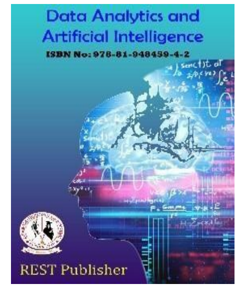
Data Analytics and Artificial Intelligence

Vol: 4(2), 2024

REST Publisher; ISBN: 978-81-948459-4-2

Website: http://restpublisher.com/book-series/daai/

DOI: https://doi.org/10.46632/daai/4/2/10



Hydro Electrometric Tracking Application

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Abstract: *We offer a brand-new technique for real-time control over the project's water flow rate and electricity usage. Unlike current systems, which are frequently costly and solely monitor power or water, our method integrates both parameters into a single, reasonably priced platform. Our solution allows users to track their resource consumption in real-time by utilizing Arduino-based sensors and a user-friendly mobile application created with MIT App Inventor. By providing consumers with the knowledge, they need to make educated decisions about how much water and power to use, this promotes more effective and sustainable resource management. It is unique in that it provides an affordable solution that integrates water and power metering capabilities, solving major issues with current systems.*

Keywords: *Resource management, energy monitoring, mobile application, smart monitoring, environmental sustainability, Arduino, water flow sensor, and CT sensor.*

1. INTRODUCTION

The goal of our project, "Smart Energy and Water Monitoring System," is to address the pressing problem of maximizing the use of water and electricity in residential settings. There is an increasing need for creative solutions that let consumers efficiently monitor and control their water and energy usage due to rising utility costs and environmental conservation concerns. In light of this, our project suggests creating an all-encompassing monitoring system that combines an easy-to-use mobile application interface, cloud-based data management infrastructure, and advanced hardware sensors. The hardware component, which consists of Arduino microcontrollers intricately interfaced with cutting-edge sensors meant to measure water and electricity consumption, is the beating heart of our system. We use current transformers (CT sensors) to measure the exact current flow in home circuits in order to monitor the electricity. The Arduino boards, which function as the data acquisition units in charge of gathering, analyzing, and sending the consumption data to the cloud for additional study, are carefully connected to these sensors. Water flow sensors are strategically placed to measure the volume and flow rate of water usage at the same time. This allows for the analysis of patterns and trends in water consumption over time. Our project's software component involves creating a solid backend infrastructure that is suited to manage the enormous amounts of data that the sensors produce. In order to accomplish this, we make use of cloud services like Google Cloud Platform (GCP) that are scalable and flexible in order to effectively handle the inflow of sensor data. To enable data preparation and analysis, Python scripts are carefully written and implemented to extract useful information from the unprocessed sensor data streams. In addition, a frontend interface is carefully designed with a combination of HTML, CSS, and JavaScript, resulting in an eye-catching and intuitive mobile application. With the help of this front-end interface, users can see their real-time energy and water use data and gain the knowledge and skills needed to make informed decisions. Our attention turns to creating a dynamic and interesting mobile application interface in the frontend area, which will be the main interface via which users will engage with the monitoring system. We maximize the reach and accessibility of our application by ensuring broad compatibility across both iOS and Android devices by utilizing cross-platform frameworks like React Native. Through interactive charts, graphs, and dashboards, the mobile app provides users with easy access to their energy and water consumption statistics in an aesthetically pleasing and straightforward manner. Users can further customize their experience by customizing alerts and notifications to obtain timely tips for optimizing resource consumption and to stay informed about their usage trends.

