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Robotics for a heart operation and new trends in Cardiorobotics (SNAKE ROBOT)

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Abstract: This paper considers the new functionality added to a snake robot which is for heart surgery. Normally snake robots are used for inspection, search, rescue and reconnaissance missions. Here we have conceived a new dimension to it – 'Instead of completely opening up your rib cage for a heart operation, what would you say about a smaller incision and letting a snake do it'. The concept of heart surgery mainly requires the robot has 102 joints, a camera in the head, and can slither around your organs with amazing precision . While we've spent a lot of time writing about humanoid robots, doggy packmule robots, autonomous quadcopter robots, and even the science of falling in love with robots, *medical* robots are possibly the most important sphere of robotics. Scientists and doctors are already using the creeping metallic tools to perform surgery on hearts, prostate cancer, and other diseased organs. The snakebots carry tiny cameras, scissors and forceps, and even more advanced sensors are in the works. It's like the ability to have little hands inside the patients, as if the surgeon had been shrunken, and was working on the heart valve.

Keywords: Humanoid robots,Snake,Medical robots,Snakebots.

I. INTRODUCTION

This Snake robots come in all shapes and sizes and it resembles a snake. Snake robots unique shape and ability to navigate challenging environments make them suitable for broad range of tasks including surgery, bomb detection, search and rescue, inspection and reconnaissance missions. Though snake robots can vary greatly in size and design, there are two qualities that all snake robots share. They are (i) their small cross section to length ratio allows them to move and maneuver through tight spaces. (ii) Snake robots have ability to change the shape of their body. It allows them to perform a wide range of behaviors, such as climbing stairs or tree trunks. It has locomotive flexibility. The actions performed by this robot are climbing, swimming and crawling. This robot yield high robustness. It has high degrees of freedom.

II.PHYSIOLOGY AND LOCOMOTION ABOUT SNAKE

Biological snakes, inchworms and caterpillars are the source of inspiration for this snake robot. We will therefore start with a short introduction to snake physiology and snake locomotion.

2.1 Snake Skeleton

The skeleton of a snake often consists of at least 130 vertebrae, and can exceed 400 vertebrae. The range of movement between each joint is limited to between 10 degree and 20 degree for rotation from side to side , and to a few degrees of rotation when moving up and down. A large total curvature of the snake body is still possible because of the high number of vertebrae.

A very small rotation is also possible around the direction along the snake body. This property is employed when the snake locomotes by side winding.

2.2 Snake skin

Since snakes have no legs, the skin surface plays an important role in snake locomotion. The snake should experience little friction when sidings or wards, but great friction when pushed backwards. The skin is usually covered with scales with tiny indentations which facilitate

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forward locomotion. The scales form an edge to the belly during motion which results in that the friction between the underside of the snake and the ground is higher transversal to the snake body than along it.

2.2 Locomotion

It is the source of inspiration for snake robots. Most motion patterns used by snake robots to locomote are inspired by locomotion of snakes, but also inchworms and caterpillars. The relevant motion patterns of such creatures will be outlined in the following.

2.2.1 Lateral undulation

Lateral undulation (also denoted serpentine crawling) is a continuous movement of the entire body of the snake relative to the ground.

2.2. 2 Concertina locomotion

A concertina is a small accordion instrument. The name is used in snake locomotion to indicate that the snake stretches and curves its body to move forward.

2.2. 3 Side winding locomotion

Side winding is probably the most astonishing gait to observe and is mostly used by snakes in the desert.

2.2. 4 Other snake gaits

Snakes also have gaits that are employed in special situations or by certain species. These are e.g. rectilinear crawling, burrowing, jumping, sinus-lifting, skidding, swimming, and climbing.

III.STRUCTURE OF ROBOT

The snake robot presented here is made up of five modules. Each module has length of 60 cm. And the total length of this robot is 3 metres. Each module functions as single rotational joints. We assemble the modules such that each module's axis of rotation is perpendicular to the length of the robot and rotated 90 degrees from the previous module. Every module can be able to change their shape (i.e) it can be placed in horizontal or vertical position. Modules look like a hollow segment. Drive ropes are also present for movement purpose. The novelty of this robot lies in the "follow-the-leader" mechanism – when the distal link as its location set, the other 49 links follow its location, allowing the operator to "snake" around curves to reach the desired target.

