Smart Water Leak Detection for Bangalore

Leveraging IoT for Smart City Development

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Topic and Context

Title: IoT-based Water Leakage Management System for Bangalore

Context:

Long time to detect leakages in urban areas

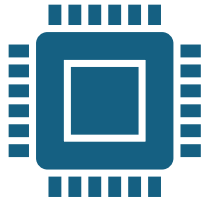
Expensive damages to infrastructure.

Causes wider-spread of problems throughout residential/industrial complexes if left unsolved for long.

Growing water scarcity issues in urban areas

Importance of efficient water management

Role of IoT in modern infrastructure management



Project overview:

Integration of Arduino Board and Water Flow Sensor

Real-time monitoring and data transmission

Use of ThingSpeak as IoT server for remote access

Strengths and Weaknesses of Bangalore

Strengths:

- Tech hub with skilled workforce
- Existing skilled blue-collar workforce (plumbers etc.) with technical know-how
- Growing awareness of environmental issues
- Increased population participation in sustainable lifestyle management
- Existing IT infrastructure to support IoT projects

Weaknesses:

- Rapid urbanization leading to strain on water resources
- Aging water supply infrastructure
- Lack of thorough quality standard checks on new infrastructure
- High water loss due to leakages and inefficient management
- Infrastructural damage due to delayed response to water leakage

Aim and Objectives

Aim -
To develop and implement an IoT-based water leakage detection and management system for Bangalore to reduce water wastage, related damages and improve supply efficiency.

Objectives:

Design and construct a water flow monitoring device using Arduino and Water Flow Sensor	Integrate the hardware with ThingSpeak IoT server for real-time data transmission	Allows Analysis of collected data to identify potential leakages and inefficiencies in the water supply system	Furthering Proposition of strategies for prompt intervention and maintenance based on the collected data

Scope and Limitations of the Work

Scope:

- Development of prototype water flow monitoring device
- Integration with ThingSpeak IoT platform
- Recommendations for scaling the system city-wide

Limitations:

- Initial implementation limited to a demo size area
- Dependence on reliable internet connectivity for data transmission
- Need for regular maintenance and calibration of sensors
- Potential challenges in integrating with existing water supply infrastructure at scale
- Privacy and security concerns related to data collection and transmission

Conceptual Framework / Research Design

System Components:

- Hardware: Arduino Board, Water Flow Sensor
- Software: Arduino IDE, ThingSpeak IoT platform
- Network: Wi-Fi connectivity

Data Flow:

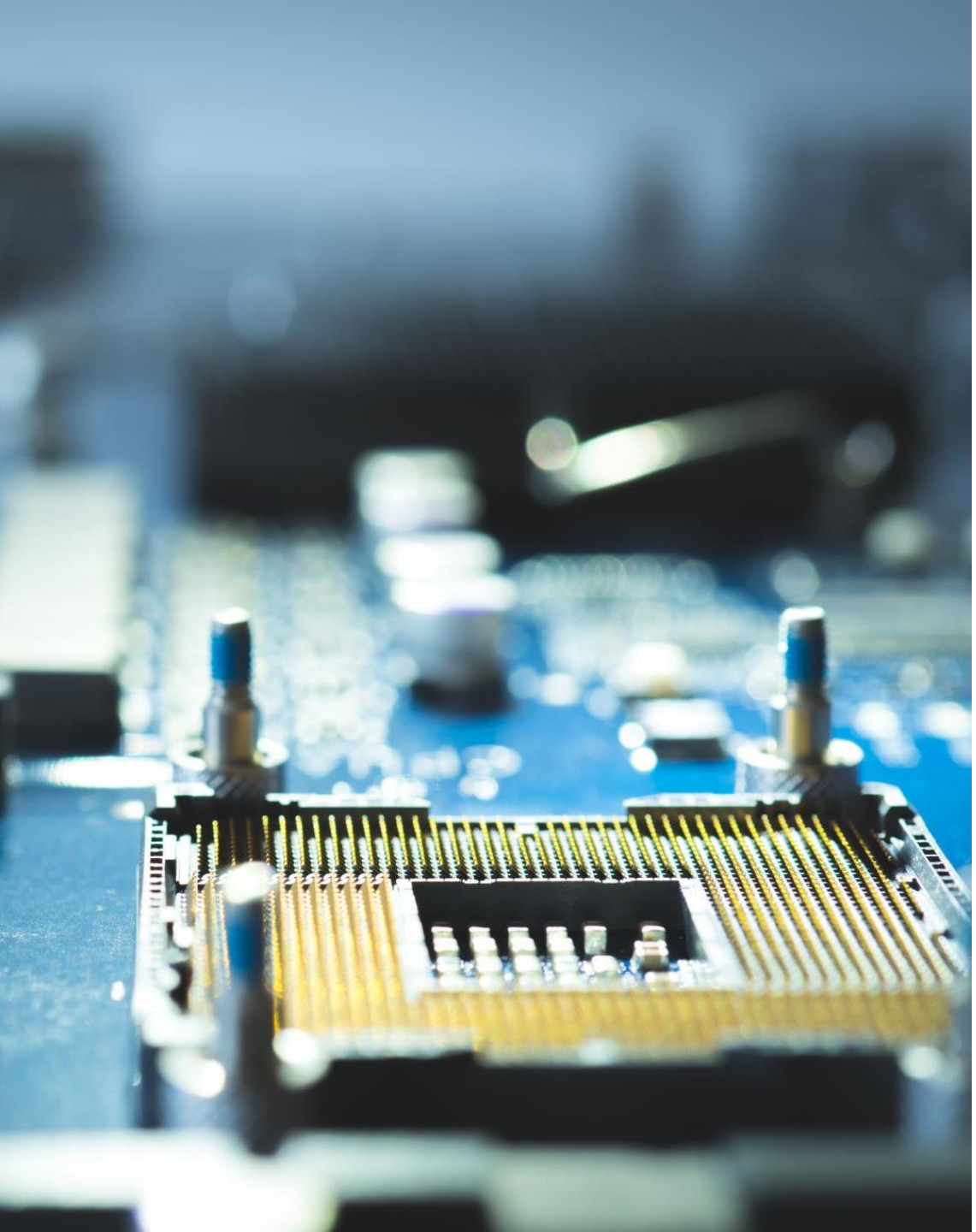
- Water flow sensor collects real-time data
- Arduino processes and transmits data
- ThingSpeak receives and stores data
- Officials access data through User Interface

