ISSN: 0974-2115
www.jchps.com Journal of Chemical and Pharmaceutical Sciences

Arduino Controlled Robotic Snake for Monitoring the Rescue Operations

P.Sabthagiri Rajan|*, M.Purushothaman
Department of mechatronics engineering, Jeppiaar engineering college, Chennai.
***Corresponding author: Email: sabthagiri93@gmail.com**

ABSTRACT

This paperaims to design the robotic snake which have the capabilities of moving in different environment for monitoring the rescue operations. The snake robot have both active and passive wheels for high stability. This paper presents a robotic snake design that possess the ability to monitor the room temperature and helps to find the possibility of human's life. The robotic snake is designed with sensors such as temperature sensors, ultrasonic sensors and it is designed in moderate size to attain easy locomotion. The most effective moving pattern of robotic snake is sidewinding is implemented. The robotic snake is used for many application such as surveillance purpose, monitoring the rescue operations, inspection of tightly packed space that people and conventional machinery cannot access. Detecting the temperature of tightly packed space. To access the robotic snake like a real biological snake, it is constructed with several joints that helps the robotic snake to have various degrees of bends, and gives the flexible to reach the area. This type of approach helps the robotic snake to move around in difficult and different environments.

KEY WORDS: robotic snake, monitoring, inspection, locomotion, search and rescue**.**

1. INTRODUCTION

Robotic Snake mechanisms are designed to move like biological snakes. The main advantage of such mechanisms is their long and exile body, which enables them to move and operate in challenging environments where human presence is unwanted or impossible. Future applications of these mechanisms include search and rescue operations, inspection and maintenance in industrial process plants, medical fields and subsea operations.

Based on the inspiration of biological snakes, the robotic snakes are carry the potential of meeting the growing need for robotic mobility in challenging environments. Snake robots consist of serially connected modules capable of bending in one or more planes. The many degrees of freedom of snake robots make them difficult to control, but provide reversibility in irregular environments which surpasses the mobility of more conventional wheeled, tracked and legged robots.

The authors' research on snake robot locomotion. Here the author decided to achieve the tracking to a desired trajectory avoiding postures without giving any gait beforehand. Here they says that the snake-like robot. Theordinary manipulability is not always associated with actual locomotability. When the number of links is large, zigzag windingshape is associated with high manipulability, whereas the actual locomotability may not be good because large forces on the wheels would be required.Therefore,They consider another manipulability for the snakelike robot taking side force on the wheels into consideration. Here they propose a simple controller capable of trajectory tracking and avoiding singular posture using proposed manipulability. Simulation results show that the robot spontaneously generates a suitable gait avoiding singular posture (Date, 2000).

The biological snakes and fishesare the inspirationfrom snakes and elongate fishes such as lampreys to produce a novel type of robot with dexterous locomotion abilities, andto use the robot to investigate hypotheses of how central nervous systems implement these abilities in animals. And also the locomotion is achieved with the CPG central pattern generators. They have two control patterns trajectory-tracking control, online gait generation control. They produces the snake like robot simulation and output of the robot locomotion (Alessandro Crespi, 2005).

Here the authorsuggests a new construction snake robot. This snake robot has ropes around body. When ropes are droved by motor, ropes around total snake robot body can drive shake robot move. Snake robot has driven force at any point touching ground. This construction make snake robot move forcefully. It is easily controlled than ordinary snake robot which only use twisting and wrenching. This construction is newkinds of snake robot construction and also its joints, control methods are discussed (Gao junyao, 2008).

Shigeo Hirose and Hiroya Yamada discussed about the biomechanical research on snakes and developmental research on snake-like robotsthat they have been working. There were also a smaller snake-like active endoscope; a large-sized snake-like inspection robot for nuclear reactor related facility, 1 m in height, 3.5 m in length, and 350 kg in weight; and several other snake-like robots. They feel that the technical difficulties in putting snake-like robots into practice have almost been overcome by past research, so that they believe such practical use of snake-like robots can be realized soon. Here they described the mathematical derivation for the locomotion and mechanical design for snake like robot are discussed briefly.

