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# A Head Stabilizer of A Snake Robot Crawling in Serpentine Locomotion

**Zihao Li, Jiangpeng Hu, Qinyuan Ren**

**College of Control Science and Engineering**

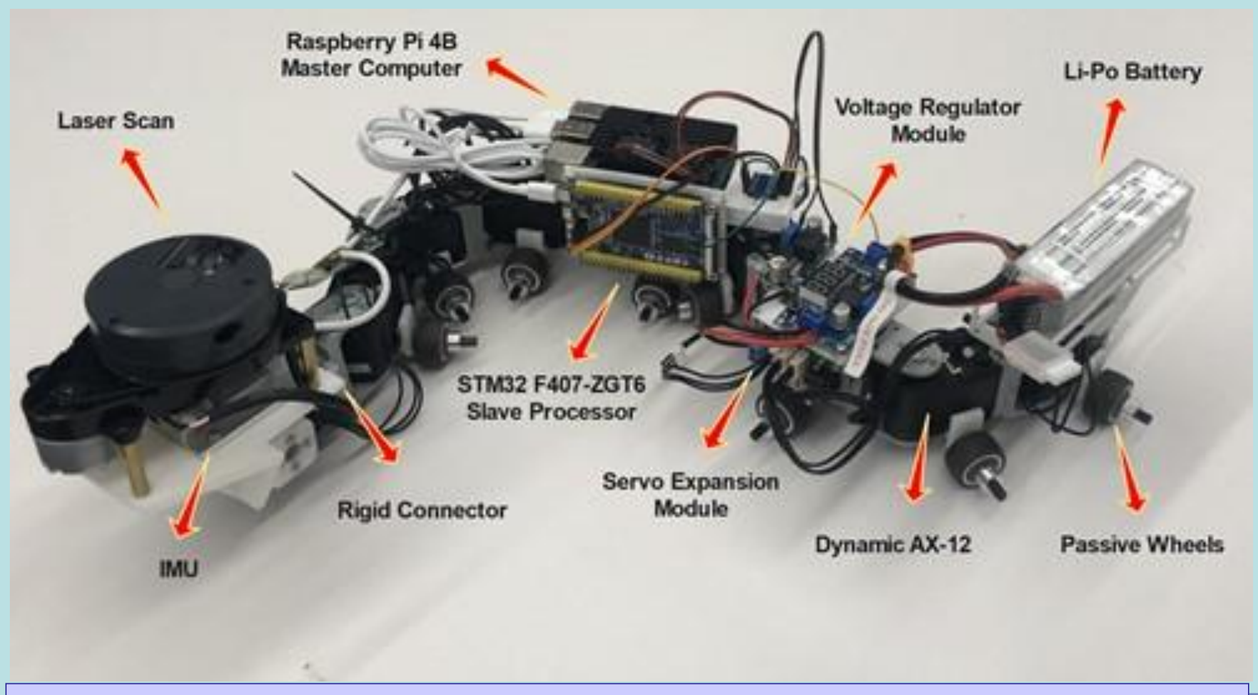
**Zhejiang University**

## Abstract:

Stabilizing the head module of snake robots is challenging, because these robots implement swinging locomotion to move. In this paper, a snake head stabilizer is designed based on Serpentine locomotion, which is similar to the head stabilizer of a real snake. In this stabilizer model, some feature points, namely inflection points, are defined on a Serpenoid curve through deriving the parametric equations of Serpenoid curve. These inflection points are proved that all of the points are on a certain circle, whose radius and position of center are determined by the parameters of Serpenoid curve. The desired direction of the snake head module can be obtained by the positional relationship between the circle center and the head joint. To verify the effect of stabilizer, simulation and experiments are conducted. The results prove that the stabilizer effectively reduces oscillation amplitudes of the head module during movement, which is worthy to be popularized in industry.