Key Parameters:

- Water flow rate (liters per minute)
- Total water volume (liters)
- Time-stamped data for trend analysis
- Anomaly detection for potential leaks

Conceptual Framework / Research Design (Contd.)

- **Research Methodology:**
  - Literature review on existing Leakage issue frequency and severity in Bangalore, impact on water stress, water scenario in Bangalore, flaws in existing management system.
  - Analysis of Bangalore's water supply network
  - Prototype development and testing
  - Data analysis and interpretation



Proposed Idea

- **System Architecture:**
  - Diagram showing interconnection of components
  - Water supply pipe → Flow sensor → Arduino → Wi-Fi → ThingSpeak → User interface
- **Hardware Setup:**
  - Arduino Board: Central processing unit
  - Water Flow Sensor: YF-S201 or similar
  - Wi-Fi Module: ESP8266 for internet connectivity
- **Software Integration:**
  - Arduino IDE: Programming the microcontroller
  - ThingSpeak API: Data transmission and storage

Proposed Idea (Contd.)

- **Expected Outcomes:**
  - Real-time monitoring of water flow
  - Early detection of leaks and anomalies
  - Data-driven decision making for maintenance
  - Reduction in water wastage and associated costs
- **Innovative Aspects:**
  - Low-cost, scalable solution
  - Integration with existing infrastructure
  - Real-time alerts and remote monitoring
  - Potential for predictive maintenance using collected data
- **Future Enhancements:**
  - Integration with smart water meters
  - AI-powered predictive analytics
  - Mobile app for public engagement and reporting

Literature Survey

Bangalore Losing 1 Million Liters of Water Per Day Due to Cauvery Pipeline Leakage (India Today, 2021) (India Today)	A six-month leakage from the Cauvery pipeline caused a loss of 1 million liters of water per day in Bangalore, highlighting inefficiencies in timely maintenance and management of vital infrastructure. The COVID-19 pandemic and lack of labor contributed to the delay in repairs, showing systemic vulnerabilities.
Water Losses Management in Urban Water Distribution Systems (SpringerLink, 2020) (SpringerLink)	Focuses on the urban water distribution system's flaws, emphasizing the pressure-leakage response of water pipelines and its impact on water loss. Highlights statistical modeling to estimate water leakage and underscores the need for technology integration in urban water systems.