This paper gives the locomotion of snake robot by employing nonlinear system analysis tools for investigating fundamental properties of snake robot dynamics. Here they produce five contribution **(**1) a partially feedback linearizedmodel of a planar snake robot influenced by viscous ground frictionis developed. (2) A stabilizability analysis is presented provingthat any asymptotically stabilizing control law for a planar snakerobot to an equilibrium point must be *time-varying*. (3) A controllabilityanalysis is presented proving that planar snake robots are*not* controllable when the viscous ground friction is *isotropic*, butthat a snake robot becomes *strongly accessible* when the viscousground friction is *anisotropic*. The analysis also shows that thesnake robot does *not* satisfy sufficient conditions for *small-timelocal controllability* (STLC). (4) An analysis of snake locomotionis presented that easily explains how anisotropic viscous ground friction enables snake robots to loco move forward on a planar surface. The explanation is based on a simple mapping from linkvelocities normal to the direction of motion into propulsive forcesin the direction of motion. (5) A controller for straight line path following control of snake robots is proposed and a *Poincare map*is investigated to prove that the resulting state variables of the snake robot, except for the position in the forward direction, trace out an exponentially stable periodic orbit (AlLiljeb ack, 2011).

A new idea of robotic snakeare proposed s-shift control and a v-shift control for a snake robot moving vertical direction to its body. The v-shift control is installed to an experimental snake robot and the locomotion performance of robot is evaluated for the pipe composed of a straight pipe and an elbow pipe. As a result, the snake robot could successfully changes its locomotion mode to move the inside of the pipes with two types of helical rolling motion. And also derive the mathematical calculations for the helical bending curve. Bending curve, smooth shape movement, s shift and v shift calculation are done (AlLiljeb ack, 2011).

Here they succeed the robotic snake with straight line path follow robot are designed. This robot can avoid obstacles using tactile sensors. The mathematical calculations for this snake robot are derived by the author to refer. It took place for motion control, joint force control, and also using can bus controller to control the entire network for the snake robot. The simulation results are also shown in this paper for the mathematical calculation of snake robot. It shows that the way point of the snake robot can move by avoiding the obstacles (AlLiljeb ack, 2011).

The robotic snake which can swim in water aresuggested a new type of snake robot design that can also swim in the water. Here they present a modular snake robot of waterproof with joint mechanism using force and torque sensors. Here the gives a modular snake robot and a new type of design is shown. Using the can bus technology the control all the joints and force of the joints. For this joint control the mathematical calculation is presented (AlLiljeb ack, 2011).

The calculation of the snake robot are designed a new type of snake robot that can climb tree and move as per the locomotion by revolve itself. The design of the snake robot is said to be unified snake as per the snake robot size, weight, speed each module is designed. They contain motor and gear train and additional calculation and simulations are also took place (Cornell Wright, 2012).

Mathematical calculation are discussed and derived the snake robot calculation similar to biological snake. Here the calculation is analysis with the snake robot with line following path. The matrix derivation is done here for snake robot with analysis of controllability and stability. And also average analysis for snake robot is done for locomotion (Pettersen, 2013).

The author gives the complete study of paper on snake robot with sinus-lifting motion with a sequential optimization of a hybrid system. Here the robot moving pattern is done with lifting links. Were the active wheels and passive wheels are presented and the lifting links are presented in between them. The motion like earthworm moving. This moving pattern is otherwise called concertina motion. The complete mathematical calculation and equation for this moving pattern with simulation are done here (Satoshi Toyoshima, 2014).

The demonstration of locomotion reduction by automatically and its controlling a differential-drive car with 16 degree of freedom. And also the experimental validation of the snake robot locomotion is done. They place the camera in the head to monitor the environment and implementing the special system architecture. The clustered environment is analysis and motion according to that is analysis by visual feedback method. Here the path following robot have autonomously path free operation. The locomotivereduction technique allows for online control by directly modifying the gait in a continuous manner. This allows the robot to move in any direction as needed, rather than having to choose from a library of precompiled, discrete, motions are discussed (XuesuXiao,, 2015).

KamiloMelo describes an on-line method to calculate the position and orientation of the FFR for side-winding gaits in real-time. This serves as a basis for proposing a kinematic model to determine the magnitude and direction of therobot’s velocity V. Model validity is provided by comparisons with experiments (KamiloMelo, 2015).

The snake robot design is shown. This snake robot is designed with USAR. It helps to navigate and search purpose. This snake robot is designed with new development with gait and body parts. This snake robot have special system architecture and mechanical overview. And further electronics overview and simulation results are shown (Pramod Chavan1, 2015).

