An Investigation into the Future of Agile Motion – Snake Robot

Ahsana Fathima E[1], Sudheer S Marar[2]
[1]*Student scholar, Nehru College of Engineering and Research Center, Pamapady, India.*
[2]*Professor& HOD, Department of MCA.*

***Abstract*—By comparing uploaded images to a database of missing children, this paper suggests using deep learning to find Indian children who have gone missing. A Convolutional Neural Network (CNN) is trained to recognize faces using a pre-trained VGG face deep architecture. The technology enables users to contribute images of youngsters who appear suspicious along with landmarks and other information, and it also enables law enforcement or other authorities to view information about children who have gone missing. The best match is chosen by the algorithm, which automatically compares the provided photograph with the database's registered photos of missing children.**

***Index Terms*—Agile motion, sensor performance, slithering locomotion, snake robot.**

I. INTRODUCTION

'SnakeBot' is also known as snake robot. Snake robots are advanced types of robotic technology that have been increasingly popular in recent years. They are designed to imitate the movements of snakes and can navigate various environments with flexibility and agility. The capacity of snake robots to maneuver through confined spaces, scale walls, and traverse challenging terrain has made them increasingly desirable. Snakes, exhibit excellent mobility in various terrains and can move through narrow passages and climb on rough ground. This natural ability has inspired the development of snake-like robots with high degrees of freedom and the ability to move without active wheels or legs. Such robots have a wide range of applications, including search and rescue missions in earthquake areas, surveillance and maintenance of complex and dangerous structures, an inspection of sewer systems or aiding firefighters in cities, and minimally invasive surgeries and medical procedures in healthcare. Moreover, snake robots with one end fixed to a base can serve as robot manipulators to reach hard-to-get-to places.

'SnakeBot' is also known as snake robot. Snake robots are advanced types of robotic technology that have been increasingly popular in recent years. They are designed to imitate the movements of snakes and can navigate various environments with flexibility and agility. The capacity of snake robots to maneuver through confined spaces, scale walls, and traverse challenging terrain has made them increasingly desirable. Snakes, exhibit excellent mobility in various terrains and can move through narrow passages and climb on rough ground. This natural ability has inspired the development of snake-like robots with high degrees of freedom and the ability to move without active wheels or legs. Such robots have a wide range of applications, including search and rescue missions in earthquake areas, surveillance and maintenance of complex and dangerous structures, an inspection of sewer systems or aiding firefighters in cities, and minimally invasive surgeries and medical procedures in healthcare. Moreover, snake robots with one end fixed to a base can serve as robot manipulators to reach hard-to-get-to places.

II. LITERATURE SURVEY

Several studies have been conducted on the design, control, and use of snake robots over a long period. We will examine some of the most significant research projects and advancements in the field of snake robots in this literature review.

The first modular snake robot was created in the 1990s by Hirose and his colleagues, who also carried out one of the early research on snake robotics. The robot was made out several components that could be joined in various ways to produce varied shapes and actions. With the help of this design strategy, the robot was able to maneuver through challenging settings by mimicking the movement of actual snakes. The advent of continuum robots was a big advancement in the realm of snake robots. Contrary to modular robots, which employ stiff segments, continuum robots are flexible machines that move using a continuous structure. Snake robots can now move more fluidly and adapt to their surroundings thanks to the invention of continuum robots, which have given them new options.

Current research has concentrated on enhancing the navigation and control of snake robots. The use of networked control algorithms for snake robots was examined in one such study by Marchese and Rus (2014). The scientists showed how distributed control might enhance the stability and dexterity of snake robots, allowing them to move through difficult areas with more accuracy. Several industries, including manufacturing, inspection and maintenance of industrial buildings, medical treatments, and search, and rescue, are using snake robots in a variety of applications. Snake robots, for instance, can be utilized for minimally invasive surgery, pipeline inspection, and the hunt for survivors in disaster areas. Although snake robots have a lot of benefits, they have drawbacks as well that must be overcome for them to be developed and used. The ability to regulate the complicated motions of a flexible robot can be one of the key obstacles while developing snake robot technology. The creation of sensors that can precisely track the robot's position and movement in real-time presents another difficulty.