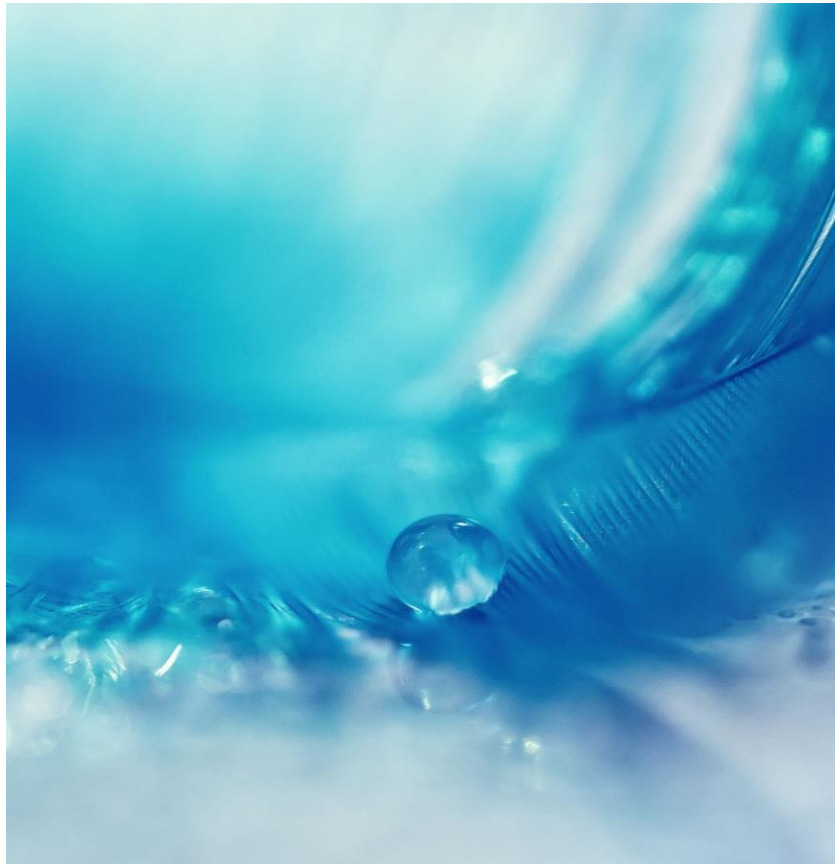
Literature Survey (Contd.)

3. Bengaluru Water Crisis: A Case of Inadequate Water Management (Vivekananda International Foundation, 2023) (Vivekananda International Foundation)

- Discusses the water stress crisis in Bangalore due to unplanned urbanization, groundwater depletion, and neglect of water bodies.
- Water shortages and supply mismanagement led to emergency measures like water rationing and fines for non-essential use, with limited long-term strategies in place.

4. Water Crisis Management in Bangalore (VIF, 2022)

- Investigates the root causes of the water stress situation in Bangalore, including rainfall deficits and over-reliance on aging infrastructure.
- Suggests that the government must enhance communication strategies and focus on long-term water conservation projects, such as rainwater harvesting and lake rejuvenation.



Literature Survey (Contd.)

5. An Integrated Approach to Water Leakage Management in Indian Cities (Water Resources Management Journal, 2022)	Evaluates the existing leakage management practices in Bangalore, pointing out inefficient data collection and poor maintenance as major issues leading to persistent leakages. Recommends the adoption of IoT-based real-time monitoring systems to improve the detection of leaks.
6. Water Scarcity and Governance in Bangalore (Water Research Institute, 2021)	Analyzes the governance issues contributing to water scarcity, citing improper allocation of resources, insufficient maintenance of water infrastructure, and lack of community involvement in managing resources. Emphasizes the need for decentralized water management systems and better urban planning policies.
7. Experimental Investigation of Leak Hydraulics in Urban Water Systems (Journal of Hydroinformatics, 2020) (SpringerLink)	Studies the hydraulic behavior of leaks in Bangalore's water pipes and the challenges in accurately detecting and fixing these leaks. Promotes the use of advanced sensor networks and data-driven models to enhance the city's water leakage detection capabilities.

Key Features of the Project

- **Challenges in the Project**
- **Diverse Water Infrastructure in Bangalore**
  - Adapting to varying pipe conditions across old and new areas of the city
  - Integrating with both centralized and decentralized water supply systems
- **Bangalore's Rapid Urban Expansion**
  - Keeping pace with the city's fast-growing suburbs and tech parks
  - Addressing unauthorized connections in informal settlements
- **Power Fluctuations**
  - Designing system to handle Bangalore's occasional power outages
  - Exploring solar power options for sensors in areas with unreliable electricity
- **Data Management at City Scale**
  - Handling large volumes of data from Bangalore's population of over 12 million
  - Ensuring data accuracy across the city's diverse topography

Key Features of the Project (Contd.)