In this paper we described a new design of snake robot with arduino processor with ultrasonic sensor to sense the environment. Here the simple type of robotic snake is designed which is helpful to monitor the various operations. It took place a electronics part, mechanical part and programming part.

Electronics part: It consists of circuit diagram, block diagram. Here circuit diagram for locomotion of the snake robot. And the block diagram consists of processor and other specification deals in electronics section.

Mechanical part: In this part the mechanical design of the snake robot is shown. This design is designed as per the speed of the snake robot, processor size, and movement of the robotic snake.

Programming part: In this part the complete robotic snake is controlling position, movement pattern, sensors decision analysis etc are shown here.This snake robots are very low cost and easy to develop. This can be used in military purpose for surveillance,Urban searches, rescue operation monitoring and forest animals monitoring etc..,

Electronics part:

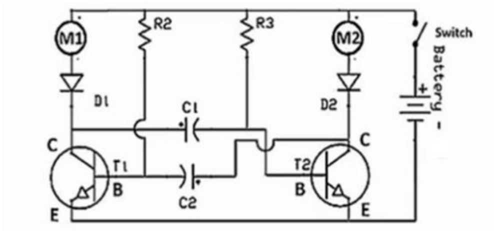


Figure.1. circuit diagram

Here this circuit diagram, shows the simple multi-vibrational circuit. This circuit shows the motion of robotic snake where the current flows alternative to both the wheels.so the motion of robotic snake can be easily achieved. The active wheels and passive wheels are present in this robotic snake. The active wheels are present in head position of the robotic snake. That wheels are connected with motors and the above circuit. So the snake sidewinding motion is achieved. Then the passive wheels are present in the below links of the robotic snake. So when the motion starts the whole body of the robotic snake starts motion. It is very low cost and easy to invent.so this can useful for many surveillance, monitoring etc.., operations.

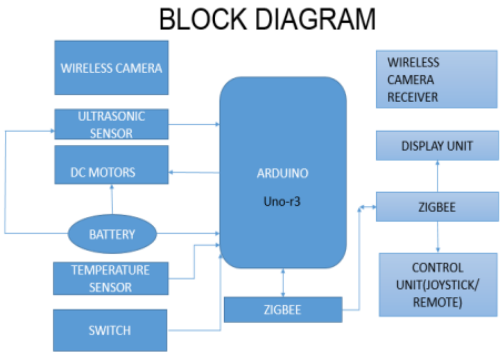


Figure.2. block diagram

As the above block diagram, shows that the robotic snake inner parts. The arduino processor is used here to control the robotic snake. This arduino processor is very cheap and easy to use and it has user friendly process. By connecting the ultrasonic sensors to the processor it sense the environment and make decision by automatic and also semi-automatic. The arduino controller controls the entire system as the program coded. Here the robotic snake requires the real time response and thus the zigbee is used to send and receive the real time data. Then the temperature sensor is used to connect with the processor and to the monitor division. So that the temperature of the particular area can be seen. It make the user to analysis the situation. At the user end computer is used for the monitoring purpose. The user can also control the snake using joystick on viewing from the computer. The controller here used is arduino Uno board. Power supply are given through the battery connected to the snake robot. The controller have sensors and detect the human and also environment. All the part of robotic snake are controlled by programming in arduino software. As per the program it can easily make decision and successful movement.

Mechanical part: The mechanical design of the robotic snake is shown in above fig. This 2d diagram, gives the dimensions and position of the robotic snake. The simple diagram is done with cad software. Thus the dimensions are made as per specification done in the paper. So this dimensions are more suitable for design and development of the robotic snake.

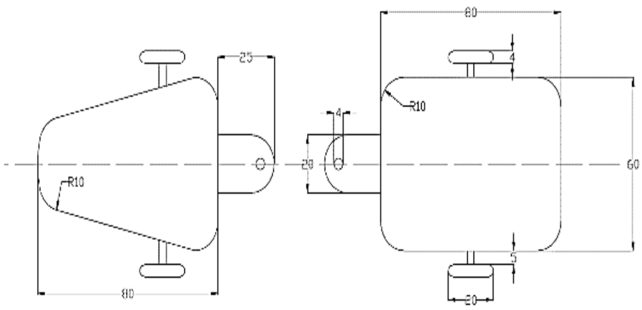
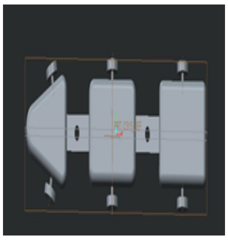


