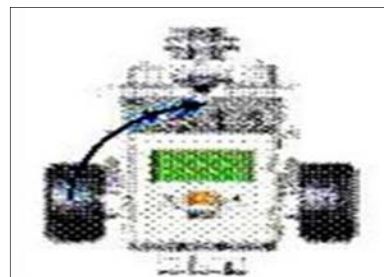


Fig 3: Swing Turn - Forward Right

Swing Turn - Forward Left

The right wheel rotates forward and the left wheel does not move, so the robot pivots around the left wheel as it turns forward. This makes a wider turn

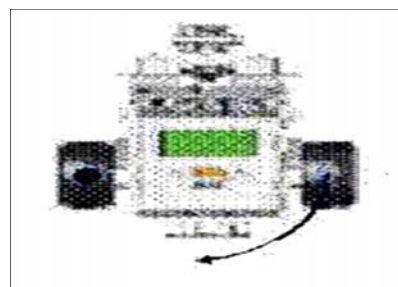
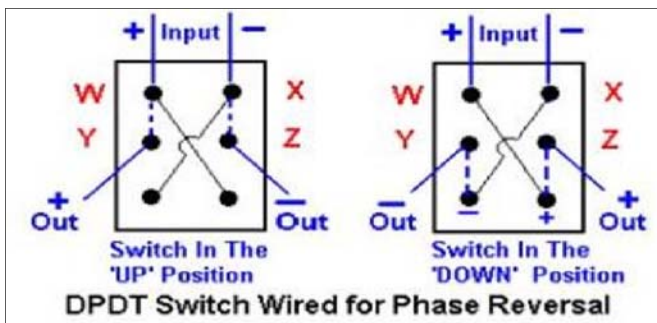


Fig 4: Swing Turn - Forward Left

DPDT Rocker Switch

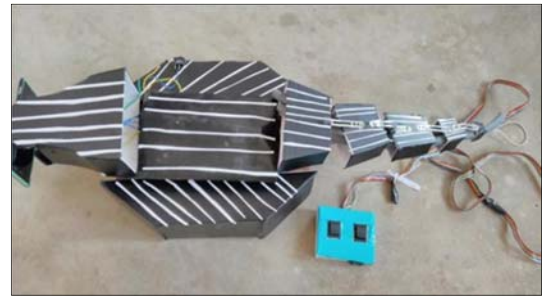
A Double Pole Double Throw (DPDT) switch is an electromechanical switch that has 2 inputs and 4 outputs and each input has 2 corresponding outputs that it can connect to. A simple way to think of this switch is imagining 2 SPDT switches side by side with the 'handles' attached to each other. Perhaps the most popular use for this switch is 'phase or polarity reversal'. So, how does the DPDT switch accomplish this? First, you have to wire the 2 'top' and 2 'bottom' terminals in a 'crisscross' fashion. The top 2 terminals become the input and the middle two terminals become the output. Now, referring to the bottom left diagram, the switch is in the 'up' position, W & Y are connected, as are X & Z. The polarity is maintained because the input and output are directly connected. No problem seeing that right?



Now let's see what happens when the switch is in the 'down' position (right diagram). The + input goes from the 'W' terminal, down to the lower right and then up to the 'Z' terminal. The negative input goes from the 'X' terminal and out through the 'Y' terminal. See what has happened? With one flip of a switch, polarity has been reversed. What applications does this have? For one thing, electric guitar players use this type of switch to put one pickup out of phase with the other, producing a thin, and 'squawky', 'inside out' kind of sound. In the 'old days' before 3 prong plugs, power switches on some electrical devices used this switching arrangement to switch polarity in case the plug was in the outlet the "wrong way".

Operation

This pleurobot is controlled by remote board. It has 4motors which are used to drive wheels, head and tail of the robot. This robot is balanced by castor wheel. On the robot, a camera can be placed to take a video of the affected areas which can further help in rescuing operations and surveillance. The benefits of rescue robots to these operations include personnel requirements, reduced fatigue as well as access to unreachable areas. Due to its structure it is used for tunnel inspection. It has IR proximity sensor which is used for obstacle detection and fire sensing element. It can be made wireless.



Conclusion

This pre-study report has described the pleurobot. The report has also presented and analysed a novel solution to it: the pleurobot. Though snakebots can vary greatly in size and design. A snake robot can traverse cluttered and irregular environments by using irregularities around its body as push-points to aid the propulsion. It is capable of many capabilities like it is fully remote controlled and also it is used in surveillance, obstacle detecting, fire sensing agent, inspection. From the construction of this prototype, we can arrive at several conclusions for the final Prototype:

- The robot can move in any direction.
- It is fully controlled by remote.
- It can pick up light objects from a place and put them to another place.
- It can also put objects to a height and put down them from the height also.
- It takes power supply of 12V, 1.2AH.
- It can pick a maximum weight of 50 grams.

In this paper we have developed Pleurobot for providing the service to replace the human in many fields like office, military tasks, hospital operations, industrial automation, security systems and dangerous environment. The developed model has completed the task successfully. The benefits of rescue robots to these operations include personnel requirements, reduced fatigue as well as access to unreachable areas. These robots have the ability to move over irregular terrain of collapsed or destroyed buildings. On the robot, a camera can be placed to take a video of the affected areas which can further help in rescuing operations. More sensors could be added to the snake-like robot, to allow it to know its position and the environment that surround it. The gyroscope can be added, so that the snake-like robot can stabilize itself in the climbing process

Future scope

In this pleurobot it only goes on two wheels which can only transverse through cluttered irregular environments and driven by DC Motor. So further we can use more and other motors which are suitable to this robot so that it can go on water, climb trees. This robot is controlled by remote which have DPDT switches. It can be made wireless by using Arduino board, relays, and other sensors so that it controlled from anywhere.

Firstly, a camera is recommended to install to the snake-like robot in order to let then snake-like robot have high level of decision making instead of just using the ultrasonic sensor, because the surface form of the obstacles is impossible to get by just using the ultrasonic sensor. With a camera, the user can monitor the movement of the snake-like robot even in the closed environment where human cannot be inside. Besides

that, the image processing technology like machine vision can program to the snake-like robot, so that the robot can make decision based on the processed image.

Secondly, more sensors could be added to the snake-like robot, to allow it to know its position and the environment that surround it. The gyroscope can be added, so that the snake-like robot can stabilize itself in the climbing process. Lastly, the additional features such as sense for fire, detect human breathing, and other useful features can be added to the snake-like robot, so that it can help human to perform rescue services in the environment that human can't reach.

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