

Design And Development Of Smart Water Billing System

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ABSTRACT

This research paper presents an application development project aimed at improving the existing water billing system, which often suffers from delays, inaccuracies, and manual errors. The project follows an Agile approach and brings together a project manager, software developers, a tester, and a database administrator. Using Java, MySQL, and Apache Tomcat, the team develops an application that automates billing, increases accuracy, and makes the process more convenient for consumers.

The application includes features such as customer registration, automated bill generation, simplified payment processing, and customer service support. The goal is to streamline operations, strengthen efficiency, and raise overall customer satisfaction. Through coordinated teamwork and the use of Agile practices, the project maintains a smooth development cycle and delivers a system that offers significant improvements to the current water billing process, benefiting both the utility provider and its users.

The project is designed to support urban residential water billing in India. It introduces a reliable solution for water metering and usage monitoring through cloud integration, mobile communication, and mobile applications. A water flow sensor is incorporated to measure usage accurately. With growing concerns about the availability of natural resources, especially in regions facing drought, effective water management has become essential. Accurate measurement of water consumption plays a key role in promoting conservation and ensuring sustainable use.

Keywords: Water billing, urban residential water billing, smart billing

Introduction:

An automatic water billing system uses components such as a water flow sensor, Arduino controller, IoT connectivity, a solenoid valve, and a DC power supply to measure and regulate water consumption. The need to conserve accessible water resources has become a serious concern in many regions. Much of this problem arises from poor water use and weak management practices. Water is consumed heavily in agriculture, industry and domestic activities, so proper monitoring is essential. Charging a small, fair fee can discourage unnecessary use and help reduce waste.

In many buildings, a single bill is generated for the entire structure and the cost is shared equally among residents. This means people who use more water end up paying the same as those who use very little, which is neither fair nor efficient. Water scarcity and poor resource management are now global issues. Traditional billing methods depend on manual meter readings, which often lead to errors, revenue loss and dissatisfaction among users.

To address these issues, this project introduces a smart water billing system that provides accurate, real-time measurement of consumption along with automated billing. With the help of advanced metering and data analysis, the system encourages responsible use and supports long-term conservation of water resources. In the current digital era, smart city applications built on IoT and wireless connectivity offer reliable solutions for water management. This system uses modern

automation techniques to simplify billing, reduce human error, avoid delays, and prevent wastage caused by manually operated water supply systems.

The proposed design uses a low-cost water flow meter to measure the rate of water passing through a user's supply line. Bills are generated based on each user's actual consumption. This ensures fair distribution of cost and gives users better control over their usage without affecting others.

Literature survey:

1. Mulmane, S. R. & Korbu, S. (2022). Cloud Based Smart Digital Water Billing Meter. Journal of

Pharmaceutical Negative Results, Vol. 13, Special Issue 10, pp. 711–716. DOI: 10.47750/pnr-2022-13.510.075

This paper describes a water billing setup that combines digital sensors with cloud storage to record usage and generate bills automatically. The system measures water flow, uploads the readings to an online server and creates real-time consumption reports. Because the readings are stored online, both users and service providers can check the data whenever needed. This helps avoid mistakes that usually occur in manual meter reading and provides clear billing information. The cloud platform makes the system easy to scale and also supports future additions like mobile applications or data-based predictions. The authors show that this method improves accuracy, reduces manual work and makes the billing process more transparent for modern water supply networks. Rajashekhar, B., Rahul, S., Nayakta, S. K., Siddesh, K. S., & Anand, M. (2022). Automated Water Billing and Detection and Control of Water Leakage Using Flow Conservation. *International Journal of Research in Engineering, Science and Management (IJRESM)*, Vol. 5, No. 6, pp. 334–336.

This work explains an IoT-based system that monitors water flow and identifies leaks by comparing the measured flow with expected values. It uses flow sensors along with an Arduino controller and a GSM module. When the system notices an unusual drop or rise in flow, it sends an alert by SMS and can also close the valve to stop water loss. Along with leak detection, the setup calculates the water consumed by each user and prepares the bill according to the actual usage. This allows users to see their consumption clearly on the device or website and prevents billing disputes or hidden charges. For our project, the idea of calculating the bill directly from measured consumption has been taken from this reference to ensure transparency and ease of use.

