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Water Supply Monitoring and Controlling System for Cooperative Housing Societies in Urban Area Using IoT Analytics

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ABSTRACT - Things in IoT can be everything that we use every day. In this project, the "thing" is a water container. We use water in the water container usually the level of the water container is reduced and keep on changing as per the usage. To maintain and keep track of the water level we need to monitor it closely 24 x 7. That is why we propose to use the Internet of Things concept which can solve the problem. In order to do this, we have embedded an algorithm that integrates functions like data acquisition and data management in a master device that dynamically computes and compares the quantity of water being dispensed. Our approach utilizes a controller of ESP8266 that can provide monitoring level of the water container. We use an ultrasonic sensor to sense the level of the water. We utilize the Firebase and Android app service in providing water level monitoring and control. Alert notifications are sent to the owners about the water level.

Keywords: Sensor, Water Management, Internet of Things (IOT), Flow control, Real Time Monitoring, ESP8266, Firebase, React Native

I. INTRODUCTION

1.1 Introduction

A Things in IoT can be an object that we use every day such as sensor which detects motion, temperature, a sensor that can remind driver when tire pressure is low, a trash can that will inform a user when the box is full. Internet of things is very closely associated with the machine to machine communication. Internet of Things is usually supported by the device/controller that used to carry sensors and actuators such as Raspberry Pi, Arduino based processor and so on. By using those boards, data from sensors can be monitored and controlled remotely via the Internet. [1]

Water is the most vital component to sustain any organic structure on our planet. 96.5% of the Earth's water is found in seas and oceans and also the rest 3.5% is found in groundwater, glaciers and ice caps. Out of this 3.5%, only 0.3% is usable. Water is such a scarce resource that approximately 1 billion people lack access to safe drinkable water today. It is estimated that by the year 2030, quite half the planet population will face water-based vulnerability.

We are aiming at developing a tool that may efficiently alert water level and also the amount of water (volume) supplied. Since there is auto alert system of water when the tank gets filled which reduces the water being wasted. The setup features a monitoring system that continuously provides the user with real time data about consumption or the level/volume of water that is being filled.

IoT based water monitoring system for urban societies measures water level in real-time. The sensors installed in tanks collect periodic measurements that are reported in real-time and further action are going to be taken according in step with the reading from the sensors.

Our main aim is to develop water supply monitoring and controlling system for cooperative housing societies in urban area which can help to society administrators and members of society to allow real time water consumption information and controls consumption by distribution of water using statistical information and provide report and also average consumption using IOT analytics.

To achieve this goal we performed the study on existing various scenarios of water supply, distribution, monitoring and controlling in cooperative housing societies and also identified suitable sensors. We designed and implemented a algorithm for proper water distribution, monitoring and controlling system using cloud computing technology. We have provided statistical information regarding water consumptions to the user and society administrator by developing android based mobile application which helps them further control and manage uses of water by referring to the average consumption and take appropriate decisions. Graphical reports are generated based on selection of different parameters using analytical

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tools considering sensed and developed data under cloud database.

The outline of the thesis is as follow. Section 2 discusses regarding the literature review. Section 3 discusses the proposed model. Section 4 discusses on expected results and followed by Section 5 discusses on conclusion.

II. LITERATURE REVIEW

Tanvir Rahman et al(2018) discuss regarding household water supply monitoring & billing system using arm processor, water level sensors and water flow sensors. The feature of this system is automatic switching of the DC water motor based on the level of water present in reservoir along with display of the amount of water used in each block. Volume of water consumed by each floor is also set and bill will be generated according to the usage. It also helps in saving water by reducing wastage.

