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IoT based Mobile Application Development for Power Management and Monitoring in Commercial building

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Abstract

According to several UN assessments, the water crisis might significantly affect approximately 20 percent of the global population by 2025, as well as economics and environmental overall economic. Enhancement in the technology and the growth in the population of the country the requirement of the power and water is getting increase and production of electricity is considered as one of the big issues. Electricity is normally the source of this power. Not only does electricity play a significant role in our everyday lives at home, but it is critical to everything else that takes place in our contemporary world, including the industries on which we rely, communication methods like radio and television, e-mail, and the Internet. The improper utilization of water and power is slowly becoming a global problem. So, it needs continuous monitoring of the resource to save these resources for the future generation. Innumerable technologies have developed along with the development of the human and technologies like Internet of Things, big data, and artificial intelligence (AI)-based smart water systems can assist to prevent these and to forecast to repair the harm previously by reckless utilization water and power resources. An IoT-enabled microcontroller has been used in this system to monitor and manage the system. The volume of water and the power utilization for the particular building will be allotted according to the average requirements and it will be continuously monitored using the designed device. The volume of the water used by the particular building will be monitored using the flow sensor and the unit of power used by the building will be monitored using the current sensor. When the usage of the building exceeds the allotted unit of power and liter of water per month means then the user of the building is supposed to pay to avail the extra usage of the resource. So, whenever the user of the building exceeds the indication will be given to the person staying in the building, and also the amount that needs to be paid also will be notified. And one of the major problems in day-to-day life is leakage of water from the pipeline. It is common to see the breakage in pipelines or some loose contact in the pipelines. It is really necessary to provide a solution for this problem so using water sensor the leakage of water can be deducted easily and that will be indicated. The system is employed with an IoT-enabled controller the data will be communicated to the mobile app through the cloud. The Blynk has been used in this system to gather the data and to provide integration with the device and the user. All these notifications will be displayed in the mobile app which is developed in the Blynk application.

Keywords— ESP32 module, Wireless, power, Mobile application.

I. Introduction

India is supposed to preserve its economic and social prosperity in the coming years, it will need to make sufficient resources available to fulfill the criteria of agriculture, manufacturing, and the commercial sector. Because the country's available resources are growing at an astonishing rate, effectively managing freshwater resources and power resources is becoming increasingly important to the government. Poor water planning, lack of water, and insufficient implementation of proposed remedies have combined to create a difficult-to-manage situation. As a result, India's scarcity rating is growing progressively flat at present. Water conservation, water use control, water reuse, groundwater recharge, and eco-system sustainability are not given the attention that they need in today's world. Many parts of India are already facing water shortages, which vary in size and intensity throughout the year in different parts of the country.

Water flow control requires the application of human strength to move water from one location to another. Because there is no method to keep track of the amount of water is being distributed to people, there are no restrictions on the amount of water that can be provided. A violent battle for water supplies is taking place between the agricultural, industrial, and commercial sectors. This situation has arisen as a result of a mix of natural occurrences and human activity. Because the pressure of the water flowing through the pipe is unknown, it is possible that the pipe may be damaged, resulting in the commencement of leakage on the damaged region when the water is distributed to customers. When resources are lost during distribution, it is difficult to trace down the distributors who have lost track of the resources. Despite its importance, power distribution is the weakest link in the electrical supply chain. When it comes to commercial viability, it acquires a lot of relevance because this group affects customers who pay for electricity. Because of the low metering levels and poor financial health of utility companies, this industry has suffered from large distribution losses and power theft. Thus, distribution businesses have been unable to make the necessary expenditures in infrastructure enhancements. To save the essential resource for the future, people are supposed to use them efficiently, and also the government is necessary to monitor the resources.