2. Jacques, D. & Bugingo, E. (2025). Enhancing Model of IoT Based Smart Water Meter and Billing System: A Case Study. *International Journal of Innovative Science & Research Technology (IJISRT)*, Vol. 10, Issue 4, pp. 3370–3385. DOI: 10.38124/ijisrt/25apr1647

This case study explains how an IoT-based water metering and billing system was deployed in Rwanda to improve monitoring and billing for households. The authors created a setup where digital water meters send flow data to a central web platform. This allows continuous tracking of consumption and automated bill generation. The collected data is stored online so both users and service providers can view accurate readings at any time. By reducing manual meter reading and paper-based billing, the system improves efficiency and builds trust between users and the utility. The study reports better service delivery, higher user satisfaction and improved management of water resources after introducing smart meters. The model also gives users a clear view of the water they use and the amount billed, ensuring a transparent process without the risk of hidden or incorrect charges.

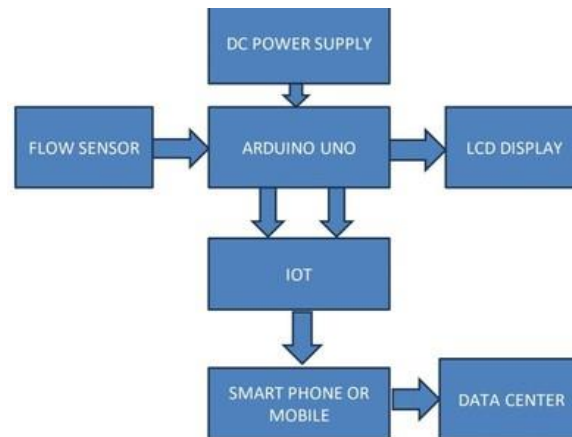
3. Purboyo, A. K., Fakhurroja, H., Pramesti, D., & Chaidir, A. R. (2024). Mobile Application Development for Prepaid Water Meter Based on LC Sensor. *Sensors*, 24(20), 6762. DOI: 10.3390/s24206762

This research focuses on a prepaid smart water metering system that works together with a mobile application. The system uses LC (Inductor-Capacitor) sensors to measure water flow with high accuracy. A main feature of the design is its prepaid setup, where users add credit through the mobile app just like a prepaid mobile recharge. The app lets users check their balance, monitor real-time usage, receive alerts when credit is low and review past consumption. This approach gives users better control over their water use and ensures transparent billing. It also helps reduce wastage, avoids unpaid bills and encourages responsible consumption by making the entire process simple and convenient.

Problem Statement:

Meter readings are often inaccurate, and many bills are based on estimates instead of actual usage.
Leaks and water theft are difficult to identify because the system lacks continuous monitoring.
Manual data collection is inefficient and slow, which reduces reliability.
Billing mistakes and late payments lead to revenue loss for utility providers.
Consumers have limited awareness of how much water they use, which affects conservation efforts.
Manual meter reading increases the chance of human error and results in incorrect bills and customer complaints.
Staff must physically visit each meter, prepare paper bills and collect payments, making the process slow for both providers and users.
In some buildings, a single bill is divided equally among all households, even though consumption differs, leading to unfair billing.
Traditional setups offer very little data for analysis, so utilities cannot easily study usage patterns or plan for future demand.

Block Diagram:



Explanation:

A water billing system uses a flow sensor, IoT module and a microcontroller to monitor and record water usage. The flow sensor measures the amount of water passing through the pipeline, and the readings are sent to the microcontroller for processing. In this setup, the Arduino board reads the pulses from the flow sensor and, using its calibration factor, calculates the exact number of liters consumed. The IoT module sends this information to the user's mobile device, allowing easy access to usage data and billing details.

Smart billing through IoT offers several advantages. It minimizes human error, provides accurate and timely bills, improves user awareness and reduces operational costs by automating most of the process. Traditional billing systems face problems such as heavy manual work, frequent mistakes, inaccurate readings, delayed payments and low awareness of tariffs. These issues affect the accuracy of billing and the overall efficiency of water management.

