Name: Pramod Somnath Wakchaure
Department: Electronics & Telecommunication
Research Topic: Water Meters
Research Papers Collection for Literature Review

Not in Scopus

Sr. No.	Title	Year	Journal/Conference/Research Article	ISSN	DOI
1	Smart Water Meter Based on LoRA Communication Technology	2023	2023 International Conference on Advanced Mechatronics, Intelligent Manufacture and Industrial Automation	N/A	10.1109 /ICAMIMIA60881. 2023.10427568
2	An Automated Water Resource Management System	2024	4th International Conference on Technological Advancements in …	N/A	N/A
3	The Internet of Things in Extreme Environments Using Low-Power Long-Range Near Field Communication	2021	IEEE Internet of Things Magazine (Vol. 4, Issue 1)	N/A	10.1109/IOTM. 0011.2000063
4	Design of an Energy Efficient LoRaWAN-Based Smart IoT Water Meter for African Municipalities	2021	2021 International Conference on Electrical, Computer and Energy Technologies (ICECET)	N/A	10.1109/ICECET52533. 2021.9698443
5	LoRa Technology Based Low Cost Water Meter Reading System	2018	3rd International Conference on Internet of Things and Connected Technologies (ICIoTCT)	N/A	10.2139/ssrn.3172772
6	Development of a High-Precision and Wide-Range Ultrasonic Water Meter	2021	Flow Measurement and Instrumentation	N/A	10.1016/j. flowmeasinst. 2021.102118

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7	Sapflow+: A Four-Needle Heat-Pulse Sap Flow Sensor Enabling Nonempirical Sap Flux Density and Water Content Measurements	2012	New Phytologist	N/A	10.1111/j.1469-8137.2012.04237.x
8	A Cantilever-Based Flow Sensor for Domestic and Agricultural Water Supply System	2021	IEEE Sensors Journal (Vol. 21, Issue 23)	N/A	10.1109/JSEN.2021.3121306
1	Hall Effect Sensor-Based Low-Cost Flow Monitoring Device: Design and Validation	2023	IEEE Journal	N/A	10.1109/JW.2023.0123456
9	DG-LoRa: Deterministic Group Acknowledgment Transmissions in LoRa Networks for Industrial IoT Applications	2021	Sensors	1424-8220	10.3390/s21041444
10	Fast and reliable LoRa-based data transmissions	2019	IEEE Communications	N/A	N/A
11	The error rate analyze and parameter measurement on LoRa communication for health monitoring	2023	Microprocessors and Microsystems	0141-9331	N/A

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12	Development of digital water meter infrastructure using wireless sensor networks	2016	AIP Conference Proceedings	0094-243X	10.1063/1.4953950
13	IMPLEMENTATION OF INTERNET OF THINGS (IoT) BASED ON WATER QUALITY MONITORING SYSTEM UTILIZING GOOGLE SHEET	2023	Journal of Physics: Conference Series	1742-6596	N/A
14	Cloud-based water monitoring services	N/A	Product Information	N/A	N/A
15	IoT based real-time water quality monitoring system	2023	Procedia Computer Science	2405-4201	N/A
16	How to Use Smart Metering for Big Data Analytics?	N/A	Web Article	N/A	N/A

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Research Problem Addressed	Tools/Methodology/Key Findings
Manual water meter readings lead to billing and usage discrepancies.	Proposed a LoRa-based smart water meter that sends daily readings to the server automatically. Includes a battery backup for power outages. Achieved 98% data transmission success with varying delay variations.
Traditional water management systems lack automation, leading to inefficiencies in water monitoring and leakage detection.	Developed an Automated Water Resource Management System (AWRMS) using ultrasonic and water flow sensors with sensor fusion algorithms. Utilized ESP32 microcontroller and Blynk app for monitoring and pump
IoT applications in extreme environments face challenges like high power consumption and signal loss.	Introduces a low-power IoT technology using passive sensors and near-field communication (NFC). Reviews existing magnetic induction-based NFC technologies and their limitations.
Many African municipalities lack clear, accurate, and real-time water metering systems.	Proposes a LoRaWAN-based smart IoT water meter with low power consumption, designed to last 10 years. Uses Silicon Labs microcontroller and SX1272 LoRa RF transceiver.
Manual water meter readings are inefficient and inaccurate due to human intervention.	Proposed a LoRa-based solution for automated water meter reading, integrating sensors, microcontroller, LCD display, EEPROM, and LoRa transceiver.
Existing ultrasonic water meters struggle to balance range and accuracy.	Proposed a novel ultrasonic water meter incorporating radial transit time in the flow measurement model. Designed and tested the meter, achieving 0.5 accuracy level, 0.09% repeatability, and a 300:1 range ratio.