Figure.3. (2d) robotic snake design



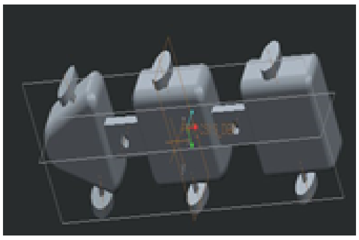


Figure.4. (3d) robotic snake design

This above 3d diagram shown in fig is robotic snake. Where the images are done with the help of pro-e software. This gives the robotic snake in 3-dimensional manner. The above image shown the roughly calibrated snake robot. The snake robot needs to add 6 more links to get the same locomotion as biological snake. The robotic snake are satisfy by the arduino controller.

The above fig shows that the position of the wheels placed in the robotic snake. Here the first head position of robotic snake alone be active wheels and other following robotic snake wheels are passive wheels. Where the motion belongs to the active wheels of the robotic snake. The motion are also the same as above images shows. The arduino controller makes the motion with the above shown circuit diagram. So by placing the wheels as same as the above image the robotic snake is achieved.

Programming part:

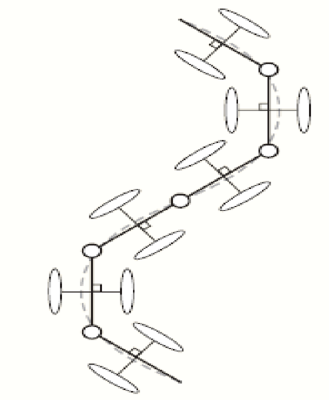


Figure.5. robotic snake design wheel position

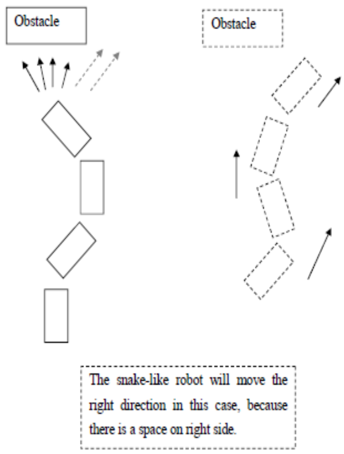


Figure.6. robotic snake and its movement decision

Here the robotic snake is programmed and the movement is achieved as by the above fig. The above fig shows that the motion and decision are taken when the obstacles are there the robotic snake makes move to its free end. While the obstacles is little closer than the sidewinding are move towards free end easily. Where this decisions are done by the programming section of the arduino software.

2. METHODS AND MATERIAL USED IN ARDUINO PROCESSOR SYSTEM

Arduino processor: Arduino controller provides the feature of robotic snake with all required action are available. There are many other processor are manufacturing by the various electronics companies. At-mega is the electronics company were controller manufacturing are done. Here the processor has the flash memory of 32kb its operating voltage of 5v.it input voltage various (7-12) v and output voltages various (6-20) v. Its static memory of 2kb and eeprom memory of 1kb.pulse width modulation digital I/O pins 6.analog input pins 6.clock speed 16 MHz .Its converts the pulse width signal to the control to move the snake robot. The generation of PWM as per. Signals using motor driver which helps the dc motor to rotate at required torque.

The Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, 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. You can tinker with your UNO without worrying too much about doing something wrong, worst case scenario you can replace the chip for a few dollars and start over again (AlLiljeb ack, 2012). Arduino uno board is shown in figure 4.2.

Figure.7.Arduino processor Configuration

The snake robot locomotion is mainly depends on the motor movement and it helps to control with the help of motor drivingL293d IC in which simultaneous running of two motors is possible.to make the robotic snake work in desired way and make if function various sensors are used to attach in the robot body (AlLiljeb ack, 2011). The snake robot is equipped with ultrasonic sensors. Ultrasonic sensors are also used for transceivers as they both send and receive, and referred as transducers. The Principle of ultrasonic sensor depends similar to SONAR or RADAR, by evaluating attributes of a distant object.

