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Amphibious Pipe Inspection Robot

Today, robots are designed for use on and in complex terrains and environments. In situations where it is cumbersome and/or hazardous to humans, unmanned vehicles are essential. For example, utility pipe cleaning can cost up to $400,000 per 10-mile segment, with workers scouring miles-long stretches of pipe to remove debris and identify problem areas. In some segments, the cleaning hose (~850 ft.) may not reach the center of the pipe sections. In order to address these challenges, robots must feature multi-functional and multi-modal means of locomotion.

Researchers at Arizona State University have developed an untethered and unmanned amphibious submersible robot for maneuvering through irrigation pipes to locate and detect obstructions and infrastructure imperfections. The robot can traverse complex deformable terrain, dry and semi-wet media, as well as swim underwater. Onboard visual and sensors allow for self-navigation and self-extraction.

Its four legged-wheels or "whegs" maximize traction and slippage when on land (e.g., granular, gravel, and rocky terrain) and wetland (e.g., saturated and muddy environments). As the robot transitions from dry to wet conditions, the two back propellers provide forward thrust. Since the robot is naturally buoyant, two additional propellers oriented vertically enable vertical propulsion in water. This allows the robot to easily maneuver in 3D space. The robot is capable of self-navigating and self-extracting through visual feedback provided by a front-mounted laser scanner and camera system. Additionally, the robot features a six-degree-of-motion robotic arm with a sonar image sensor at its end effector, allowing for localized analysis. Although the system has been designed for irrigation pipe inspection, its versatility can extend into other domains.

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Potential Applications:

- Irrigation inspection
- Mining and cave exploration
- Agricultural land assessment
- Deep sea exploration
- Search-and-Rescue

Benefits and Advantages:

- Capable of traversing different forms of terrain (e.g., sand, gravel, rocks, mud), over and through various obstacles (e.g., confined spaces with obstructions), and underwater (e.g., pipes, channels, coves)
- Untethered and unmanned
- Robotic arm with integrated sonar sensor enables localized analysis