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Serpentine Locomotion: Enhancement in Applications

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Abstract

Snake bot is an artifact which has been inspired by a specie of reptile that is a snake.As the name suggest, the robot movements are similarto that of a snake.This versatile reptile is capable of several different modes of locomotion, including forward motion, circular motion, sidewinding, serpentine motion and back ward motion. Using these motions, the snake can be implemented on uneven surfaces, martial landscapes and places where human interference is highly impossible such as pipelines, underground ways, hazardous places, etc. which is also the focus of our research.

The snake is capable of autonomous movement as well. Based on the requirement it can also be controlled manually using a Joystick, Bluetooth or Smart phone. Such a robot can be constructed using servo and a low speed rpm dc motors, Arduino mega, spy camera, sharp, IR sensors, etc.

Keywords

Snakebot, Arduino mega, C programming, serpentine motion,

Introduction

Snakes are unique creatures in that their bodies allow them to get into the cracks and crevices of the world that most other creatures cannot. Lacking rigid skeletons and extremities, snakes can contort their bodies in order to get into tiny holes, wrap around tree branches and slither over otherwise unmanageable rocks. Generally, snakes have certain types of moving methods which are mentioned below.

Serpentine method: This motion is what most people think of when they think of snakes. Snakes will push off any bump or other surface, rocks, trees, etc., to get going. They move in a wavy motion. They would not be able to move over slick surfaces like glass at all. This movement is also known as lateral undulation.

Concertina method: This is a more difficult way for the snake to move but is effective in tight spaces. The snake braces the back portion of their body while pushing and extending the front portion. Then the snake drops the front portion of their body and straightens the back portion along. It is almost like they through themselves forward.

Sidewinding: This is a difficult motion to describe but it is often used by snakes to move on loose or slippery surfaces like sand or mud. The snake appears to throw its head forward and the rest of its body follows while the head is thrown forward again. (See picture.)

Rectilinear Method: This is a slow, creeping, straight movement. The snake uses some of the wide scales on its belly to grip the ground while pushing forward with the others.

These qualities of snake have inspired to create a robot which has serpentine motion. A snakebot could navigate over rough, steep terrain where a wheeled robotic rover would likely get stuck or topple.Man is sometimes unable to operate independently in environment, rescue in city during natural events and examine dangerous and nuclear spaces so he needs the robot help. In recent decades in relation to robotic fields the robots and their movement mechanisms were created by inspiration from realities and living creatures. The snake robots are made according to the natural ones. A snake can traverse cluttered and irregular environments by using irregularities around its body as push points to aid the propulsion [1]. The engineers name such robots, Snake–like robots because they are a new moving bionic machine may move without hand and foot and move like a real snake [2].Snake robots most often have a high number of DOFs, and they are able to move forward without using active wheels or legs.

Literature Survey

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.

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 analyzed 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.