2. LITERATURE SURVEY

Manoj Kumar's project represents a significant advancement in water management technology, harnessing the power of Arduino microcontrollers and flow sensors to accurately measure water flow rate and volume [1]. This innovative approach holds immense promise for various applications, from optimizing irrigation systems in agriculture to detecting leaks in residential plumbing networks. By leveraging open-source hardware and software platforms like Arduino, Kumar's project also promotes accessibility and affordability, democratizing the tools necessary for effective water management. Moreover, the scalability of this solution makes it adaptable to both small-scale and large-scale water infrastructure, thereby catering to a wide range of users. As water scarcity continues to be a pressing global issue, initiatives like Kumar's underscore the importance of technological innovation in addressing sustainability challenges and ensuring efficient resource allocation. The development of a mobile app for smart electricity usage monitoring by Anagha Choudhari and team marks a significant step forward in empowering users to track and optimize their energy consumption patterns [2]. This app, likely built on user-friendly interfaces and data visualization techniques, provides real-time insights into electricity usage, enabling users to identify energy-intensive activities and implement strategies for conservation. The integration of mobile technology into energy management reflects the evolving landscape of smart home solutions and the increasing reliance on digital platforms for everyday tasks. Moreover, by fostering awareness and accountability among consumers, apps like this have the potential to drive behavioral change and promote a culture of energy efficiency. As the demand for sustainable energy solutions grows, initiatives like Choudhari's underscore the pivotal role of technology in promoting environmental stewardship and mitigating climate change [3]. The empirical study conducted by Ying Jin, Emily J. Yang, and Julian Fulton delves into the intricate interplay between energy production, water usage, and environmental sustainability within the context of the United States. By analyzing large-scale datasets and employing advanced predictive modeling techniques, the study aims to forecast environmental impacts arising from the energy-water nexus, thereby informing evidence-based policymaking and resource management strategies. This research is particularly timely given the growing recognition of the interconnectedness between energy and water systems and their implications for ecological resilience and human well-being. By shedding light on the complex dynamics at play, Jin, Yang, and Fulton's study contributes to a deeper understanding of the environmental challenges facing the United States and underscores the need for integrated approaches to address these pressing issues. Konstantinos Madias and Andrzej Szymkowiak's systematic review offers a comprehensive synthesis of existing research on residential sustainable water usage and management, providing valuable insights into current trends, challenges, and future research directions in this critical domain [4]. By examining a diverse array of studies, the review identifies key factors influencing residential water consumption behavior, ranging from socio-economic variables to technological interventions. Moreover, by highlighting gaps in knowledge and areas for further investigation, Madias and Szymkowiak's work lays the groundwork for future research endeavors aimed at enhancing water efficiency and promoting sustainable practices at the household level. This systematic approach not only consolidates existing knowledge but also fosters interdisciplinary collaboration and knowledge exchange, ultimately contributing to more effective water management strategies and improved environmental outcomes. Xiangdan Piao and Shunsuke Managi's study offers valuable insights into the complex relationship between household energy-saving behavior, energy consumption patterns, and overall life satisfaction across 37 countries. By analyzing survey data from diverse cultural and socio-economic contexts, the study sheds light on the drivers and implications of energy-saving practices at the household level [5]. The findings underscore the importance of psychological, economic, and environmental factors in shaping energy consumption behavior, highlighting the need for tailored interventions that address multiple dimensions of human well-being. Moreover, by adopting a comparative approach across multiple countries, Piao and Managi's study contributes to a broader understanding of global trends in energy consumption and sustainability. As countries strive to transition towards more sustainable energy systems, research initiatives like this play a crucial role in informing policy decisions and promoting behavioral change on a global scale.

3. METHODOLOGY

The project embarks on a methodical path, beginning with a comprehensive requirement analysis phase to thoroughly understand features, functionalities, and user expectations through personas and use cases. Scalability and compatibility of platforms like MIT App Inventor for mobile apps, Arduino UNO—a flexible microcontroller platform used to create digital devices and interactive objects that can sense and control physical devices—and cloud services for data processing are carefully evaluated during the technology selection phase. System design then laboriously crafts a robust architecture with hardware configuration and user-centered UI/UX. Implementation involves writing extensive Arduino code for sensor connectivity, creating mobile apps with advanced features like notifications, and smoothly integrating cloud services for data analysis. During the system, integration, and user testing phases, extensive testing ensures perfect functionality and performance. Deployment requires careful real-world configuration and continuous monitoring. In order to ensure that water flow and electricity are accurately tracked, maintenance must include comprehensive documentation, prompt support, and iterative user-driven innovations. Modern technology and best practices from the industry support all of these. In the system initialization phase, buttons, labels, and other graphical elements are produced, and event handlers are configured to handle user inputs effectively. With its full TCP/IP stack and microcontroller capabilities, the low-cost Wi-Fi microchip ESP8266 makes it easier to integrate mobile devices with the Arduino board by building reliable communication protocols that leverage Bluetooth or Wi-Fi networking opportunities. Setting up event listeners ensures that data packets from the Arduino board are received and understood in real time, which makes it easier to collect sensor data. After that, users may accurately track how much electricity and water are used by using the right visualization tools on the user interface, including labels, graphs, or gauges. The system has user interface elements that make it simple for users to switch between sensors and request updates to data. Feedback systems are also used to alert users to any anomalies or irregularities. Carefully initializing and calibrating the sensors on the Arduino side ensures accurate data capture. The mobile device then receives structured messages via serial communication channels.