## Contribution:

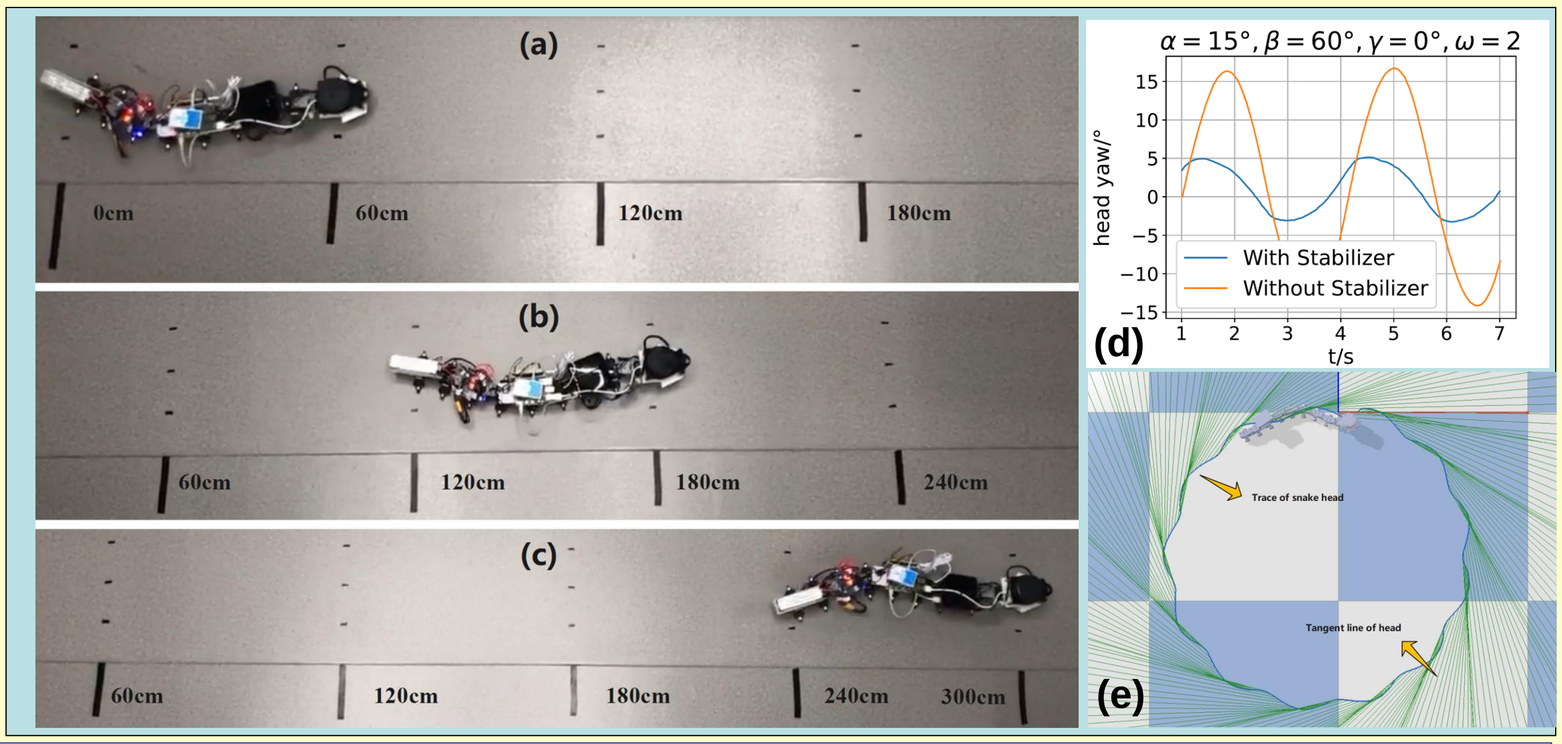
1) The objective of our work is to solve the head stability problem when a snake robot moving in Serpentine locomotion.
2) We propose an algorithm on head stabilizer based on the robot's body shape which has a respectable performance in all movement directions.
3) Both simulation and experiments on the snake robot are conducted, which verifies the effect of head stabilizer. The additional experiments on path tracking are carried out based on the proposed head stabilizer.




**Experiment platform consists of 8 servo motors, equipped with Raspberry Pi, laser scan and IMU.**

## Experiment Results

**Fig. (a)~(c): The snake robot is following a straight line based on the head stabilizer and IMU feedback. At a distance of 2m, its lateral offset is significantly reduced compared with the results with no head stabilizer. Fig. (d): The measured yaw angles of head module in PyBullet simulation environment. Fig. (e): The direction of head module when the robot is turn around.**




## Summary

In this paper, the stability of a bionic snake head is studied. Based on Serpentine locomotion, a method of approximate motion direction control of the snake head is designed. For Serpenoid curve, this method proposes an assumption that all inflection points are on a circle and we strictly prove it. Through this method, the direction of the snake head is very close to the true direction of motion, with a small amplitude of sinusoidal error. Adopting this method to stabilize the snake head, a relatively stable platform in dynamic motion is obtained, which provides necessary conditions for the installation of sensors. The head stabilizer performs well in multi-direction controls, which makes the proposed method reliable and convenient to be employed in further research on robotic applications.