PROJECT ABSTRACT

In-Pipe Inspection Robot with Camera

A tethered in-pipe inspection crawler for 100–150 mm pipes with ESP32-CAM live video, LED illumination and spring-loaded traction wheels. Delivered built-to-order with working prototype, firmware, test-pipe guide, report, PPT and viva kit.

01. Title

In-Pipe Inspection Robot with Camera

02. Introduction / Background

Pipelines fail where nobody can see: cracks, root intrusion, scale and joint displacement grow inside buried and built-in pipes until the failure surfaces as a burst main, a blocked drain or contaminated supply. Professional inspection crawlers exist but cost lakhs, putting them beyond college labs and small municipalities. This project builds the concept at student scale: a tethered in-pipe crawler with live camera video, sized for common 100–150 mm pipes, verified in a transparent test pipeline the student builds.

03. Problem Statement

Pipe-robot concepts are easy to sketch and hard to make work — traction inside a smooth round pipe, lighting a dark tube for the camera, and guaranteeing retrieval are the real problems. The project addresses them directly: spring-loaded wall traction, LED illumination design, and a tether that makes losing the robot impossible, each documented as design analysis in the report.

04. Objectives

- Build a compact crawler fitting 100–150 mm pipes.
- Achieve wall traction with spring-loaded drive wheels.
- Stream live inspection video with LED illumination.
- Guarantee retrieval with a tethered control design.
- Verify with defect-spotting trials in a transparent test rig.
- Deliver the complete student kit: prototype, firmware, rig guide, report, PPT and viva Q&A.;

05. Proposed Methodology

The project proceeds in three stages. (1) Mechanical: compact chassis, spring-loaded traction arms with geared DC motors, ESP32-CAM and LED array at the nose, tether attachment. (2) Firmware: Wi-Fi video streaming, drive control and LED control on the ESP32. (3) Trials: the student builds the transparent test-pipe rig with a bend, plants known defects, runs the crawler through, and logs detections against the planted defects for the report.

06. System Architecture / Working

Inserted at the pipe mouth, the crawler's spring arms press the drive wheels against the wall. The operator drives it via the tether link while the ESP32-CAM streams illuminated video to a phone or laptop. Through bends the spring arms keep the wheels loaded and traction holds (design). Planted defects — crack tape, intrusions — are spotted on the live

feed and logged with distance markers; the tether then retrieves the crawler.

07. Hardware / Software Requirements

- ESP32-CAM module
- Compact geared DC motors
- Spring-loaded traction arms (fabricated)
- White LED array
- Compact H-bridge motor driver
- Lightweight tether cable
- Transparent test-pipe rig materials (acrylic/PVC)
- Arduino IDE (C/C++ firmware)

08. Expected Outcomes

- A crawler that traverses 100–150 mm test pipes with live video.
- Documented traction, lighting and tether design analysis.
- Student-run defect-spotting trials with a detection log.
- A complete report, PPT and viva Q&A; on in-pipe robotics and test methodology.

09. Applications

- Pipeline-inspection concept demonstrations for civil/mechanical labs.
- Teaching compact mechanism and traction design.
- Drain and duct inspection studies at lab scale.

10. Future Scope

- Onboard defect detection with edge AI on the video feed.
- Untethered variant with onboard battery and data logging.
- Articulated multi-segment crawler for complex pipe networks.
- Sonar ranging for pipe-diameter profiling.