4. ALGORITHM

Set up the hardware first in order to develop a real-time water and electricity monitoring system utilizing an ESP8266, a CT sensor, an ultrasonic sensor, and a mobile application created with MIT App Inventor. Ascertain that the power supply and connections for the ultrasonic water level sensor and the CT electricity monitoring sensor are connected correctly before connecting them to the ESP8266 microcontroller. To program the ESP8266, utilize the Arduino IDE. Include libraries for web server and Wi-Fi capability, and set up Wi-Fi credentials. Setup the ESP8266 to establish a Wi-Fi network connection, initialize the sensors, and launch the web server to process requests from clients. Measure the water level and electricity consumption in the loop function by reading the analog output of the CT sensor, converting it to voltage, and computing the current. The ultrasonic sensor is triggered, and the distance is calculated based on the echo time. Utilize the web server to process and deliver this data. Utilizing MIT App Inventor, create an interface for the mobile application that includes a WebViewer component to show the data from the ESP8266 and a button for manual data refresh. Configure the WebViewer URL to the IP address of the ESP8266 and set it to refresh data on button clicks and at regular intervals. Make that the hardware is powered on and appropriately connected before deploying the ESP8266 code, and that the mobile device and ESP8266 are connected to the same Wi-Fi network. To make sure that real-time data is displayed, test the mobile application. The implementation code includes initializing the web server, initializing the Wi-Fi, and looping over sensor data reading and updating the web server response. This system makes it possible to manage smart homes and use resources more effectively by offering an efficient way to monitor water levels and electricity consumption in real time.

5. EXISTING SYSTEM

Sense provides real-time insights into consumption trends by detecting the energy fingerprints of particular devices, so enabling comprehensive home energy monitoring. Its dependence on machine learning methods, however, can occasionally result in inaccurate device detection, which could lead to incomplete data. Neurio provides tailored recommendations together with whole-home energy monitoring; however, some users may find the installation process difficult, which could restrict the number of users who use the system. While Belkin WeMo Insight makes remote energy monitoring for devices that are plugged in easier, the system's dependability may be compromised by data loss or communication problems due to its reliance on Wi-Fi. The Moen Flo has leak detection and water monitoring features, but because it relies on a single sensor for whole-home monitoring, it might not cover as much ground in larger homes and might even leave some parts unprotected. Furthermore, even while each system provides insightful information about particular facets of resource utilization, the fact that they are set up differently for monitoring water and electricity could result in fragmented data analysis, which would make it more difficult for consumers to have a thorough understanding of their overall resource consumption patterns. Notwithstanding these disadvantages, the availability of these monitoring systems helps consumers adopt more effective resource management techniques by increasing awareness of energy and water usage.

6. PROPOSED SYSTEM

Unlike other systems that only monitored one aspect, our suggested method provides a complete solution by combining the monitoring of power and water. With this integrated approach, customers can learn more about the ways in which they use resources. One major benefit is the system's affordability, which is made possible by the use of affordable sensors and widely accessible hardware like Arduino boards, making it accessible even to households with tight budgets. With the help of the companion mobile application, users can quickly make informed decisions about resource consumption on their smartphones or tablets thanks to real-time data visualization. A user-friendly interface with intuitive data visualization components such as charts and graphs make navigating simple even for users with different levels of technological skill. Users can take proactive control of their consumption by swiftly correcting abnormalities like leaks or excessive electricity use thanks to personalized notifications and alerts. Furthermore, the modular nature of the system makes it easy to scale and expand, enabling future improvements through the addition of more sensors or the monitoring of other home environment characteristics like temperature or air quality.

