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Design and Development of Water Flow Network using IoT

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Abstract: ***During the past decades water needs have risen exponentially to an unprecedent- ed scale in India. Due to increase in population, water consumption and water distribution has become critical problem. To triumph over problems related to water supply and for equal distribution of water there is a need for efficient automated device. This paper pro- poses the conceptual design of automated water flow network and distribution system using IoT for highly populated urban areas such as apartments. The system is fully automated with closed loop structure. The heart of proposed design has a microcontroller which ex- tracts and processes the data from electronic flow rate sensors and monitors the flow of wa- ter to each user based on predetermined threshold level. Hence the water is equally distrib- uted among the user according to their needs. IoT provides the information services required for water flow networks.***

Keywords: IoT, Water distribution system, closed loop water distribution system, water level sensor, solenoid valve.

I. INTRODUCTION

Water shortage is both a herbal and human made phenomenon. There is sufficient freshwater on the planet for 6 billion human beings however it's miles distributed unevenly and an excessive amount of its miles wasted, polluted and unsustainably managed. Worldwide, greater than 1.2 billion human beings lack for smooth pota- ble water. Due to frequent environmental changes and inappropriate rainfall water scarcity is evolved all over the world. According to the survey made by United Na- tion Development Program, it is found that the major cause for water scarcity is poor management of water supply, negligence of user. Undoubtedly water is a very precious resource for all living beings on earth. Therefore if sustainability is not done properly, then it can be devastating to our communities. Hence by applying the right technology, water scarcity problem can be minimized. [1]

Water management system can be automated in order to limit the supply of water, fair usage of water and to decrease the manual errors. The major goal is to design and broaden a low fee, dependable, worthwhile and efficient approach to make suitable water distribution with the aid of non-stop tracking and additionally con- trolling it from imperative server with a view to clear up water associated compli- cations.

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The smart tariff system with IoT [2] enabled web portal provides statistics of various water usage parameters such as water level in tank , amount of water consumed etc [3].The designed water flow network assists the admin to distribute water equally among multiple users.

Rapid innovations in the area of digital things and Information Communication Technology are driving rapid deployment of Internet of Things (IoT) around the globe [4]. Device to Device communications (D2D) in IoT are envisaged through various protocols such as Constrained Access Protocol (CoAP), Message Queue Telemetry Transport (MQTT) and MQTT-SN (for sensor networks)[5],[6]. The heart of a system is a microcontroller which controls the distribution of required quantity of water in timely manner. The IoT device will help to manage and plan the usage of water [7]. Once the level of water supplied reaches the predetermined level, the solenoid valve is closed and the information regarding the same is trans- mitted to the admin via Wi-Fi. With the advancement of engineering and technolo-

gy, process automation has come into reality with satisfying accuracy. The system is fully automated with closed loop structure [8].This paper helps to automatically monitor the supply of water from the authorities and to get alert regarding it which helps in the proper utilization of it. This will help the masses to fill up their con- tainers even in case of unusual timing of supply with automated procedures. Also the automation helps to reduce the wastage of water when containers are filled.

This paper describes the layout and improvement process of an automated control device for tap water the usage of ultrasonic water stage sensor which can keep wastage of water without the presence of any operator body [9]. This sensing de- vice utilizes a aggregate of a solenoid valve, electromagnetic relay (a kind of elec- trical switch), develops a system which can robotically manipulate the water faucet accordingly when level sensor can feel the lower level of water tank [9]. Also, the system has ability to prompt the relay which starts off evolved solenoid valve. The complete method continues till it experiences the higher stage of water. After that the device deactivates the relay in addition to the solenoid that may stop the water glide through faucet, whilst the upper level is sensed [9]. In precise, the evolved machine is capable of manipulate the water faucet to shield the wastage of treas- ured water by way of this mechanism. This machine is low-cost evaluate to differ- ent commercial systems, become tested to assess the achievement rate of the im- provement [9]. The end result shows a self-reliant plus strong tracking device with satisfactory result which is relatively simple to install [9].

II. PROPOSED METHOD

The proposed method is fully computerized. Hence, requires less time and manpower [10]. This system can be implemented on water tanks for secure, green and waste much less consumption.The Basic Block Diagram of Water Flow Network is shown in Fig.1 which includes Level Sensors that can be incorporated in each tanks to check its degree and a predetermined level is set according to the quantity of apartments. The limit supplied for usage of water may be notified to the person. The water level in tank is verified frequently based on which threshold level can be updated and notified to the consumer. Based on the users request the admin in control room initiate the system to deliver water for the particular person.