Anjana et al. (2015) discuss regarding IPv6 network connected IoT design for real-time water flow metering and quality monitoring using CoAP for monitoring and control approach which supports internet-based data collection. The system addresses new challenges in the water sector - ease of billing, fair billing and the need for a study of supply versus consumption of water in order to create awareness to curb water wastage and encourage its conservation. Automatic detection of leakage through any of the outlets is notified to the user. The measurement of quality of water distributed to every household by deploying pH and ORP sensors is discussed. The traditional water metering systems require periodic manual intervention for both metering and maintenance making it inconvenient and often least effective. System is designed to measure the pH and ORP of water supplied to each house and also allows the users to monitor these parameters in real time through a web enabled interface. Shortcomings of the existing models is overcome by CC2538 motes programmed using ContikiOS to monitor the water consumption and communicate the data to a gateway wirelessly.

Thinagaran Perumal et al (2015) [1] discuss regarding IoT based water monitoring system that measures water level in real-time. [2]This prototype will help to detect flood occurrences especially in disaster prone areas. A water level sensor is used to detect the level if it reaches the limit, the signal will be feed in real time to social networking site like Twitter. A cloud server was configured as data repository. The measurements of the water levels are displayed in remote dashboard.

Prachi Dutta et al (2016) [2] discuss regarding developing an efficient and cost-effective method of placing an upper limit on the amount of water used daily. The design has two modes of operation: running mode and filling mode and user is pre-alarmed when more than optimum water amount is being dispensed. The design would efficiently reduce the water being wasted by alerting the user through an audio-visual alarm even before the water level is reached. The setup also has a monitoring system that continuously provides the user with real time data about how much water is being used or the level/volume of water that is being filled. By using above design there was a reduction in the amount of water wasted by 60% in a month.

L.Goswami et al [3] discuss regarding a model which is to be distinguish the shortcoming in transmission line by looking at the node MCU is connected to an transformer, if power is flowed through this than a subsequent signal will go to GOOGLE Firebase database, it is depend on the number of transformer and its corresponding node MCU , if all signal will go to GOOGLE database means power line is on ok condition but if some data signal gone through on database and some data does not go so whose data signal is not working so it will assume that node MCU is not working and every node MCU has a unique area code id .The data with respect to issue event specifically stage is send to page through IOT gadget which is NODE MCU(Esp8266) and furthermore appeared in show.. Here microcontroller NODE is utilized in this IC writing computer programs is done which think about the voltage signal furthermore, send yield to IOT module and show. The power supply is given to supply 3.3-volt dc capacity to all segment this stock is separate from the stock which is utilized to check the issue event.

Ronald Tulus et al [4] discuss regarding Sea level prediction system which is an important tool for many coastal engineering applications, such as for designing of engineering structures in coastal or in offshore, routing of vessels, predicting and preventing flood in low land coastal areas, etc. One classical method to predict sea level is by using the Tidal Harmonic Analysis, in which the sea level is approximated by summation of tidal components. The method needs long historical time series data, and it cannot predict non-tidal component or sea level anomaly. In this paper, they propose a sea level prediction by using the Autoregressive Integrated Moving Average (ARIMA) and the Seasonal Autoregressive Integrated Moving Average (SARIMA) to predict sea level and choose a study case in Tanjung Mas Harbour in Semarang, Indonesia. Several input combinations for the ARIMA and the SARIMA are investigated for finding the best fit parameters. Results of prediction by using both methods are compared with the classical Tidal Harmonic Analysis. The accuracy of each method is investigated by calculating the RMSE and R-squared value. Despite of the seasonal data that is used in this paper, the ARIMA method gives the best prediction.

Depriya Soni et al [5] discuss regarding understanding of stock market analysis using some well defined algorithms and machine learning techniques. Stock price forecasting is a popular and important topic in financial studies and at academic levels. Share Market is not a neat place for analysing since there are no significant rules to estimate or predict the price of share in the share market. Many a method like technical analysis, fundamental analysis, time series analysis

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and statistical analysis, etc. have been used in an attempt to analyse the share trends in the market but none of these methods have so far proved to be a universal approach for acceptance as a prediction tool. The intricacy while analysing market trends is that they have a dependency on a number of external factors some of which are not under one's control. The goal of this work is to analyze stock market trends using some machine learning and nature inspired techniques, these were first studied and then implemented (a few of them used in this paper are Decision Tree, PSO, Black-Hole, Naïve Bayes.) After analyzing the trends with the help of standard techniques, we then proposed an entirely new approach to analyze stock market indices over which accuracy is calculated and compared over different techniques and algorithms.