7. ARCHITECTURE DIAGRAM

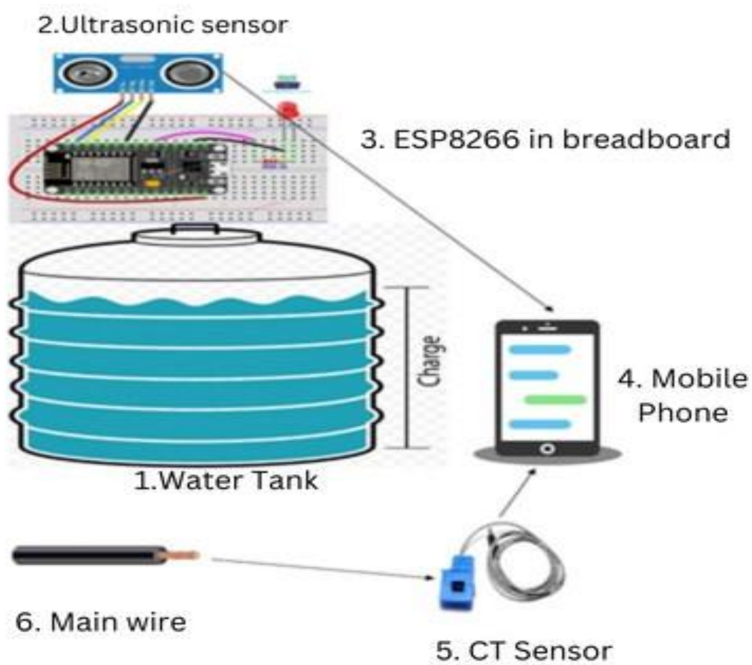

FIGURE 1

Water Tank: The water tank is a typical container used to store water, the level of which needs to be checked. It is typically positioned at a height where it can change depending on usage and replenishing. Ultrasonic Sensor: The HC-SR04 and other ultrasonic sensors estimate the water level by measuring the time it takes for an echo to return after generating ultrasonic waves and calculating the distance between the sensor and the water's surface. Breadboard-Based ESP8266: The ESP8266 module functions as a microprocessor and Wi-Fi module to receive data from the ultrasonic and CT sensors, process it, and communicate it wirelessly to a phone. It is mounted on a breadboard for convenience of connections. Mobile Phone: A smartphone that is customized to receive real-time data from the ESP8266 and display data on water levels and electricity usage, and that has the MIT App Inventor app installed. CT Sensor: The primary electrical line is clamped around by a CT sensor, such the SCT-013, which monitors the current flowing through it and converts it into a small, proportional current or voltage that the ESP8266 can read to monitor electricity usage. Main Wire: The primary electrical wire that the CT sensor attaches to, and which carries the current whose usage is being tracked to deliver information on energy usage.

8. FUTURE SCOPE

There are numerous directions that this field could go in the future for research and development. First off, improvements to the functionality and user interface of mobile applications could enhance the overall system experience and increase its potential. Furthermore, the integration of machine learning algorithms and advanced analytics may facilitate automatic resource optimization and predictive insights. Additionally, investigating integration with IoT ecosystems and smart home technologies may provide opportunities for cooperation and facilitate more easy control and management of family resources. Working together with utility companies and environmental groups may also help our system become more widely adopted and support more comprehensive sustainability programs.

9. CONCLUSION

To sum up, our project is a major step forward in the management of home resources, especially when it comes to power and water conservation and monitoring. We have devised an affordable and user-friendly system that enables homes to track their resource usage in real-time by integrating Arduino - based sensors with a mobile application produced using MIT App Inventor. A number of important advantages come with putting our suggested approach into practice, such as scalability, configurable alarms, and thorough data visualization. Our solution facilitates proactive conservation measures and supports sustainable initiatives by giving consumers insights into their consumption patterns, thereby encouraging responsible resource usage.

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