A Novel Robotic Mechanism for Efficient Inspection of High-Voltage Transmission Lines

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The Problem: Risks and Costs of Traditional Inspection

- Inspections of high-voltage lines are essential for power system reliability.
- Traditional methods involve helicopters and human operators, making it a hazardous and costly task.
- Robotics emerges as a safer alternative, aiming to carry out these tasks autonomously and eliminate human exposure to risk.

Project Challenges & Objectives

Challenges:

- Physical Obstacles: Presence of vibration dampers, markers, and other components on the lines.
- Stability: Maintaining the robot's balance, especially under adverse conditions like wind.

Our Objective:

- To develop a robotic mechanism capable of efficiently overcoming these obstacles through sequential movements, all while maintaining balance and continuous locomotion for inspection.

Design Strategy: A Focus on Stability and Modularity

Stability Principle: The center of gravity is positioned as low and centrally as possible.

Material & Build: The main structure is built from aluminum profiles, ensuring lightness and high modularity for future enhancements.

Protection & Counterweight: Steel plates protect components and also serve as counterweights.

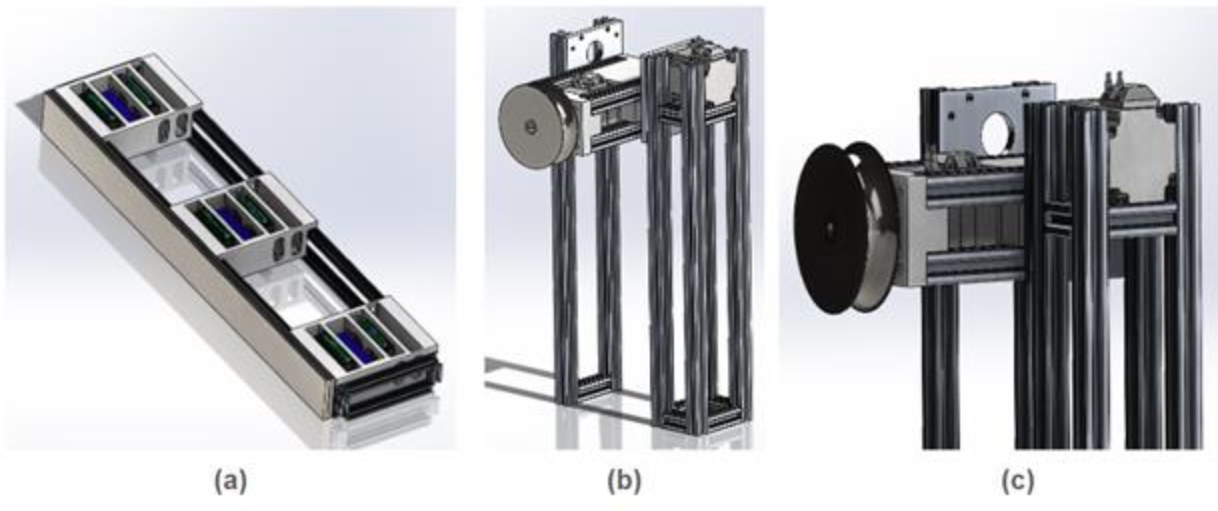

Figure 1: Parts of the robot: (a) the main section, (b) and (c) the vertical structures.

Locomotion Mechanism

Components:

Three stepper motors for locomotion.

Steel pulleys with a one-inch gap to move along the cable.

This provides stable and precise linear motion along the steel cable.