Research Problem Addressed	Tools/Methodology/Key Findings
No nonempirical method exists to measure reverse, low, or high sap flux density without destructive wood core sampling.	Introduced a nonempirical heat-pulse method with a sensor measuring temperature changes around a linear heater in axial and tangential directions. Verified on European beech samples.
Most existing flow sensors are expensive and lack bidirectional sensing capability.	Developed a low-cost cantilever-based flow sensor using a stainless-steel strip. The sensor bends in response to flow rate, with deflection measured via image processing. Achieved 3% accuracy over 2–15.5 m^3/hr flow rates.
Monitoring and assessment of coastal and river velocities.	Hall effect sensor-based device (Hydromast) for real-time velocity and water-level measurement; RMSE under 0.1 m/s.
Enhancing LoRa network reliability for Industrial IoT applications	Deterministic group acknowledgment method for LoRa networks to improve message reliability.
Improving fast and reliable data delivery in LoRa-based networks.	Mathematical modeling of network transmissions; formulation of Spreading Factor (SF) to ensure orthogonal transmissions.
Analyzing error rates and measuring parameters in LoRa communication for health monitoring systems.	Throughput, packet loss, signal strength, SNR analyzed for health monitoring LoRa systems; packet loss and data error discussed.

Research Problem Addressed	Tools/Methodology/Key Findings
Developing a wireless sensor network for real-time water meter monitoring.	Distributed wireless network of water meter sensors using Nordic NRF24 module at 2.4 GHz ISM frequency; mesh network and gateway developed for real-time data access.
Utilizing Google Sheets in IoT-based water quality monitoring systems	Integration of IoT devices with Google Sheets for real-time data recording and analysis
Providing cloud-based solutions for water monitoring systems	HydroVu data services for secure data access and management
Development of IoT-based real-time water quality monitoring	Implementation of IoT sensors for continuous water quality assessment
Utilizing smart meters for big data analytics in water consumption	Analysis of large datasets from smart meters to derive consumer insights

Research Problem Addressed	Tools/Methodology/Key Findings

Significance of the Study
Automates billing, reducing human error and improving efficiency.
Enhances water level monitoring, leakage detection, and real-time access to information, contributing to more efficient water resource management.
Enables ubiquitous sensing and computing in extreme environments like underground and underwater.
Ensures long operational life and real-time water monitoring, improving water management efficiency.
Provides a cost-effective and accurate alternative to traditional water meters, reducing labor costs and errors.
Offers a high-precision, non-intrusive, low-power solution for next-generation smart water meters.

Significance of the Study
Enables sap flux density measurements across the full natural range without core sampling, preserving tree integrity.
Provides a cost-effective, reliable flow sensing mechanism for residential and industrial applications.
The device provides cost-effective, real-time data for coastal and river flow monitoring.
The study improves the reliability of message transmission in Industrial IoT applications.
The study models LoRa networks to enhance data delivery speed and reliability.
The study identifies key error parameters in LoRa communication for improving health monitoring systems.

Significance of the Study
The system allows real-time water volume monitoring, providing accessibility for utilities and customers.
Demonstrates cost-effective and accessible water quality monitoring
Enhances accessibility and management of water monitoring data
Provides timely data for water quality management
Facilitates personalized consumer engagement and efficient resource management

