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Operation Viper Scope

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Abstract: *Robotic systems designed for confined and hazardous environments are increasingly important in modern engineering applications such as search and rescue, industrial inspection, and surveillance. Traditional wheeled and legged robots face mobility constraints in narrow, cluttered, and irregular terrains. This paper presents Operation Viper Scope, a low-cost, modular snake robot integrating bio-inspired locomotion, real-time vision streaming, low-latency wireless communication, and audio feedback mechanisms. The system utilizes the ESP32 microcontroller for motion control and system coordination, the ESP32-CAM for live video streaming, and the nRF24L01+ module for reliable low-latency control communication. A DFPlayer Mini module provides SD-card-based audio alerts to enhance operational awareness. The modular architecture ensures scalability and adaptability for multiple applications. Experimental validation demonstrates improved maneuverability, responsive control, and stable visual feedback in constrained environments. The proposed system offers a cost-effective, open-source solution suitable for academic, industrial, and defense applications.*

Keywords: Snake Robot, Bio-Inspired Robotics, Modular Robotics, Real-Time Video Streaming, Wireless Communication, ESP32, NRF24L01, Embedded Systems, Search and Rescue, Surveillance Robotics

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