In this model, components such as Arduino Uno, an AC pump, a flow sensor, a solenoid valve and a relay or switch are used. When the switch is turned on, the power supply activates the AC pump, which pushes water through the pipe. The flow sensor detects the movement of water and the Arduino records the volume consumed. The solenoid valve works like a controlled tap, allowing the system to start or stop the water flow. The LCD displays the bill amount and the percentage of water used. Through the IoT connection, all this information can also be viewed on a smartphone.

Components:

1. Flow Sensor:

A water flow sensor is made up of a plastic valve body, a small rotor and a Hall-effect sensor. When water passes through the valve, the rotor spins, and its speed changes according to the flow rate. The Hall-effect sensor reads the movement of the rotor and produces pulse signals that represent the amount of water flowing through the pipe. These sensors are commonly used in devices like water dispensers and coffee machines. They are available in different pipe sizes, so the suitable one can be selected based on the requirement.

2. Liquid Crystal Display (LCD):

An LCD is widely used in many electronic devices because it is light, compact and energy efficient. It appears in televisions, computer monitors, instrument panels, aircraft displays and various types of indoor and outdoor signboards. Small LCD screens are also used in portable devices such as digital cameras, watches, calculators and mobile phones. Over time, LCDs have replaced the older cathode-ray tube (CRT) displays because they offer better clarity, use less power and are easier to handle

3. Arduino Uno:

The Arduino Uno is an open-source microcontroller board introduced by the Arduino company in 2010. It is built around a microcontroller and includes several digital and analog input/output pins that can be connected to sensors, modules and other electronic circuits. The board has 14 digital I/O pins, including 6 pins that support PWM output, and

6 analog input pins. Programming is done through the Arduino IDE using a USB Type-B cable. The board can be powered either through the USB connection or through a barrel jack that accepts a supply voltage between 7 and 20 volts, such as a standard 9-volt battery.

4. Solenoid Valve:

A solenoid valve is an electromechanical device that controls the flow of a fluid by opening or closing when electrical power is applied or removed. It is commonly used in both pneumatic and hydraulic systems. The number of solenoid valves in a control panel depends on the application. In basic setups, one valve may be enough, while systems that need extra safety features, such as an emergency shut-off, may use two or three valves. The valve works by using an electric coil to move a metal plunger, which either allows the fluid to pass or blocks the flow.

5. DC Power Supply:

One way to deliver electricity to a load or circuit is via a direct current (DC) power source. The primary role of this component is to transform the incoming electrical energy into the specific voltage and current needed by the linked parts. A power converter is a common name for this device since it modifies the voltage and current to meet certain requirements. Many power supplies are integrated within the equipment they power, while others are standalone systems used in testing or labs. Desktop computer power supply, chargers, and other electrical appliances are typical examples.

Advantages:

- **Accurate Billing:** Removes estimation-based billing and provides charges based on actual water usage.
- **Higher Efficiency:** Automates data collection and billing, reducing the need for manual work.
- **Supports Water Conservation:** Real-time tracking helps users monitor usage and reduce wastage.
- **Better Revenue Management:** Timely and precise billing improves payment collection and reduces losses.

Disadvantages:

- **High Initial Cost:** Installing sensors, controllers and communication modules can be expensive at the start.
- **Technical Challenges:** System failures, connectivity issues or hardware faults can disrupt billing.
- **Data Security Concerns:** Storing user information on digital platforms requires strong protection to ensure privacy.

Applications:

- **Residential Water Management:** Helps households track their daily water usage and manage consumption more efficiently.
- **Industrial Water Monitoring:** Measures and monitors water usage in industries such as manufacturing and processing plants.
- **Agricultural Water Management:** Supports efficient water use in irrigation systems and other agricultural activities.
- **Municipal Water Management:** Assists local utilities in managing water distribution, detecting leaks and improving service delivery.

References:

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4. Purboyn, A. K., Fakhurroja, H., Pramesti, D., & Chaidir, A. R. (2024). Mobile Application Development for Prepaid Water Meter Based on LC Sensor. *Sensors*, 24(20), 6762.
5. Paul, N. & Ali, M. R. (2013). Cost Effective Digital Water Billing System. *Global Journal of Research in Engineering*, 13(J3), 21–24.