H. Sammaneh et al [6] discuss regarding the hierarchical design of an adaptive water distribution system is presented in a way that it can optimize the water distribution. It based on a dynamic knowledge based system that is used to analyze the demand and the consumption as well as to detect any leakage occurrence. Therefore, it controls the distribution of the aim of conserving water and sustaining the citizen functionalities. Furthermore, the nature of hierarchical design facilitates the detection of faulty components as it exploits the idea of decomposition of the system into subsystems

III. METHODOLOGY

3.1 System Design

Internet of Things (IoT) is a well-established paradigm that allows the physical objects or things to connect, interact and communicate with one another. We propose a low-cost open platform based on ESP8266 to supervise and monitor the state of components of the water monitoring systems. The system provides centralized monitoring and management for various technology systems. Working as a central component of a facility control centre, it can acquire, process, and visualize data from sensors. The aim is to increase the efficiency and reliability of water supply cycle.

Node MCU (ESP8266): Node MCU is a WIFI micro controller unit; the main use of this module is to transfer any real time values to the websites or database via internet. It works only when internet hotspot is applied through this . ESP8266 designed to have Wi-Fi directly integrated with , so ESP8266 doesn't require Wi-Fi module. The controllers can provide the supervisor with different parameters, such as water level, time and volume. The real time values are stored in Json format.

Ultrasonic Sensor: In ultrasonic sensor, there are two modules in one circuit package, the receiver module and transmitter module. The transmitter is used to generate and transmit ultrasonic waves toward the observed objects. When an ultrasonic wave touches or hits an object, the ultrasonic wave bounces and is captured by the receiver module [7]. The project performs water level measurement by using an ultrasonic sensor, however, the level was just transmitted via wireless transceiver locally.

Firebase database: It is a free platform where all types of apps (android, ios, webapp) can be created, Firebase console platform provides many features, as they are such as 2- real time database. Real time database is used for storing the real time value . The Firebase Realtime Database is a cloud-hosted database. Data is stored as JSON and synchronized in real time to every connected client.

In system design, there are consists of two parts, The first is software system and the second is a hardware system.

Android SDK: Android SDK is a software development kit developed by Google for the Android platform. The Android SDK allows you to create Android apps. The Android SDK is a collection of software development tools and libraries required to develop Android applications. These tools provide a smooth flow of the development process from developing and debugging, through to packaging.

React Native: React Native is a JavaScript framework to create cross-platform mobile applications. It is used to develop applications for Android, Android TV, iOS,

A. Hardware System

In fig 1 there is a system diagram of the design of IoT Based Water Level Control System. On the top of the water container, we place an ultrasonic sensor to read the level of the water. On the ultrasonic sensor there a two cable for trigger the ultrasonic sensor and receive the echo of ultrasonic sound. The ultrasonic sensor is used to find the volume of water in the tank and all sensor value is updated on the cloud. The microcontroller communicating via Wi-Fi to the internet to connect with the Android App. [1]