The proposed system will help to monitor the resources where the commercial or any building is initially allotted with a certain unit of power and liters of water that may be required for a month. If the user required an excess of power or energy, the user is supposed to pay the excess amount and can get the resources. The user can also keep an eye on their usage of the resources. So that they can reduce the utilization or make it more effective if the usage of the resource exceeds the monthly limit. The mobile application has developed with the help of the Blynk application and using this application the user can have a visualization of graph which shows the volume of water or the unit of power used by the consumer. Developing a Smart Controller system for dynamic distribution would allow consumers and resource providers to make better use of resources by allocating them based on priorities and needs. Implementation of this system will help to reduce the unnecessary utilization of the resources and also can monitor the utilization of the resource by each consumer can be monitored using the mobile application and the data will be stored in the cloud so that the data can be used if it is required. Even the over usage alert indicator has also been included in the system which helps to notify the user regarding the over usage of the resource. One of the main features included in this system is the leakage indicator. The leakage in the pipeline is one of the major causes for the resource wastage where the water source was wasted. So, to avoid that wastage due to leakage of water will be indicated using the indicator which has been included in the system will notify about the leakage.

II. LITERATURE SURVEY

Kuganesan Kumar et.al [1] have proposed an online mobile app that monitors and regulates the flow of water from taps if there is an anomalous reading in household water use. This software has been developed in this work by Kuganesan Kumar and colleagues. The newly developed app, which can be accessed by an internet-connected mobile device, allows users to monitor and regulate the water flow in their homes. By using the manual analytical technique, Rasin, Z et, al [2] have overcome the challenge of this approach. An experimental system for remote water flow measurement and monitoring was proposed in the study. Although it is employed in water flow detection, the system's real-time performance is inadequate. A ZigBee wireless sensor network has been used to enable remote probing and real-time monitoring of water quality parameters in the Smart water flow control and monitoring system 2017-2018, which is controlled and monitored remotely.

Zainal Rasinand Mohamad Rizal Abdullah et, al [3]. The article makes use of water distribution and monitoring system that is specifically designed for wireless networks. Water distribution and monitoring system with a built-in communication system It is recommended to test the quality and outline our channel measurement strategy. A domestic gateway controller with a central management system was designed by N. Kushiro et.al [4] and used weather conditions to construct an operating plan for all connected nodes in a home network. An XML interface was used to convey information about the devices' status and power usage to the webserver. Since XML files tend to be huge and bulky, delivering them across the network will be a substantial bandwidth problem for the design.
The Internet of Things (IoT) is a phrase that was coined by Kevin Ashton in 1999 [5]. The Internet of Things (IoT) is a communication network in which devices are connected and to bigger systems. A vast amount of data is converted into useable information by this network, which is acquired from a variety of devices that we use regularly [6]. The Cisco research states that while there were 500 million interactive devices in 2003, the number is expected to grow to 50 billion by 2020 [7].

This demonstrates that cities, where we live with the Internet of Things, will transform into smart cities to keep up with our increasingly dynamic and scheduled lifestyles [8]. This change will also provide us with several options to make our lives more convenient [9]. Among the many "smart" features of a home that are regularly discussed are lighting controls, heating and air conditioning systems, a computer, entertainment, and audiovisual systems, security, and a video system [10], to name just a few examples. As technology has advanced, our daily lives have become increasingly dominated by it. This includes everything from the television and audio-visual system in our homes, which begins to operate when we arrive home, to lighting and electrical devices that can be controlled remotely [11], heating systems that can be controlled remotely by our cell phones after receiving location information [8], as well as automatic adjustments based on regional weather conditions [12].

The microcontroller for the automated Water level monitor with feedback, Ejio for VirginiaEbere, Oladipo Onaolapo Francisca et.al [13], has completed its essential testing with the other components interfaced to it and is now shown. Using this technology, an overhead tank's water level can be monitored, and when the tank is empty, the water pump may be turned on and then off without the need for human interaction. Water waste is reduced as a result, as is the need to switch off the water supply suddenly. A wireless sensor network (WSN)-based water monitoring system is being developed by T.Deepiga et.al [14]. The water may be monitored in three distinct ways: at the level, in terms of water pollution, and terms of leakage in the pipeline. Finally, wireless sensor technology will be used to complete the smart home/office water monitoring system study idea. Frank A. Richerand et.al [15] A series of monitors functioning in tandem or in conjunction with interface probes reading several places and direct diversion valves will be used to create the system. Used the interface probe sand monitors as input and output signals. The water Interface position is sent by the probes many times during the operation and sent to a Programmable Logic Controller (PLC) (PLC).