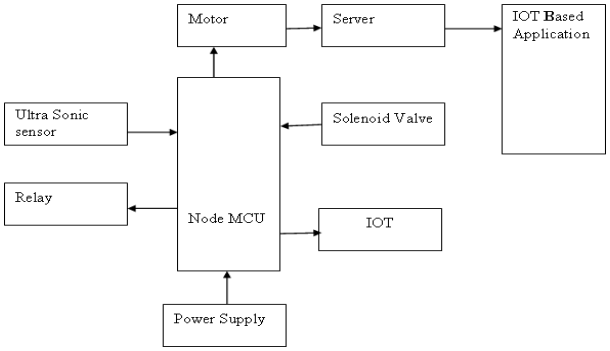

Fig.1: Basic Block Diagram of Water Flow Network

The admin of a web based applications, tally the water requested and consumed by each resident. Water flow sensors[11] measures the flow rate in each pipeline. The solenoid valve is closed once the threshold is reached and the information is sent to the web page through WiFi which can be accessed by the admin in controlling unit. The drift of distribution and amount of water both will be monitored from the net page which may be displayed everywhere using internet. Hence, the proposed device helps in handling water deliver correctly according to the availability i.e,
Additionally beneath scarce conditions. Our automatic system consists of a solenoid valve, relay, and ultrasonic sensing device. The overall project works in different phases. The initial state of valve is on. The ultrasonic sensor is used to measure the level of water in the container and whenever the water level crosses a set limit, valve is closed. Ultrasonic sensor, solenoid valve and water pump are controlled by the relay from which the data are sent serially to the Node MCU. Node MCU sends this data to database. This data can be retrieved from database through Admin Dashboard. Initially, the valve is kept on. When water arrives at the pipeline, the level of water in the container is measured using ultrasonic depth sensor. If the level of water in the container exceeds a certain threshold, the valve should be turned off. Else, the valve is kept open until the level of water reaches the threshold.
As a whole, the automated water flow control system helps automating the pro- cesses of detection of water arrival, storage and calculation of water usage. This will help the society to use water judicially along with the ease of water manage- ment. The computerized pump controller minimizes the need for any manual switching and human interference [12]. System operates on behalf of water conduc- tivity. This system has its own power supply and solar power backup system, which provides continuous electric supply in case of load shedding which is common in many countries [12].

III. SYSTEM DESIGN

In order to satisfy the specified requirement, the architecture, modules, interfaces and data for the system is defined. The designed system is shown in Fig.2.

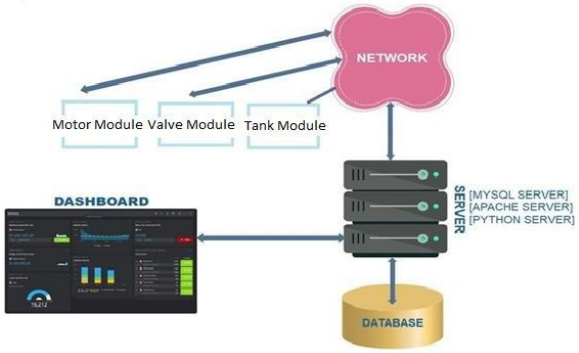

Fig.2: Design module of Water Flow Network

Motor module in Fig.2 will be attached to water pump and upon switching it on it sends configuration packet to server where this module can be configured by putting details about the module like label, port number etc. through the dashboard to let it communicate with other module in the network and as well as details about itself. Valve module in Fig.2will be attached to valve and up- on switching it on it sends configuration packet to server where this module can be configured by putting details about the module like label, port number
etc. through the dashboard to let it communicate with other module in the network and as well as details about itself.
Tank module in Fig.2 will be attached to tank and upon switching it on it sends configuration packet to server where this module can be configured by putting details about the module like label, port number, tank length valve list, motor list etc. through the dashboard to let it communicate with other tank and valve modules in the network and as well as details about itself. When the tank module is successfully configured it keeps on checking the water level and sends the water level status as a log packet to the server every 5 minutes which can be viewed in dashboard. If the water level is below the threshold value the tank module take the appropriate action to fill the tank by sending the ON command packet to respective valve modules and motor modules and sends OFF command packet to respective valve modules and motor modules if water level is above threshold value.
When the command received by the motor module or valve module it fulfills the commands by taking appropriate actions by switching the motor or valve ON/OFF and sends the status log packet of the module to the server as well which can be viewed in dashboard.