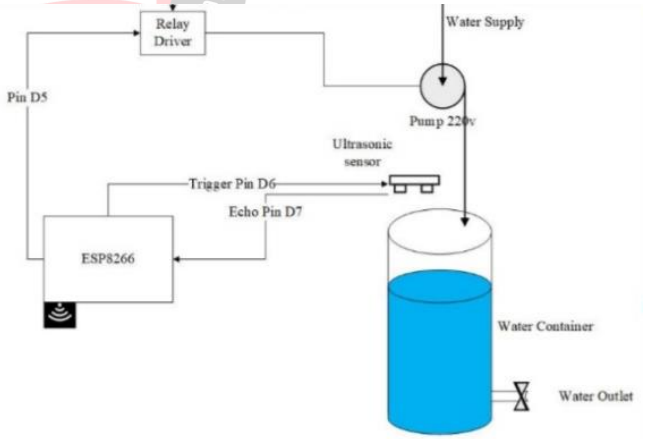

Fig 1 : Block Diagram

B. Software System

Firebase console platform provides many features, as they are such as cloud fire store and real time database. Real time database is used for storing the real time value and cloud Fire store is used for cloud messaging. Figure 2 shows how the information is transferred between Node MCU and android App.

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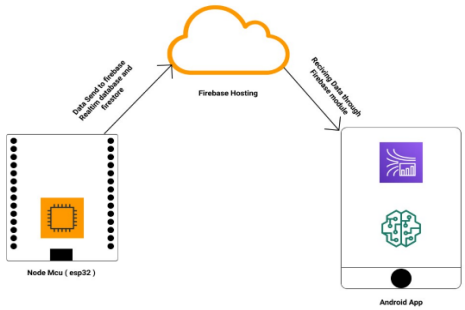

Fig 2: Firebase

Fig 3 shows a flowchart of microcontroller coding. On the flowchart, there is a process that gets level from the sensor. When ultrasonic sensor shoots ultrasonic pulse to the water surface and capture ultrasonic pulse reflection from the water surface. The different time between sensor ultrasonic shoot pulse and receive pulse must be converted into the distance (cm).

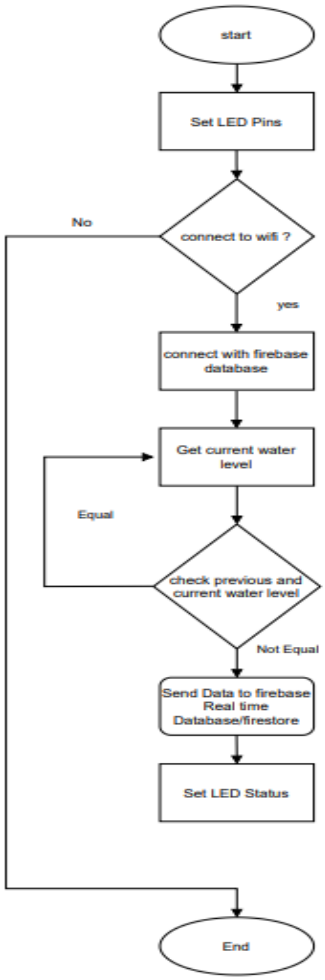

Fig 3: Flow Chart

3.2 System Architecture

Taking about this system, we have used NodeMCU, Ultrasonic sensor and Firebase to build a water monitoring system. Figure 4 represents the system Architecture which describes the connection of our model.

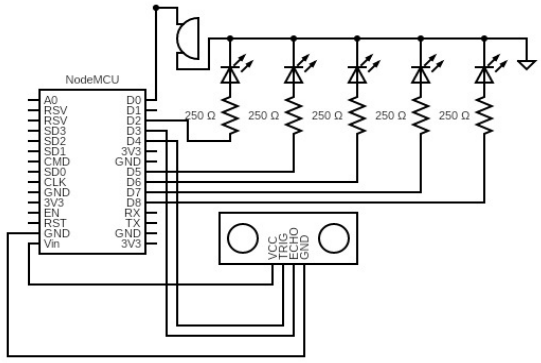

Fig. 4. Schematic of hardware

IV. RESULT AND DISCUSSION

In urban area societies are facing issues regarding daily adequate water supply. The system is been developed to provide information regarding availability of water levels, precautions to measure for utilization of water, decision making for further enhancement of water storage and statistical analysis report of required period through android mobile application based on the real time values received from sensors which will help to regulate the utilization of the available water resources and use effectively. Sensor based real time data processed by control program to take real time decision and real time values will be stored in firebase. The graph will help the user to compare the water consumption on day-to-day basis and also to predict the future use on basis of moving average algorithm. The display of water tank using graphics in application will help the user to track the water consumption. The registered users will get the messages regarding water level updates.