Using ZigBee as the communication protocol, Han et al. [16] devised a method for monitoring power consumption in a WSN. [17, 18] proposed a System failure in this setup would result in data loss because data was collected and aggregated by the home server. ZigBee and TCP/IP must be bridged to connect this system with a community of houses. Internet of Things devices can be remotely operated using GSM/GPRS networks, as demonstrated in [17, 18]. The use of the Internet of Things (IoT) for HVAC control and scheduling methods has been examined in several research [19, 20, and 21]. For example, [22] outlines a hierarchical smart-home service architecture that utilizes several houses displays for user interfaces. Data from all of a homeowner's gadgets can be collected by a home controller system that is connected to sensors on the devices. Security cameras and other home network devices that are positioned within a community's boundaries are connected with a broker server for use by community representatives. A comparison of the Message Queuing Telemetry Transport Protocol (MQTT) and the Hypertext Transfer Protocol (HTTP) is also included in this study to determine whether the protocol is more efficient in providing home management services. [22]. For Big Data to handle and analyze the huge volumes of data received from a variety of home sensor networks and other sources, however, the suggested architecture does not incorporate.

III. PROPOSED METHOD

The proposed device is to monitor the volume of the water consumed by the consumer as well as the unit of electricity consumed by the user. The design is planned to develop using the internet-enabled controller like ESP 32 module and the necessary input and output peripherals will be connected with the microcontroller. As the population increases the requirement by the consumers also getting increased. The main issue is to share the available resource with all the people and need to save the resource for the future generation. The volume of water flow will be measured using the flow sensor. One of the frequently faced issues which lead to the wastage of water is leakage. It is come to find leakage in the pipelines and most of the people are not considering this issue as a major one because that the leakage of the pipe will seem to be lesser only. So, that this was not considered as a serious issue but on the whole if the calculation made for the wasted water means it will be a huge volume only. It is necessary to provide a solution for the leakage issue also. Here, in this work, the water sensor has been used which detects the occurrence of water leakage.

The consumption of electricity is also an important factor that needs to be focused on. Still, most of the small villages are not having proper electricity due to lack of electricity. So, the produced electricity is supposed to be divided with all the consumers equally and it is our responsibility to save some power resource for the future generation. The proposed system may employ the current sensor to measure the unit of electricity consumed by the consumer.

In the proposed device the amount of water and the unit of electricity required by the user will be prepaid and can be availed for the paid amount and if the consumer is crossing the limit of usage in water and power means that will be indicated using the over usage indicator. As well as the user will be notified with a pay alert for the consumption and all these features were developed in the mobile application. The mobile application used here is Blynk and it provides better communication between the consumer and system. Using this proposed system, the consumer may also know much power they are consuming and the liters of water they are using per day. So, this may help the user to restrict themself from over usage of the available resource. Implementation of this device will help the consumer to schedule their resource usage in an optimized way to avoid unnecessary wastage.

IV Block Diagram

To design IoT based Mobile Application Development for Water and Power Management and Monitoring in Commercial buildings, the WiFi-enabled controller along with the input and output peripherals are required which is discussed below,