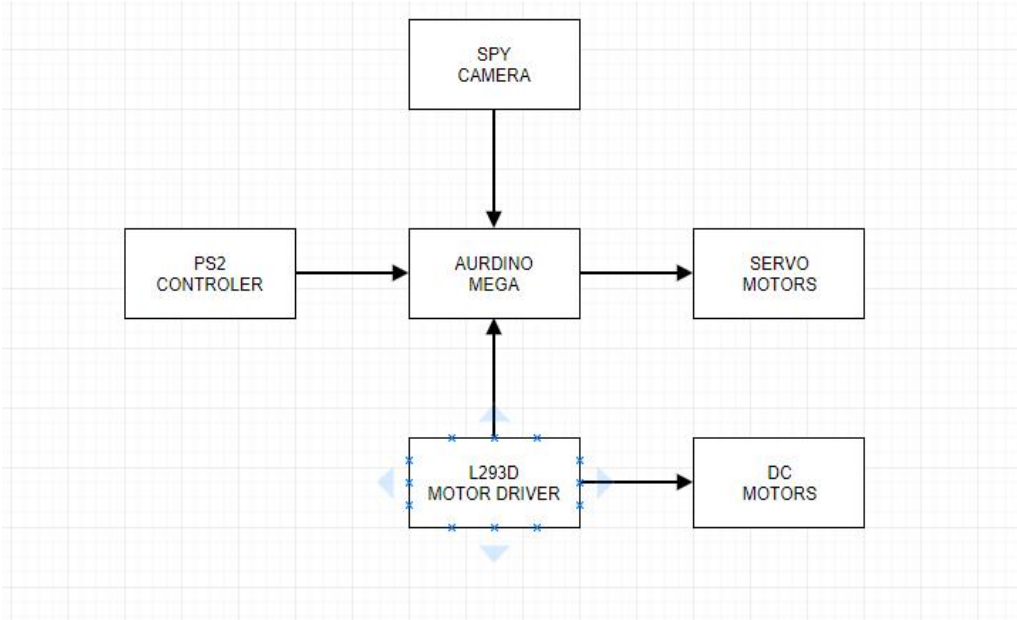
Pal Liljeback, Oyvind Stavdahl, Kristin Y. Pettersen, et.al. (2010) conclude that there is need of intelligent snake robot locomotion in unstructured environment and suggest two approaches for this. First design approach is based on measuring the joint constraint forces at the connection between the 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 analyzed 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.

Working Module



Snake robot is made by using Aurdino mega and servo motors. A servo motor is an electrical device which can push or rotate an object with great precision. It is used to rotate and object at some specific angles or distance. It is just made up of simple motor which run through servo mechanism. A very high torque servo motor in a small and light weight packages will be available.Arduino Mega 2560 is a developer board based on ATmega2560 microcontroller.Based on the structure and size of the snake robot,the servo motors used will be controlled by the Arduino mega and the adequate amount of power will be supplied for proper mechanism of the bot.Aurdino mega is programmed according to the movement of the snake and its stability.Initially servo motors are aligned in a straight position then it is precisely tilted in right and left directions by programming the Aurdino mega.

The snake robot consists of 8 segments.Each segment consists of servomotor.Those 8 servo motors are controlled by Aurdino mega.A pair of lego wheels are attached to segment for better and desire movement of the snake.ps2 controller is used to control the snake in different motions.A Mini spy camera is attached at the head part of the snake for the application* purpose and Two dc motors are used for forward and back ward motion of the snake which are controlled by the motor driver and 9v battery .

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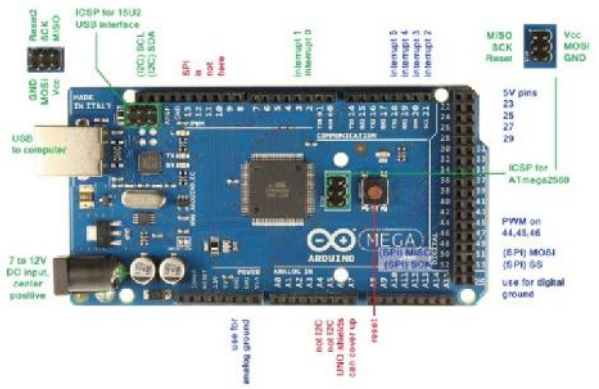
Arduino Mega



The Arduino Mega 2560 is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

PS2 Controller

The controller is the primary user interface for the PlayStation 2. With its winged shape, analog controls and abundance of well-positioned buttons, it is easy to use yet powerful.

The standard PS2 controller has 15 buttons; all of them, except for Analog, Start and Select are analog. They include:

four buttons arranged as a directional pad on the top left

Analog, Start and Select buttons in the top middle

• four action buttons on the top right

• two action buttons on the front left

• two action buttons on the front right

• one analog joystick on the top left

• one analog joystick on the top right

Servo Motor

A servomotor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration.

Servomotors are not a specific class of motor although the term servomotor is often used to refer to a motor suitable for use in a closed-loop control system.

Servomotors are used in applications such as robotics, CNC machinery or automated manufacturing.