A. Experimental Result

Analytics show the data based on daily time frame. We can find the entire data for a day presented in line graph with addition of a bar graph. The firebase real-time database was used to connect the components. Figure 5 represents the graph based on the real time values fetched by the sensor and saved in the Firestore.

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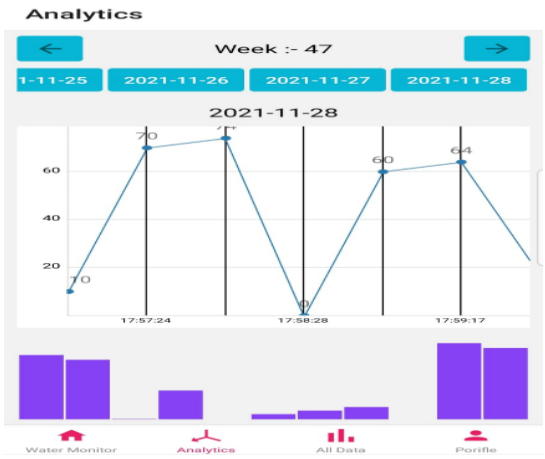

Fig 5: Analytics

The water level monitoring system shows the water level. It must have a proper internet connection to load the data in real-time. The hardware unit must be installed over the tank and it is necessary to set properly. Sensor data must be sent to the database which was developed in the firebase. Then firebase data must be retrieved in real-time to display the value in the chart. We also calculate the moving average of the values and display the same which will help us to predict the future usage of the water. We have automatic monitoring of motor switch. When the water level reaches 0% the switch will ON automatically and when the water level reaches

100 % the switch will get off.

B. Application

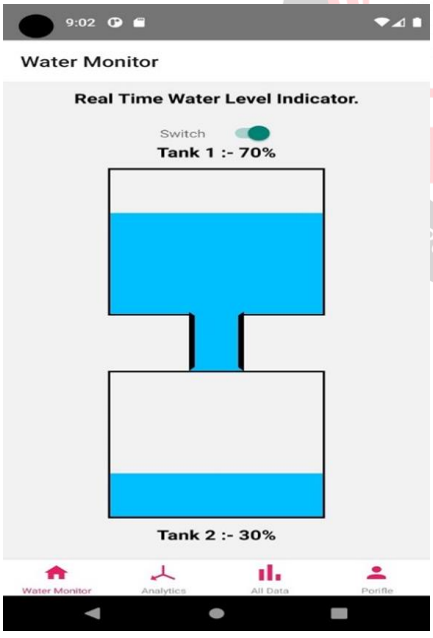

Fig 6: Home Screen

Figure 6 is the Home screen of the application representing water level and status of the switch. Home screen shows the real time water level whenever water in the tank increase or decrease, a ultrasonic sensor on the top measure the values and convert it into the percentage. In Home screen if water level gets below 25% alert SMS will be sent to all the members. If the water level reaches 0 % then the switch of the motor gets ON which will pump the water from the storage tank.