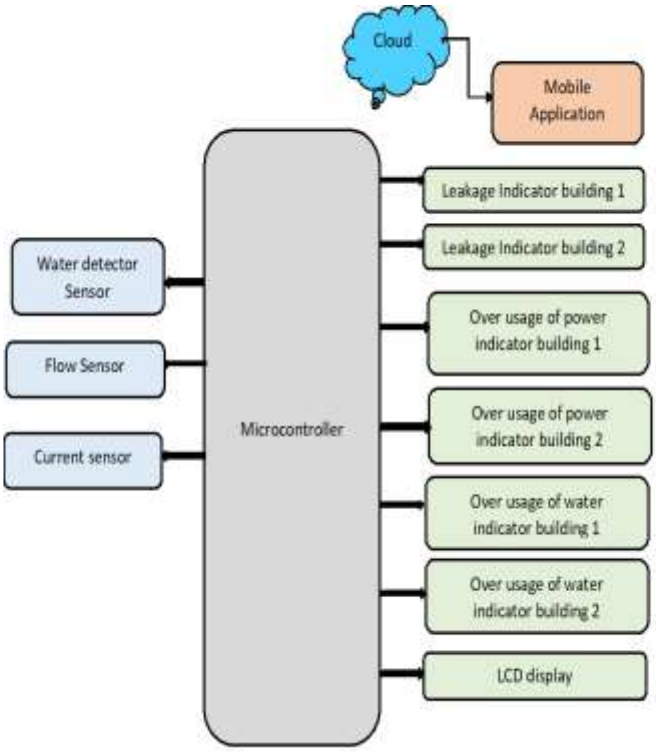

Figure 4.1 Block diagram of water and power management and monitoring

The above block diagram figure 4.1 consists of the required components for IoT-based Mobile Application Development for Water and Power Management and Monitoring in Commercial buildings, The system consists of the microcontroller which is ESP 32 module, current sensor, flow sensor, and water detector sensor along with the indicators.

ESP 32 module: This module is a microcontroller with a WiFi option that helps to transmit and receive the peripheral data between the cloud and the input and output peripherals. The sensor data will be received and processed in this module and the output will be enabled according to the input received from the sensor.

Flow sensor: Flow measurement is accomplished by the use of a flow sensor to detect leaks in a pipe. The precise measurement of the flow is a critical stage in both the qualitative and economic aspects of the process. The panel is located next to the water line and includes a panel that calculates the amount of water that has traveled through it so far. Every time the wheel is turned, an inbuilt Hall-Effect magnet sensor creates an electric pulse.

Current sensor: A Current Sensor measures the flow of current in a wire or conductor and outputs an analog voltage or a digital signal proportional to that flow. The ACS712 Current Sensor calculates the current using the Indirect Sensing method. One low-offset Hall sensor circuit is employed to sense the current in this integrated circuit. The copper conduction channel leads to this sensor, which is on the IC's surface. A magnetic field is generated when current flows through the copper conduction path and is detected by the Hall effect sensor.

Blynk: Blynk is a mobile application that allows anyone to control a microcontroller board from their smartphone. A new platform called Blynk allows you to simply design interfaces to manage and monitor your hardware projects from the convenience of your iOS or Android mobile device.

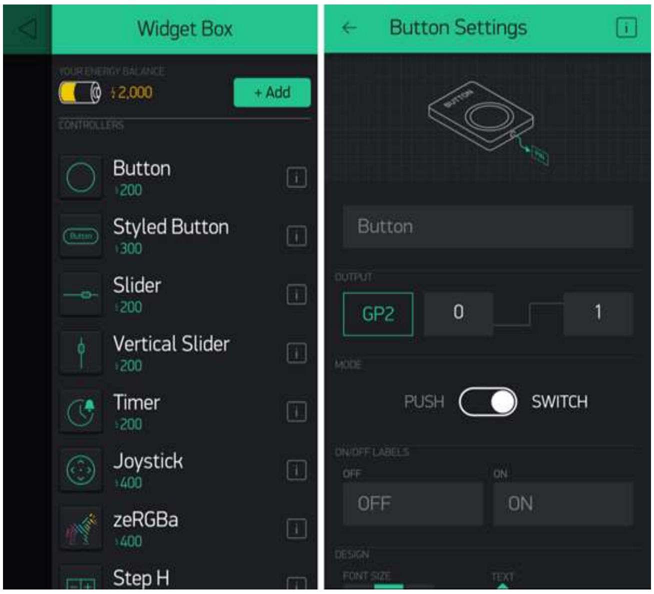

Figure 4.2 Blynk mobile application

Figure 4.2 show the view of the Blynk application in mobile phone. It currently supports the majority of Arduino boards, Raspberry Pi versions, ESP8266, the Particle Core, and a few other popular microcontrollers and single-board computers, with support for even more devices on the horizon. Arduino Wi-Fi and Ethernet shields are not yet supported, even though USB-connected devices can be controlled by the user. Use Widgets and not code to develop a visual interface for projects in the shortest period possible. Project developers can leverage Blynk's cloud service and cost-effective choices at the same time.

Cloud Server: It is a virtual server that runs in the cloud rather than on a physical server. Cloud servers Using a cloud computing platform, it's created, hosted, and delivered across the internet. The term "virtual server" refers to the same thing. Cloud servers are self-contained and include all the software they require to function.

