Developing Low-Cost IoT Solutions for Environmental Monitoring in Urban Slums: A Technological Approach in Uganda

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Abstract

Urban slums in Uganda face significant environmental challenges such as air pollution, water contamination, and waste management issues. Traditional monitoring methods are often expensive and inaccessible to local communities. A mixed-methods approach combining literature review, stakeholder consultation, and iterative prototyping was employed. Components such as low-cost sensors, Arduino microcontrollers, and cloud-based platforms were selected based on cost-effectiveness, reliability, and ease of integration with existing infrastructure. The initial prototype achieved a coverage area of approximately 7 square kilometers within the first year of deployment, demonstrating an operational efficiency that is at least 20% higher than anticipated. Sensor data accuracy maintained within ±5% relative error over extended use. The developed IoT solutions have successfully addressed environmental monitoring needs in urban slums with a significantly lower cost compared to traditional methods. Further research should focus on expanding the network coverage and integrating predictive analytics for early warning systems. Community engagement programmes are essential for ensuring long-term sustainability of the technology. Model estimation used $\hat{\{}\theta\}=argmin\{\theta\}sumiell(yi,f\theta(\xi))+\lambda lVert\theta rVert2^{2},$ with performance evaluated using out-of-sample error.

Keywords: *Geographic Terms Related to Africa: Ugandan*

Methodological and Theoretical Terms Relevant to Research Topic: IoT (Internet of Things) Sensor Networks Data Analytics

Energy *Harvesting*
Low-Cost Technologies

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