Apart from normal snake robot, this robot contains special components. They are

1. Camera
2. Scissor
3. Forceps
4. Driveropes
5. Tri-sprung-wheel

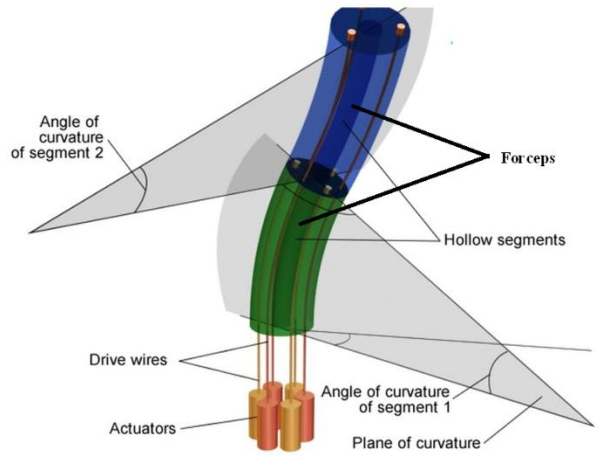

Figure 3.1

3.1 Components in detail

3.1.1 Camera

Here the camera is mainly focuses on live video sharing. The camera take role to detect the structure. Once the system is set up, the command can be shifted over to the monitor where the experts watching the video and they got current location of surgery part.paragraphs must be indented. All paragraphs must be justified, i.e. both left-justified and right-justified.

3.1. 2. Scissor

The surgical scissors is small incision or deep surgical pericardium. To handle the cardiac surgical scissors into the piece and handle of the scissors is the head, It works mainly through the wire drive rod between the scissor blades and handles the transmission, to achieve a scissors film movement control, which the surgeon by holding the handle to complete the cut operation pericardium, blood vessels and other tissue.

3.1. 3. Forceps

The forceps is resembling a pair of pincers or tongs, used for grasping, manipulating, or extracting, especially such an instrument used by a surgeon. The apex of the heart

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is then lifted, and again using curved forceps, using forceps leads to blockage of blood flow to the lungs, and this results in immediate respiratory.

3.1. 4. Drive ropes

The body of this robot has drive ropes to drive it move . This paper designs snake robot with all body drive system based on rope system. A force feedback system is in this robot body. So it can have drive force and knows all force it touching and know environment.

3.1. 5.Tri-sprung-wheel design

To navigate around corners while inspecting the pipes , the robots has a tri-sprung-wheel. To drive it , instead of controlling each wheel with a motor this robot angled the wheels about 10 degrees , similar to the design of a turbine blades but with wheels , then drove the entire thing around . This was named the “screw-drive”.

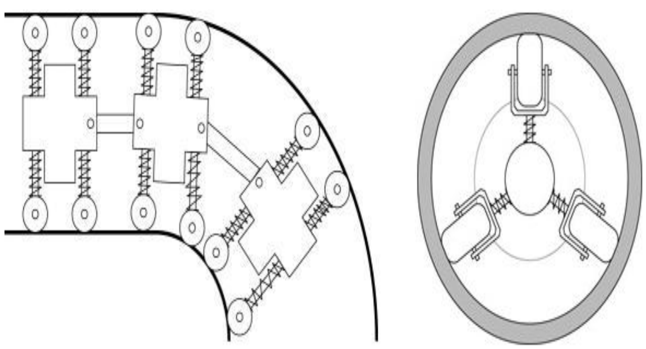

Figure 3.1.5

IV.WORKING

Snake robot works differently based on the area where it is used. The drive ropes is responsible for the movement of the robot.Control is handled by the person .It takes the input from the camera . Patients who undergo a minimally invasive procedure such as robotic heart surgery typically experience shorter recovery times than those who have open heart surgery. These minimally invasive alternatives use a set of small ports, instead of cutting the chest open and splitting the breast bone. Minimally invasive techniques can be used for a variety of procedures, including coronary bypass surgery, mitral valve repair, atrial septal defect (ASD or PFO) closure, or mitral valve replacement. (The latter is performed in cases of mitral valve prolapse, a condition that occurs when the valve does not close properly in the left side of a patient’s heart). *Robotically-assisted endoscopic heart surgery*.)(figure 4.1) is aimed at making endoscopic heart operations feasible. With this technology, the surgeon manipulates the surgical instruments with the help of a computer.
An endoscope is passed through a tiny incision in the chest wall, and two surgical instruments are passed through additional tiny incisions. The surgeon views the image provided by the endoscope on a computer screen. Instead of manipulating the surgical instruments directly, the surgeon manipulates them via a computer console - similar to manipulating a gamepad to play Ninetendo.

The computer interprets the surgeon's hand movements and causes the surgical instruments to respond accordingly. This system addresses the major disadvantages to moving the long surgical instruments manually - computer control of the surgical instruments essentially eliminates the tremor effect, and also the non-intuitive feel of maneuvering such instruments. While it takes special training to become adept at using robotically-assisted instruments, most surgeons who have had such training report that they feel quite comfortable maneuvering surgical instruments via a console instead of directly.