Simulation: The simulations are done using the arduino software and proteous software. The motor simulation of the robotic snake are done using the arduino and proteous software. The interfacing details is as follows the two dc motors are connected to the output pin (9, 10) of micro controller board. The ultrasonic sensor is used to avoid the obstacles since it can sense the environment.so it is most suitable for this application. This sensor is connected to the pin (7). The camera transmitting side to pin (2) while receiver side to (3). Then the temperature sensor also connect to the pin at arduino board. So that the temperature can be displayed at the display. For simulation, Arduino Uno library have to import first into the display and then sensors & motor have to be imported. As pin configuration is stated above the connections are made in the software. Later the program is loaded into the microcontroller for the simulation.

3. CONCLUSION AND FUTURE WORK

This paper concludes that the overall design of robotic snake inspired by biological snake. Here the special thing that the cost of the robotic snake is less. This robotic snake can easily design and develop by less expensive, robust and it is a helpful tool for the clustered areas. The department of surveillance purpose, medical field for major operations, scientific survey, searches, rescue monitoring purpose and also monitor the temperature of that particular area. The ongoing and future work is concentrated on the improvement of body design by implementing the multi-link body joints to attain the enhanced snake body sign motion and to some extent of military purpose it can locate the mines with help of advanced Sonar. The ability to traverse complex and difficult terrains like gaps, small holes, and pipes. Zigbee wireless communication is useful for robotic snake mechanism controlling. The snake robot is design and developed based on the weight, reliability, size and several metric design for performance. The main objective of our work is to provide enhanced and powerful embedded real time system for search and rescue operations, surveillance, exploration of planet and several. Other applications where it is difficult for humans and Conventional machinery to approach. The model that here is designed and Conforms that locomotion of a real biological snake by Understanding specific class of gaits. Finally, a full robotic snake can design and implement using an innovative manufacturing process aimed at reducing cost.

REFERENCES

Alessandro Crespi, Amphi Bot I, an amphibious snake-like robot, Robotics and Autonomous Systems 50, 2005, 163–175.

AlLiljeb ack P, A Modular and Waterproof Snake Robot Joint Mechanism with a Novel Force/Torque Sensor, 2012 IEEE/RSJ International Conference onIntelligent Robots and Systems, Vilamoura, Algarve, Portugal, 2012.

AlLiljeb ack P, Member, IEEE, Controllability and Stability Analysis of Planar Snake Robot Locomotion, IEEE Transactions On Automatic Control, 56(6), 2011.

AlLiljeb ack P, Member, IEEE, Snake Robot Locomotion in Environments with Obstacles, IEEE Transactions On Mechatronics, XX, 2011.

Cornell Wright, Design and Architecture of the Unified Modular Snake Robot, Robotics and Automation (ICRA), 2012 IEEE International Conference on, 2012, 4347-4354.

Date H, Locomotion Control of a Snake-Like Robot based on Dynamic Manipulability, Proceedings of the IEEE/RSJInternational Conference onlntelligent Robots and Systems, 2000

Gao junyao, Design and Research of a New Structure Rescue Snake Robot with All Body Drive System, Proceedings of IEEE International Conference onMechatronics and Automation, 2008.

KamiloMelo, Modular Snake Robot Velocity for Side-Winding Gaits, 2015 IEEE International Conference on Robotics and Automation (ICRA)Washington State Convention Center Seattle, Washington, May 26-30, 2015.

Pettersen K.Y, Snake Robots from Biology to Nonlinear Control, 9th IFAC Symposium on Nonlinear Control Systems Toulouse, France, September 4-6, 2013.

Pramod Chavan1, Modular Snake Robot with Mapping and Navigation Urban Search and Rescue (USAR) Robot, International Conference on Computing Communication Control and Automation, 2015.

Satoshi Toyoshima, A Study on Sinus-Lifting Motion of a Snake Robot With Sequential Optimization of a Hybrid System, IEEE Transactions On Automation Science And Engineering, 11(1), 2014.

TetsushiKamegawa, V-shift control for snake robot moving the inside of a pipe with helical rolling motion, Proceedings of the 2011 IEEE International Symposium on Safety, Security and Rescue Robotics Kyoto, Japan, November 1-5 2011.

XuesuXiao, Locomotive Reduction for Snake Robots, 2015 IEEE International Conference on Robotics and Automation (ICRA) Washington State Convention Center Seattle, Washington, May 26-30, 2015.