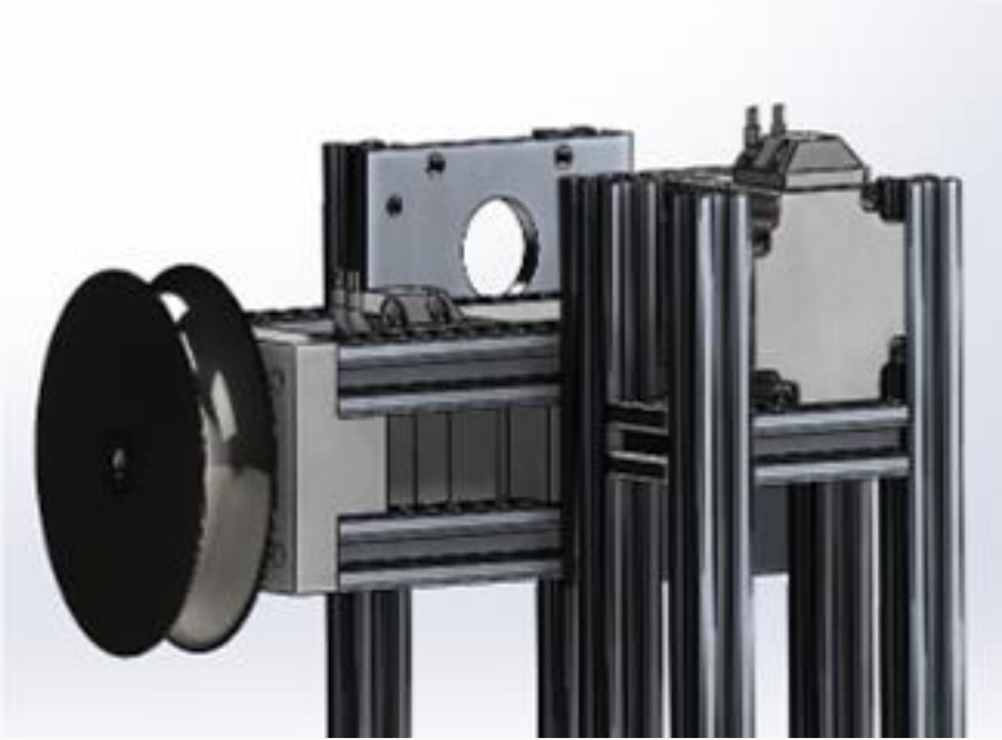

Figure 2: Locomotion System with the pulley and the stepper motor

The Innovation: The Pivoting Mechanism for Traversal

- A system designed to allow the robot to overcome obstacles.
- Each motor/pulley assembly can independently rotate 90 degrees clockwise.
- Actuated by a gear transmission system with a 2.75:1 reduction ratio.

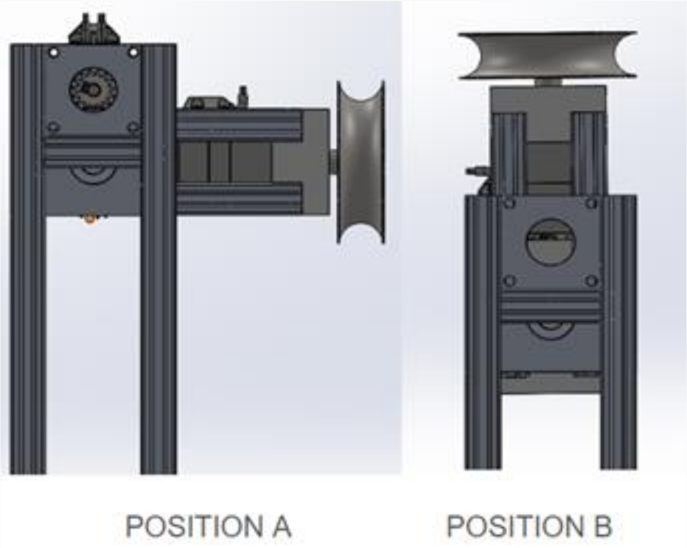

Figure 3: Pulley Positions

Traversal Sequence

1. The robot approaches the obstacle.
2. The first pulley pivots, lifts, and moves past the obstacle.
3. The second pulley repeats the movement.
4. The third pulley repeats the movement.
5. The robot completely clears the obstacle, and the pulleys return to their original position.

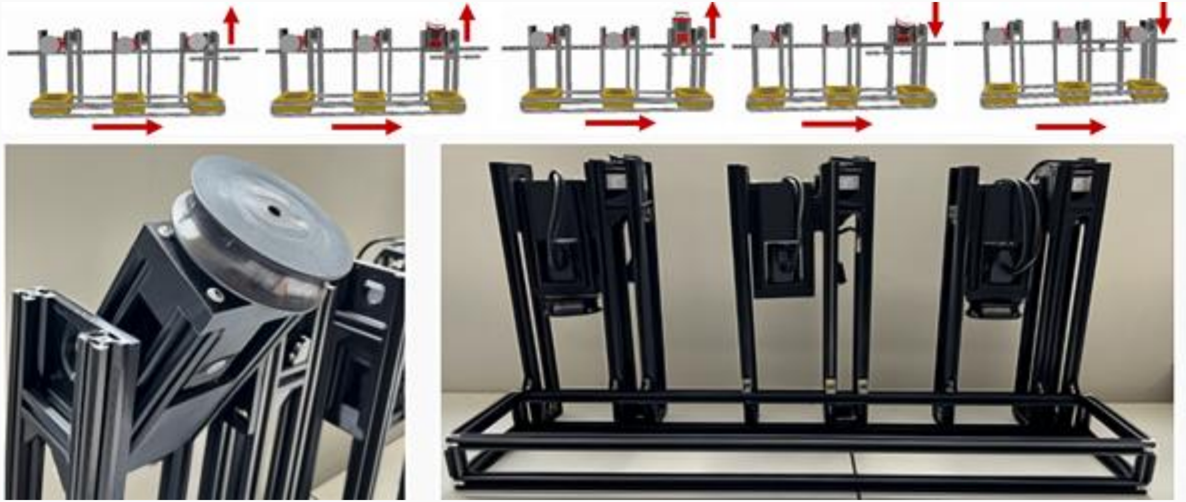

Figure 4: Demonstration of actuation and obstacle avoidance.

Ensuring Safety: Mechanical Locking System

- A locking system was implemented to protect the motors of the pivoting system.
- It uses solenoid actuators that engage to prevent excessive load on the motors.
- This functions as a mechanical safety lock, ensuring the robot remains securely suspended.

Conclusion & Future Work

Results:

- The modular aluminum structure proved to be robust and highly effective.
- The obstacle avoidance system successfully navigated around vibration dampers, demonstrating that the system is a viable solution.
- The robot offers a promising alternative for autonomous and safe power line inspection.

Future Work:

- Integration of inspection sensors (cameras, thermal sensors).
- Enhancing navigation autonomy and decision-making.

Acknowledgments & Contact

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