The working and the process flow for IoT based Mobile Application Development for Water and Power Management and Monitoring in Commercial buildings have been discussed below,

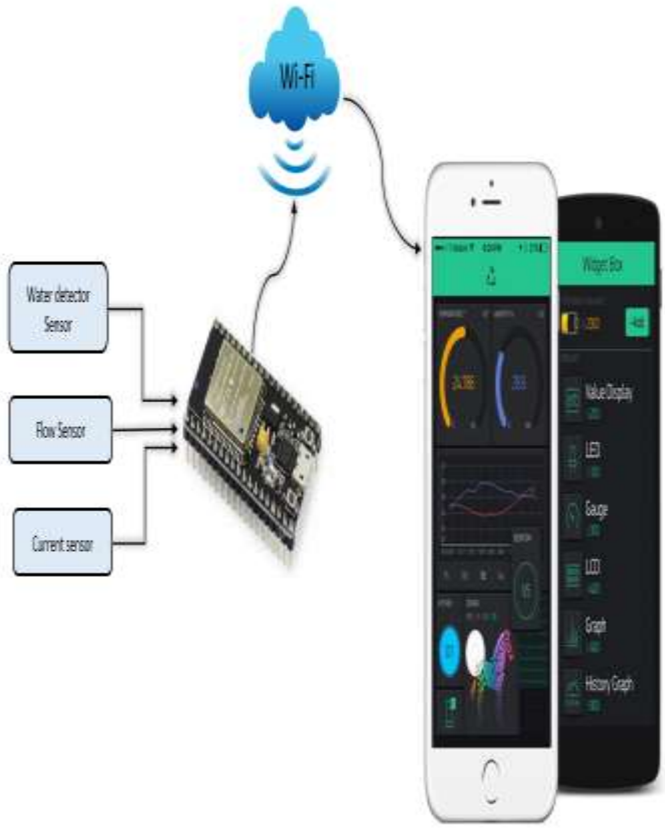

Figure 4.3 Flow of the water and power management and monitoring system

Figure 4.3 shows the work process flow of IoT-based Mobile Application Development for Water and Power Management and Monitoring in Commercial buildings. The represented flow diagram states that the data received will be given to the ESP 32 module that will process the value data received from the sensor. The allotted unit of power and the liters of water will be considered as the threshold value for the device. Likewise, the water detector sensor will detect the presence of water in the pipeline. If there is a presence of water then the sensor will detect it and intimate it as a leakage using the leakage detector. And whenever the flow of water increases and the unit of electricity consumed is observed as higher than the threshold value then the assigned indicators for the over-limit of water usage and the over-limit of power usage will be indicated. If the consumer crosses the threshold level which they availed previously then the device will suggest the consumer pay the amount for the exceeded unit of energy and the excesses usage of water in liters.

The data observed in the sensors are visualized in the mobile application. The mobile application used in this system is Blynk and the in-built widgets will be used for indicators, values, and graphs. Normally the simple family consumes an average amount of water as 27500 liters per month and the family will need a minimum of 600 units of power per month. The graph widget in the Blynk app has been employed here that will show the consuming power unit and the liters of water by the consumer. So, that the user can know the usage of the resource and also, they may reduce the usage when it closely reaches the limit. Whenever the consumer crosses the limit of usage, the consumer is supposed to pay the extra amount to avail of the resources. These options are used in the Blynk app using the in-built widgets. The observed data will be represented in the graph, and the value display, as well as the data, will be stored in the cloud that can be used for further purposes and this can be downloaded by the consumer at a time according to the requirement of the consumer.