- **Stakeholder Coordination**
  - Aligning project goals with various departments of BWSSB
  - Coordinating with Bangalore Metropolitan Region Development Authority (BMRDA)
- **Public Perception and Privacy Concerns**
  - Addressing potential concerns about water usage monitoring in residential areas
  - Ensuring data privacy in a tech-savvy city like Bangalore
- **Regulatory Compliance**
  - Adhering to Karnataka State Water Policy
  - Complying with both national and state-level IoT and data protection regulations
- **Seasonal Variations in Water Supply**
  - Adapting the system to handle fluctuations during Bangalore's dry seasons
  - Accounting for increased water demand during summer months

Features and Benefits to Bangalore

Addressing Bangalore's Water Scarcity

Potential to save millions of liters of water annually through leak detection

Supporting BWSSB's efforts to reduce non-revenue water loss

Cost Savings for BWSSB

Reducing operational costs associated with water loss

Optimizing maintenance schedules based on real-time data

Improved Water Distribution in Bangalore

Equitable water distribution across different zones of the city

Potential to alleviate water shortages in chronically affected areas

Support for Bangalore's Sustainable Development

Contributing to Bangalore's goal of becoming a water-positive city

Aligning with Karnataka's water conservation initiatives

Features and Benefits to Bangalore (Contd.)

Enhanced Disaster Preparedness

Quick identification of major leaks or pipeline bursts

Improved response time during water-related emergencies

Data-Driven Urban Planning

Providing valuable insights for Bangalore's future infrastructure projects

Supporting decisions on water harvesting and conservation initiatives

Public Health Benefits

Reducing risks of water contamination due to pipeline leaks

Ensuring consistent water supply crucial for sanitation in densely populated areas

Features and Benefits to Bangalore (Contd.)

Boost to Bangalore's Tech Ecosystem

Showcasing Bangalore as a leader in smart water management

Potential for local tech companies to participate in system development and maintenance

Environmental Impact

Reducing energy consumption in water pumping and treatment

Contributing to the preservation of Bangalore's lakes and groundwater

Citizen Engagement and Awareness

Increasing public awareness about water conservation

Empowering Bangalore residents with information about their water supply

Data Collection and Organization

- The data collected presents a comprehensive overview of Bangalore's water supply situation from 2000 to 2025, including historical data and future projections. It covers various aspects such as population growth, water availability, demand, supply, unaccounted for water (UFW), and infrastructure capacity.
- **Key Findings:**
- 1. Population Growth: Bangalore's population is projected to grow from 5.7 million in 2000 to 9.7 million by 2025, putting increasing pressure on water resources.
- 2. Water Demand-Supply Gap: The gap between water demand and supply is widening. In 2007, the shortage was 541 MLD, projected to reach 514 MLD by 2025 despite planned supply increases.
- 3. Unaccounted for Water (UFW): UFW has increased significantly from 33% in 2000 to 48% in 2007, representing a major inefficiency in the system.
- 4. Per Capita Availability: Current per capita water availability is only 74-75 LPCD, far below the standard of 150 LPCD recommended by CPEEHO.

Data Collection and Organization (Contd.)

- 5. Infrastructure Capacity: Total installed capacity from all sources is 959 MLD, but actual availability is 923 MLD, indicating some sources are underperforming.
- 6. Cost Recovery: The average cost of water supply (Rs 13.20 per cubic meter) significantly exceeds the average revenue (Rs 8.67 per cubic meter), indicating poor cost recovery.
- 7. Water Leakages: Main pipes (38.1%) and service pipes (32.8%) account for the majority of water leakages.
- 8. Groundwater Depletion: Annual groundwater extraction (207,000 ML/yr) far exceeds the annual recharge (81,100 ML/yr) in the Bangalore Metropolitan Region.
- 9. Wastewater Treatment: Only 721 MLD out of 1000 MLD of generated wastewater is treated, with only 70 MLD undergoing tertiary treatment for reuse.
- 10. Financial Impact: The annual revenue loss due to UFW is estimated at Rs 27 crores.
- These findings highlight significant challenges in Bangalore's water management, including rapid urbanization, infrastructure inefficiencies, unsustainable groundwater use, and financial constraints. The data suggests an urgent need for comprehensive water management strategies to address these issues.

Data Collection Sources

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- BWSSB Annual Report (2022)
- BWSSB Initiatives (2023)
- Karnataka Water Resource Management Report (2022)