IV. RESULT AND DISCUSSIONS

When the modules are attached to the respective device and switched on, it sends the configuration packet which can view in the list. By clicking on configure button, module can be configured.

The basic details about the module like IP address and MAC addresses are listed in the pop up window.
When the configure button is clicked it redirect to the module configuration window where the module details can be filled like generate unique ID for that module, port number, label, type of the module (tank/motor/valve) generate e-key for encryption of the data and some fields are already filled which cannot be edited like IP address, MAC address, status and working of the module.
When the module is successfully configured to the network, it sends the con- figuration details to database as well as to module and shows the module added successfully message with IP address and port number of server.

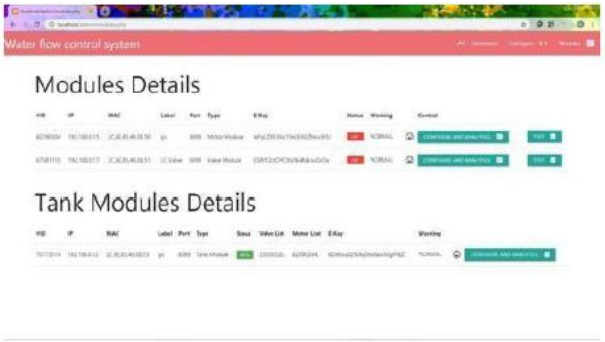

Fig.3: Module Details Window

Module detail window is shown in Fig.3 gives the list of all the motor/valve modules and tank modules with their all details like label, ID port, status working, valve list, motor list etc. Each module can be updated and analyzed separately by clicking on update and analytics button and also each module can be tested for its working by clicking on test button.
By clicking on the test button on module window for any module, it redirects test module window. In this window each module can be manually switch on or off to test for its working. This window shows the basic details like MAC address, IP address, working, status, port number.

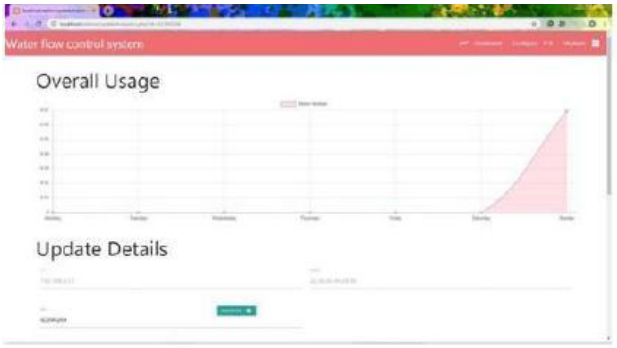

Fig.4: Update and Analytics Window

By clicking on the Update and analytics button on module window for any module it redirects to the window shown in Fig.2. The overall usage graph of module for the week is shown in Fig.2. It shows how many hours module was on for each day of the week .In this window details like label, port num- ber, ID etc can be updated.

Fig.5: Main Admin Dash Board Window

Fig.5 shows Main Admin Dash board window which has a list of all the modules present in the network and working with very basic details of each module like, label, ID, status etc. and overall usage graph of all the valve, tank, motor separated by three different colors. This graph shows the work- ing hours of all modules all together for each day of the currentweek.

V. CONCLUSION

The proposed water flow network system helps to distribute water equally among multiple users based on the requirements which minimizes the wast- age and overconsumption of water. This paper presents a solution for the easy and automated management of water in households which helps in pre- venting wastage of water. It is also supposed to help people to tackle the un- timely supply of water by authorities. The designed system helps to control the usage of water when the predetermined threshold level is reached. The flow rate sensor continuously captures the amount of water flow to each user and the data is processed in microcontroller which gives the satisfying accu- racy. The node MCU, sensors and solenoid valves are connected serially which performs the required operation. The future scope involves developing a cost effective, user friendly system which can be implementable in every household. It can be extended so that the system can be implemented in a particular area rather than a house. The statistics regarding the water con- sumption for that particular area can be stored in a centralized database which is maintained by concerned authority so that a centralized manage- ment is done. The information stored in the database can be used to generate bills thus reducing the manual work considerably. The authority can also de- cide on the amount of water supply to each house based on statistics and generate bills accordingly. This accounts for the fair usage of water. Auto- matic water level monitoring system has a good scope in future especially for agriculture sector. NRF transmitter and receiver or Ethernet shield can be used for wireless reception of information using mobile phones and to con- trol it accordingly.

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