Figure 4.1

(figure 4.2)Much of the early work with robotically-assisted heart surgery has been with bypass surgery. So far, this technique has been limited to single bypass grafts in the left anterior descending coronary artery (the LAD). The LAD is located on the front of the heart, and therefore is relatively accessible. It is predicted that with advances in technology, multiple grafts with robotic assistance will be possible, at virtually any location on the heart. Early efforts have been made at extending robotically assisted surgery to other kinds of heart surgery.

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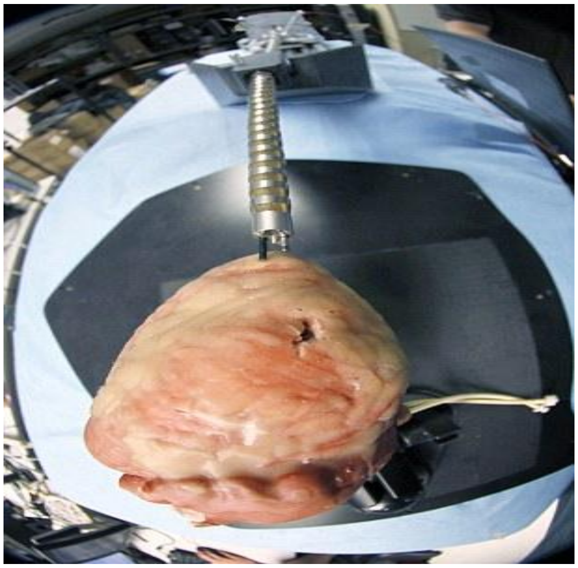

Figure 4.2

I. ADVANTAGES

5.1 Inspection of pipes

Here the robots are used for inspecting the pipes. To support this operation , IR LEDs and an IR sensitive camera was added and the robot was tethered to allow a human to control it .

5.2 Less Expensive

The chief advantage of such surgery is that the incisions that are made are tiny, and therefore recovery from surgery is extremely quick. Rapid recovery from cardiac surgery is not only better for the patient, but it is less expensive for society.

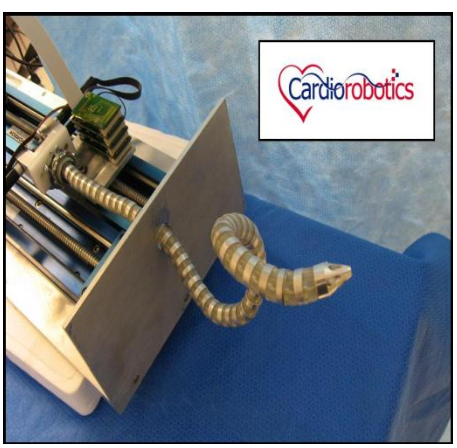

Figure 5.2

VI. DISADVANTAGES

The chief disadvantage at this point is that the technology is new, and (despite early encouraging reports) is still evolving. Its efficacy and safety have not yet been proven sufficiently to allow the FDA to approve it for widespread use. Another disadvantage is the expense of the robotic systems. They cost between $750,000 and $1,000,000, and it is unlikely that most hospitals will be able to afford purchasing the robotic systems for operations they are performing "just fine" today without the robotic equipment. The bottom line: it is likely to be several years before robotic heart surgery is widely available.

VII. RELIABILITY

A.Mechanical

The mechanical design has improved reliability in a variety of ways. We have designed this robot to be strong , thickness and lightweight. All the corners have been reinforced to resist twisting and fatigue. This design prevents the wires from pulling out or getting damaged by passing objects or the terrain. Even with all of these measures snakes do occasionally break. With the new mechanical design the modules can be completely detached by removing the two screws on the module and two on the module in front of it.

B.Wiring

Another major source of problems with previous snake robots has been the wiring. When wires break and tangle , connectors disconnect or break. This designs address all of these issues. First we reduced the number of wires running the length of the snake. For reducing the number of wires , we have have started using higher quality silicone insulated wires. Thinner wire can provide the servos with enough voltage to powerfully hold their position. Because the wires are silicone insulated with a high strand count , they can flex well without breaking.

VIII. FEATURES INTENDED TO BE ADDED

1.Enabling direction change in robot by making perpendicular servo elements.

2.Reducing the sizes of wires by using silicone.

3.Implementing the various methods used by snakes to move like sidewinding , rolling ect.

4.Attaching camera head to the snake robot so as to add an extra feature of surveillance and mapping.

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IX. FUTURE-WORKS & CONCLUSION

The presented design also considered size , weight and cost. This design maintains high reliability and high robustness and it can function in a wide variety of environments.On our current robots we are continuing to work with the various components which could be used to achieve much more advanced behaviours , instead of just simple user feedback . While the current implementation has been quite successful,more development is necessary to achieve a fully functional and robust robot .

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BIOGRAPHY

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