A servo motor has everything built in: a motor, a feedback circuit, and most important, a motor driver. It just needs one power line, one ground, and one control pin**.**

servo motor has a female connector with three pins. The darkest or even black one is usually the ground. Connect this to the Arduino GND

1. Connect the power cable that in all standards should be red to 5V on the Arduino.
2. Connect the remaining line on the servo connector to a digital pin on the Arduino.

DC Motor

A DC motoris any of a class of rotary electrical machines that converts direct current electrical energy into mechanical energy.In our study, we use dc motor for forward and backward movements of robot.

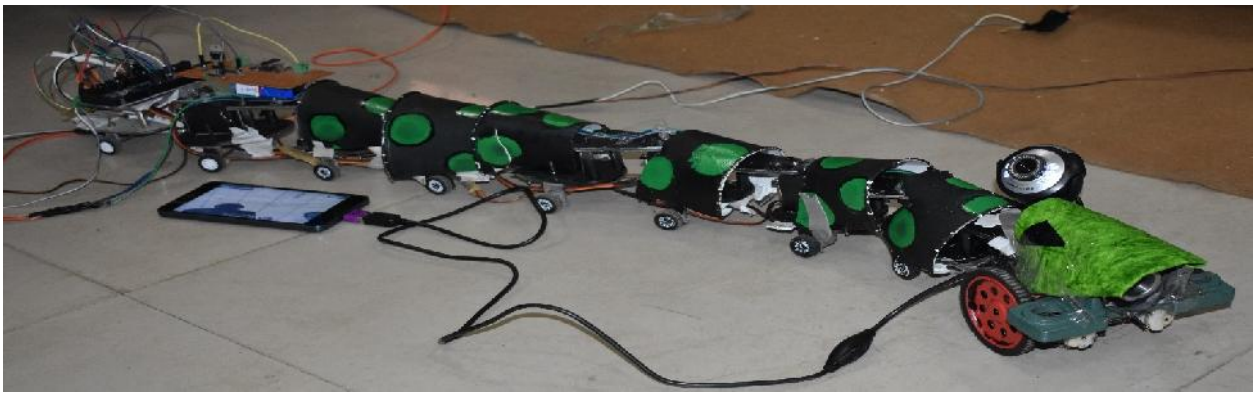


Fig. shows the prototype made by us for this research

Working model of snakebot is shown in the below link

https://drive.google.com/file/d/12TwuiNK4-pMOVEffO7dF6oJwBJuHZKJs/view

Applications

1.It can be used to detect several minerals and metals underground by knowing the exact location of the miners using GSM. This is possible by adding different sensors such as metal proximity sensors.The *spy camera attached in front of the bot allows it to see the surroundings which makes mining process easy.

2.Snake bot can be highly applicable in martial areas and can be used in many military applications.

3.It can travel easily in hollow pipes where it is impossible to reach. Pipeline leakage and blockages can easily be detected and checked

4. The exact location can be achieved by using GSM.

Conclusion

Snakebots are most useful in situations where their unique characteristics give them an advantage over their environment. These environments tend to be long and thin like pipes or highly cluttered like rubble. Thus, snakebots are currently being developed to assist search and rescue teams.Furthermore, when a task requires a number of different obstacles to be overcome, the locomotive flexibility of snakebots makes them good candidates

Also, snakebots can be used by animal control officers to subdue rabid or invasive creatures. Raccoons, barn cats, and large rodents typically respond to the snakebot's presence with attacks upon which the snakebot will emit an electrical shock and paralyze the aggressor.

In this paper we present a snake robot designed and fabricated to be able to move inirregular environment.On the other hand, a controlling system with a strong processor should be able to gather all the motors feedback with sensors data of the angle gage and by speedprocessing, if necessary, works automatically and controls the robot. We made the FSR robot to achieve these goals.The robot is a good case for mounting the different movement algorithms (e.g. going up and down the slopes and stairs) which are of our future team’s goals.

References

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