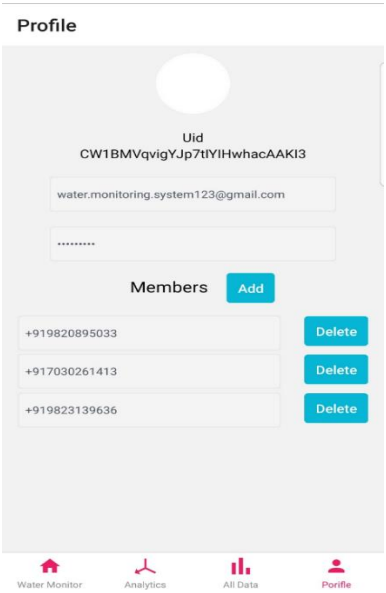

Fig 7: Profile

Profile screen show the current user profile with all the members, user can add remove n number of members, later this data will be use to send alert SMS

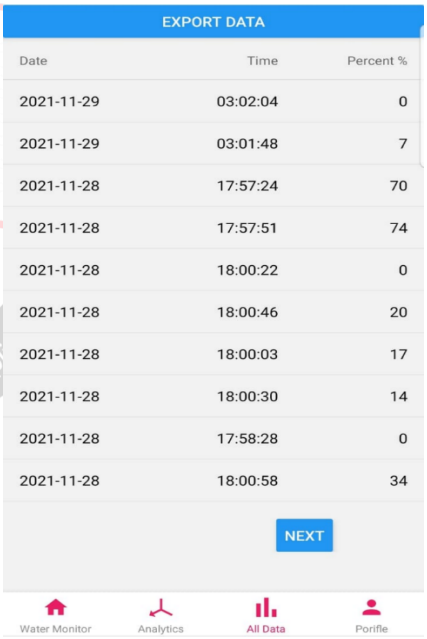

Fig 8: Application when acquisites the data

Export data screen user can show data sequentially to reduce the server load. Export data have a Export Button which will export the data in excel file later this file can be used for analysis. Figure 9 shows the structure of the document where we store data. For every new user a new document is created as shown in the figure.

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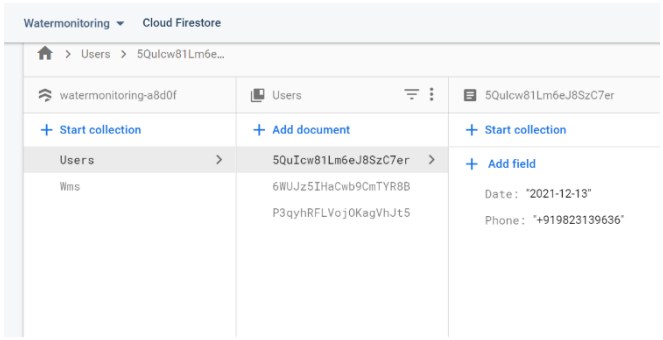

Fig 9: Database structure for the users

Figure 10 shows the list of all documents containing the percentage of water level from 0th to 24th hour of each day. Each entry is stored in separate documents as shown in the below figure.

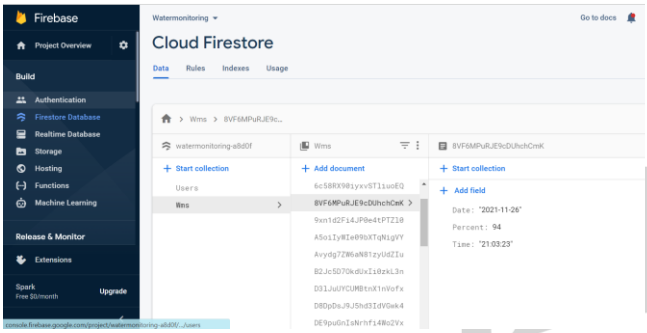

Fig 10: Database structure for the water level

V. CONCLUSION

The low-cost water monitoring system based on ESP8266 was successfully designed and developed using android application . Proposed system will provide real-time data acquisition, eliminates the manual mistakes measurement and accurate automatic operation measurement. It takes advantages because the system offers a simple, easy for user, accurate measurement, real time data acquisition and online monitoring of the levels. The system also helps us to predict the water usage-based festival season and vacation and also sends messages to the users indicating the level of water and also, we can refer the graph for analytical calculation and determine the usage pattern and plan accordingly.

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