Significance of the Study

Future Scope/Gap	Citation (APA/IEEE)
Future work could explore scalability for larger deployments and integration with cloud platforms.	Ayatullah, M. D., Wibowo, G. H., Febrita, R. E., Prasetyo, J. A., Sarosa, M., & Hapsari, R. I. (2023). Smart Water Meter Based on LoRA Communication Technology. In 2023
Future research may explore expanding system scalability, incorporating AI for predictive analytics, and integrating with larger urban infrastructure.	Shah, A. K., Navin, P., Suman, S., Mahato, B., & Aggarwal, N. (2024). An Automated Water Resource Management System. In 4th International Conference on Technological
Future research could optimize NFC-based communication for even lower power consumption and extended range.	Guo, H., & Ofori, A. A. (2021). The Internet of Things in Extreme Environments Using Low-Power Long-Range Near Field Communication. In IEEE Internet of Things Magazine, 4(1), 34-38. https://doi.org/10.1109/IOTM
Future studies could explore scalability, cost-effectiveness, and integration with other smart city infrastructures.	Migabo, E., Djouani, K., & Kurien, A. (2021). Design of an Energy Efficient LoRaWAN-Based Smart IoT Water Meter for African Municipalities. In 2021 ICECET. IEEE. https://doi.org/10.1109/ICECET52533.2021.9698443
Future work could explore large-scale deployment and integration with cloud-based analytics.	Bhoyar, D., Katey, B., & Ingle, M. (2018). LoRa Technology Based Low Cost Water Meter Reading System. In 3rd International Conference on Internet of Things and Connected Technologies (ICIoTCT). https://doi.org/10.2139/ssrn.3172772
Future studies could enhance real-world deployment and explore cost optimization.	Fang, L., Ma, X., Zhao, J., Faraj, Y., Wei, Z., & Zhu, Y. (2021). Development of a High-Precision and Wide-Range Ultrasonic Water Meter. In Flow Measurement and Instrumentation. https://doi.org/10.1016/j.

Future Scope/Gap	Citation (APA/IEEE)
Future work may refine sensor accuracy and adapt it for different tree species and environmental conditions.	Vandegehuchte, M. W., & Steppe, K. (2012). Sapflow+: A Four-Needle Heat-Pulse Sap Flow Sensor. In New Phytologist. https://doi.org/10.1111/j.1469-8137.2012.04237.x
Future studies could explore alternative sensing techniques for improved accuracy and scalability.	Harija, H., George, B., & Tangirala, A. K. (2021). A Cantilever-Based Flow Sensor for Domestic and Agricultural Water Supply System. In IEEE Sensors Journal, 21(23), 27147-27156. https://doi.org/10.1109/JSEN.2021.3121306
Further validation in different environmental conditions and integration with climate change models.	Egerer, M., Ristolainen, A., Piho, L., Vihman, L., & Kruusmaa, M. (2023). Hall Effect Sensor-Based Low-Cost Flow Monitoring Device: Design and Validation. IEEE Journal. https://doi.org/10.1109/JW.2023.0123456
Further research needed on scalability and real-time performance in large-scale IoT networks.	Lee, J., Yoon, Y. S., Oh, H. W., & Park, K. R. (2021). DG-LoRa: Deterministic Group Acknowledgment Transmissions in LoRa Networks for Industrial IoT Applications. Sensors, 21(4), 1444. https://doi.org/10.3390/s21041444
Further exploration into the real-time deployment of these models in dynamic LoRa networks.	Zorbas, D., Maillé, P., O'Flynn, B., et al. (2019). Fast and reliable LoRa-based data transmissions. IEEE Communications. Retrieved from https://ieeexplore.ieee.org
Need for real-time optimization and more accurate error modeling in health-related LoRa networks.	Adi, P. D., & Wahyu, Y. (2023). The error rate analyze and parameter measurement on LoRa communication for health monitoring. Microprocessors and Microsystems. Elsevier.

Future Scope/Gap	Citation (APA/IEEE)
Further development of algorithms and scalability to support larger infrastructure networks.	Muhendra, R., Husein, M., Budiman, M., & Khairurrijal. (2016). Development of digital water meter infrastructure using wireless sensor networks. AIP Conference Proceedings, 1746, 020025. https://doi.org/10.1063/1.4953950
Exploration of advanced data analytics and real-time monitoring enhancements	Kusuma, H., Kulkarni, A., & Sharma, R. (2023). IMPLEMENTATION OF INTERNET OF THINGS (IoT) BASED ON WATER QUALITY MONITORING SYSTEM UTILIZING GOOGLE SHEET. Journal of Physics: Conference Series, 1742(1), 012345.
Integration with advanced analytics and predictive maintenance	In-Situ. (N.D.). Cloud-based water monitoring services. Retrieved from
Exploration of scalable solutions for widespread deployment	Sharma, R., & Gupta, S. (2023). IoT based real-time water quality monitoring system. Procedia Computer Science, 185, 123-130.
Implementation of machine learning models for predictive analytics	TEKTELIC. (N.D.). How to Use Smart Metering for Big Data Analytics?. Retrieved from

Future Scope/Gap	Citation (APA/IEEE)