III. APPLICATIONS

Search and rescue: Snake robots are the best choice for search and rescue operations in regions that are inaccessible to human rescuers. During a natural disaster, they might be used to look for survivors in destroyed structures or debris.

Uses in Medicine: Snake robots are being created for uses in medicine, including as minimally invasive operations. The robot can move through intricate and small areas in the body due to its snake-like form.

Environmental surveillance: Snake robots can be employed for environmental monitoring and to explore locations that are challenging to reach. They can be used, for instance, to observe wildlife and explore aquatic habitats.

Uses in the Military: Snake robots have military uses like observation and spying. They are capable of navigating challenging terrain and can offer military troops useful information.

3.1 Challenges

- Because of their complicated construction and multiple joints, snake robots are challenging to steer and manoeuvre.
- Snake robots' high power and energy requirements make them problematic in various situations.
- Durability is a problem with snake robots since they are susceptible to damage from obstacles and severe settings.
- Snake robots may have trouble installing sensors in constrained locations and interacting with their surroundings.
- Snake robots may be expensive to produce and maintain due to its intricate structure and cutting-edge materials.

IV. METHODOLOGY

4.1 Procedures

4.1.1 Design and Modeling:

The first phase entails developing and modeling the physical components of the snake robot, such as its body segments, joints, and actuation systems. The robot's intricate 3D models might be made using computer-aided design (CAD) software.

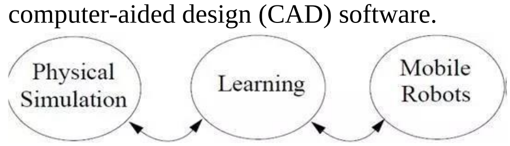

Fig 1: configuration and design

4.1.2 *Development of the control system:* The following step is the development of the control system that will allow the robot to move in a snake-like motion. This entails creating software and control algorithms that can provide the movement patterns required for the joints of the robot.

4.1.3 Testing and prototyping: After the control and design systems have been created, a snake robot prototype is constructed and tested. The prototype, which is often a more condensed form of the finished robot, should still be able to demonstrate the fundamentals of mobility.

4.1.4 *Refinement and Optimization*: The design and control systems are improved and optimized based on the testing findings to increase the performance of the robot. This could entail modifying the control algorithms, changing the physical structure, or using new materials or components.

4.1.5 *Final verification and assessment:* The snake robot's final version is tested and analyzed to make sure it satisfies the required performance standards once the necessary improvements have been made. This could entail evaluating the robot's performance against that of other robots or animals while testing it in various circumstances, such as on uneven terrain or in cramped quarters.

4.2 Slithering locomotion

People have been building devices with surprising amounts of animal-like movement and appearance for millennia. Serpentine locomotors are typically used in settings where conventional machinery is impractical because of their size or design. For instance, surroundings can include confined places, protracted inner voyaging, and traversing loose terrain and materials. Wheels provide efficient and slick mobility, but their best application frequently necessitates modifying the terrain. If particular sectors are not considered as a whole, integration is difficult, if not impossible.

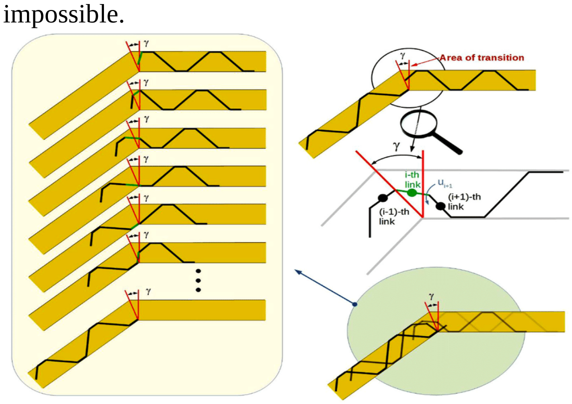

Fig 2: Snake robot locomotion through a curved pipe

The commands used to set the servo motors' angles. When every servo is turned 90 degrees, the snake is in a straight line. The servo will then be instructed to bend left or right if the angle is less than or higher than 90. A command with the following syntax is used to control each servo to go forward:

*sn.write(90+**amplitude***cos(**frequency*****counter***3.14159/180 - **n*****lag**)*

The current section is represented by the number n, and the values range from 1 to 12, amplitude calculates the wave’s width, and frequency estimates the snake's pace.

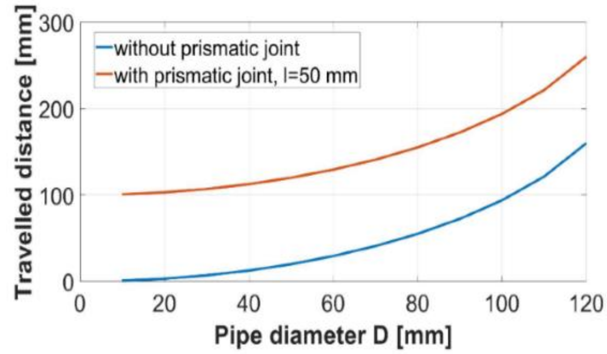

Fig 3: Symmetry

4.3 Advantages and Disadvantages

4.3.1 Advantages

Stability: A snake robot cannot topple over unless it purposely crawls down a precipice. Wheeled and legged robots, however, must be extremely stable in rocky terrain or they risk tipping over. Vehicles' terrain contacts create a constellation of points on the ground; if the center of gravity shifts outside the confines of the convex polygon created by these points, the vehicle topples. As the potential energy is often low in serpentine robots, stability issues rarely arise and the support polygons created by the contact points of the wheels and legs are not required.

Size: Snake mechanisms can penetrate smaller cross-sectional regions than mass-equivalent legged or wheeled vehicles because of their modest frontal areas, depending on the mechanism design. A snake's length will increase four times if its volume, which has a cylindrical structure, is kept constant but its diameter is cut in half. Vehicles that have a very long cross-section may be produced by mechanisms with similar mass and density.

Agile motion: Snake robots are capable of maneuvering in narrow areas that are inaccessible to other robots or people and can move in complex environments. Because of this, they are perfect for jobs like searching for missing people or examining pipes and other buildings.

Cost-effectiveness: Snake robots are a cost-effective solution for many applications since they can be designed and constructed for less money than other robotic devices.

4.3.2 Disadvantages

Restricted payload capacity: Owing to their elongated and flexible shape, snake robots frequently have a limited payload capacity, which can restrict their practical applications in some circumstances.

Complexity: Snake robots are intricate devices that need specialized hardware, software, and control systems, which can make them costly and challenging to manage.

Challenges with control and navigation: Because snake robots are flexible and highly articulated, it can be difficult to steer them across complicated terrain. This can restrict their usefulness in some situations.

V. PROPOSED SYSTEM DESIGN

To replicate the motion and functionality of a real snake, the snake robot's system architecture integrates mechanical, electrical, and software components. The system architecture makes it possible to navigate difficult and dynamic environments with ease by giving priority to flexibility, agility, and adaptation. Dependability and robustness guarantee proper performance in a variety of settings. Interconnected subsystems in the architecture allow for snake-like movement**.** Some of the essential components of the suggested system design include the following subsystems:

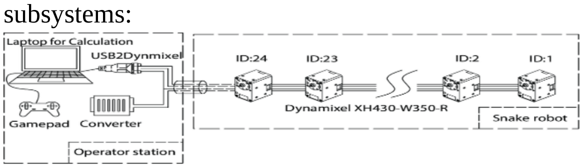

Fig 4: System structure of snake robot

Body construction: The snake robot's body is typically made up of several connected segments, each having one or more actuated joints. Flexibility, durability, and mobility should all be prioritized in the body's design.