VI Result And Discussion

The observed values using a sensor are visualized using Blynk mobile application. The visualized results are shown below,

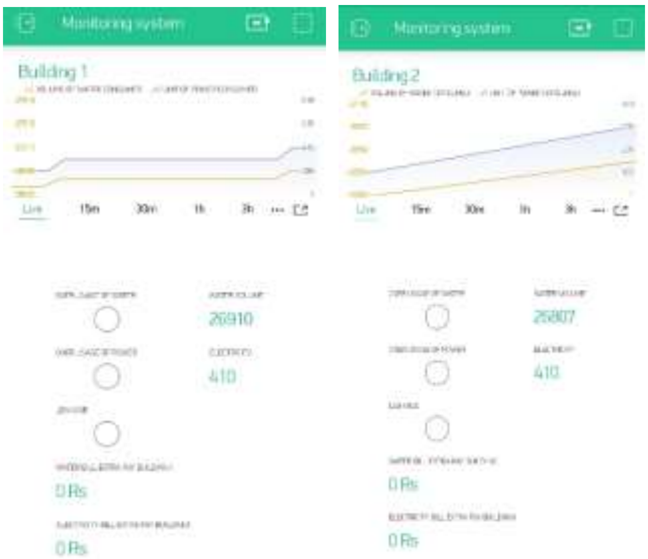

Figure 5.1 Consumed water level and the power is under the limit

The yellow line in the graph indicated the volume of water and the blue line indicates the unit of power consumed by the consumers

Figure 5.1 shows that the mobile application page for the consumer of building 1 and building 2. This page of the mobile application will be used to communicate with the user. It states the volume of the water consumed by the user and the unit of power used by the user. The consumed sources will be displayed in terms of value as well as the same will be reflected in the graph. And the over usage indicator and leakage indicator have been included along with the above features for indication. If the user exceeds the limit the consumer needs to pay the mentioned amount in the application to avail of the extra resource.

Figure 5.2 a) Over usage of Water in Building 1

Figure 5.2 b) Over usage of water in the building 2

Figure 5.2 a) shows the over usage of water by building 1 and 5.2 b) shows the over usage of water by building 2 which indicates that the consumer has over-consumed the water. So, that the over usage of water indicator has enabled and the unit of power under the threshold limit so that the indicators are in OFF state, as well as the consumed amount of water in liters and power in kWh which means unit has displayed as value also that value, has represented in the graph. And, if the user crosses the monthly threshold value, then the user can not avail of the resource until they pay the extra amount for the resource. So, that the yellow line is saturated in the graph.

Figure 5.3 a) Over usage of Power in Building 1

Figure 5.3 b) Over usage of Power in Building 2

Figure 5.3 a) shows that the over usage of power by the consumer of the building 1 and Figure 5.3 b) shows that the over usage of power by the consumer of the building 2 which indicates that the consumer has used the water over the threshold as well as the power over the threshold limit which assigned as an average amount required for the particular consumer for a month. So, that the power over-usage indicator has enabled both the buildings to notify the consumer regarding the over usage of power and the same has been reflected in the graph, and also the observed unit of power was displayed in the mobile application for the user consideration. It also shows the extra bill that needs to be paid for the over usage of the resources. The graph shows that the user exceeds the monthly threshold and also the user paid the excess amount to avail extra resource so that the graph was in saturate condition in the initial state and once the consumer paid the required amount the resource will be available for them to use. So, that both yellow and blue start to increase in the graph when the consumer paid the amount.

Figure 5.4 a) Water leakage in the building 1

Figure 5.4 b) Water leakage in the building 2

The leaking of water in buildings 1 and 2 is depicted in figures 5.4 a) and b), respectively. This is the primary factor that contributes to the massive volume of water that is wasted. The last blue indicator will alert the user if there is a leakage in the water distribution system.

VI Conclusion

Water and electricity are essential sources that need to be utilized effectively and need to be retained for future generations. The proposed work has planned to develop a device that can monitor the water and power utilization by the consumer. Wi-Fi enabled controller has been used in this system and the input sensors are connected to measure the flow of water, unit of power used, and leakage detection. The main advantage of this device is the collected data will be stored in the Blynk cloud. The mobile application with the necessary widget has been developed using Blynk and that mobile application shows the volume of water utilized and the power consumed by the user will be displayed as value as well as in the graph so that the user can have a track of their usage. The mobile application will also show the intimation regarding the over usage of power and the water resource. The consumer is allowed to avail of the excess power and water by paying the amount displayed in the mobile application. In the proposed device it is planned that the consumer is supposed to pay before using the resource. So, this will help the consumer to avoid the unnecessary utilization of the resources. Implementation of this device will help to save the resource for the future generation.

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