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PROTOTYPE ROBOT FOR THE INSPECTION OF SEWER SYSTEMS

The present work reports on the development of a low-cost robotic vehicle designed for the inspection of sewer systems, a task that currently faces a crisis of obsolescence and high rates of occupational accidents within the Mexican infrastructure context. Unlike high-end commercial systems that impose an economic barrier for municipal agencies, this proposal utilizes open-source hardware to democratize access to preventive maintenance tools. The prototype features dimensions of 20 cm x 14.5 cm to ensure transit through standard 8-inch pipelines and is based on an Arduino Mega 2560 control unit. Its functional architecture integrates a multivariate sensor network including a VL53L0X Time-of-Flight sensor for obstacle detection with sub-centimetric precision, a GY-521 inertial measurement unit to monitor orientation and stability, and an encoder system for linear odometry recording. Real-time image acquisition and video streaming are managed via an ESP32-CAM module, while teleoperation is guaranteed through a hybrid transmission system employing nRF24L01 radio frequency for control commands and wireless protocols for telemetry. Experimental results validated the efficacy of the design, achieving trajectory mapping of up to 61 meters, where the application of smoothing algorithms to the yaw signal significantly reduced sensory noise. Finally, the implementation of a user interface developed in Python facilitates the synchronous visualization of data and storage in a centralized database, consolidating a robust technical ecosystem that reduces human intervention risks in critical environments and optimizes infrastructure diagnostic times.