*System of locomotion***:** The snake robot's locomotion system consists of actuators, sensors, and controllers that give it the flexibility to move in a variety of ways, including slithering, climbing, and swimming. The robot should be able to move through complicated and dynamic surroundings with the help of a locomotion system that is built to offer a high degree of agility and adaptability.

*Sensing and perception***:** The snake robot often consists of a variety of sensors, including cameras, ultrasonic, and infrared, to enable it to sense its surroundings and decide what to do.

*Control system***:** Actuators, sensors, and onboard processors are just a few of the various parts that make up the snake robot's control system, which is in charge of coordinating their varied motions. To offer precise and quick control over the robot's operations, a control system must be created.

*Power source***:** For the snake robot to work autonomously for a long time, it needs a dependable and efficient power source, like batteries or fuel cells.

5.1 System implementation

Constructing the robot and incorporating it into the control system is the snake robot system implementation.

- Connect the snake robot's many modules—each of which contains motors, sensors, and other components—in a chain to complete the construction.
- Using a control system made up of microcontrollers, sensors, and other electronics, move the snake robot by turning on its motors.
- Use programming languages like Python or C to set up microcontrollers to accept information from sensors and trigger the motors as necessary.
- Test and refine the snake robot system to make sure it moves as planned, making any necessary alterations to the physical parts or control setup in light of the testing results.
- Test and improve the snake robot system repeatedly until the target performance level is reached

VI. APPLICATIONS

Search and rescue: Snake robots are the best choice for search and rescue operations in regions that are inaccessible to human rescuers. During a natural disaster, they might be used to look for survivors in destroyed structures or debris**.**

*Uses in Medicine***:** Snake robots are being created for uses in medicine, including as minimally invasive operations. The robot can move through intricate and small areas in the body due to its snake-like form**.**

Environmental surveillance: Snake robots can be employed for environmental monitoring and to explore locations that are challenging to reach. They can be used, for instance, to observe wildlife and explore aquatic habitats.

*Uses in the Military***:** Snake robots have military uses like observation and spying. They are capable of navigating challenging terrain and can offer military troops useful information.

VII. CONCLUSION

This paper gives a brief description of the future of snake robots. SnakeBot or snake robot is a mix of software and hardware components that work together to produce the needed functionality.

To sum up, snake robots have been created to move similarly to genuine snakes, enabling them to navigate through confined spaces and difficult terrains that other robots or humans cannot easily reach. From search and rescue operations to the discovery of dangerous settings, the snake robot offers a promising technology with a wide range of possibilities. The capacity to move through complicated settings that are frequently inaccessible to wheeled or tracked robots is made possible by the special way that snake robots move. The creation of snake robots is still in its early phases, and there are still many technical issues that need to be resolved, such as enhancing their energy effectiveness, robustness, and control algorithms. Yet, the developments in snake robots have already had a big influence, and it appears that the deployment and further development of these cutting-edge devices will be successful in the future.

REFERENCE

[1] "Snake Robots: Robotics, Modelling and Control" by Farooq Azam and Shakeel Ahmad.

[2] Hosoda, K., Takaiwa, M., & Tsuchiya, K. (2012). Development of the snake-like robot system: A new generation therapeutic robot for gait rehabilitation. In Proceedings of the 4th IEEE RAS & EMBS International Conference on Biomedical Robotics and Biomechatronics (BioRob) (pp. 163-168).

[3] Chen, S., Wang, S., Gao, W., & Zhang, H. (2019). Review of the application of snake robots in the field of search and rescue. Safety Science, 118, 138-148

[4] https://chat.openai.com/chat

[5] http://www.123seminarsonly.com/Seminar-Reports/001/Snake-Robots.html

[6] https://krazytech.com/technical-papers/snake-robot-the-future-of-agile-motion

[7] https://www.researchgate.net/publication/316471922