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Design and Development of an Autonomous Underwater Vehicle for Irrigation Canal Monitoring

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Abstract : Indus river basin's irrigation system in Pakistan is extremely complex, spanning over 50,000 km. Maintenance and monitoring of this demands enormous resources. This paper describes the development of a streamlined and low-cost autonomous underwater vehicle (AUV) for the monitoring of irrigation canals including water quality monitoring and water theft detection. The vehicle is a hovering-type AUV, designed mainly for monitoring irrigation canals, with fully documented design and open source code. It has a length of 17 inches, and a radius of 3.5 inches with a depth rating of 5m. Multiple sensors are present onboard the AUV for monitoring water quality parameters including pH, turbidity, total dissolved solids (TDS) and dissolved oxygen. A 9-DOF Inertial Measurement Unit (IMU), GY-85, is used, which incorporates an Accelerometer (ADXL345), a Gyroscope (ITG-3200) and a Magnetometer (HMC5883L). The readings from these sensors are fused together using directional cosine matrix (DCM) algorithm, providing the AUV with the heading angle, while a pressure sensor gives the depth of the AUV. 2 sonar-based range sensors are used for obstacle detection, enabling the vehicle to align itself with the irrigation canals edges. 4 thrusters control the vehicle's surge, heading and heave, providing 3 DOF. The thrusters are controlled using a proportional-integral-derivative (PID) feedback control system, with heading angle and depth being the controller's input and the thruster motor speed as the output. A flow sensor has been incorporated to monitor canal water level to detect water-theft event in the irrigation system. In addition to water theft detection, the vehicle also provides information on water quality, providing us with the ability to identify the source(s) of water contamination. Detection of such events can provide useful policy inputs for improving irrigation efficiency and reducing water contamination. The AUV being low cost, small sized and suitable for autonomous maneuvering, water level and quality monitoring in the irrigation canals, can be used for irrigation network monitoring at a large scale.

Keywords : the autonomous underwater vehicle, irrigation canal monitoring, water quality monitoring, underwater line tracking
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