SMART WATER GRID: AN IoT FRAMEWORK

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Abstract. Water scarcity became most inexorable problem these days. In urban areas most of the people live in flats or apartments where, they need to get water from the corporation and then they ought to supply for each flat and apartment. Supplying water in a normal way arises many technical issues. In this paper, a working prototype is implemented to solve these problems. This model contains one Main water tank and two small sub water tanks. Each node (tank) can function automatically based on the tank and ground water levels or for other problems and also can be controlled manually from the water level through android app anywhere in the world with the help of IOT. As the Indian populace keeps on developing, India's water infrastructure should be prepared to take care of an expanding water demand while keeping up great resource condition to guarantee good quality of water is provided to customers around the clock.

1. Introduction

A Smart Water Grid framework information and communications technologies (ICT) into the classical administration of the water conveyance framework as shown in figure 1. Sensors, meters, advanced controls and analytic tools are utilized to automate, monitor and control the transmission and appropriation of water, ensuring that water is effectively with great quality. Today, numerous ventures are making utilization of ICT to enhance their activities and procedures, especially through digitization and robotization.

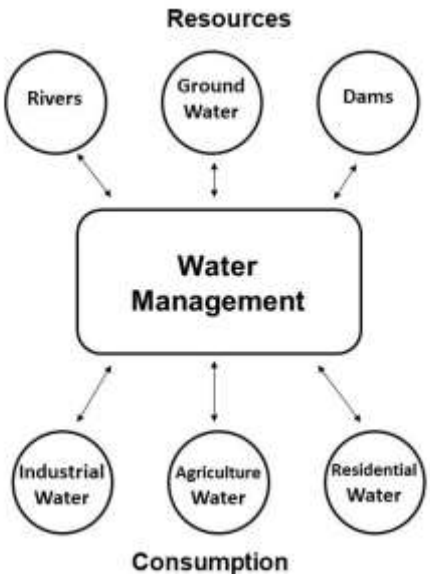

Figure 1: Smart Water Grid – A system overview

Digitization and mechanised gathering of information at site, and remote transmission to a focal framework for checking and investigation. Late progressions in ICT have been to a great extent driven by the rise of Internet of Things, cloud computing and enormous information investigation. At the point when connected to the water business, these advances in ICT empower to catch and store tremendous pools of huge information and perform capable examination and prescient investigation to contribute towards more prominent productivity and viability in water asset administration.

There is an expanding need to use on these inventive advances so as to guarantee the water infrastructure is feasible and strong. Wireless sensor networks (WSN), considered to be with lot of the operational procedures, for example, water spillage checks, water quality checks and meter readings, are as yet done physically. Against the scenery of a contracting and progressively instructed work drive, the usage of the Smart Water Grid will likewise streamline labour necessities and overhaul work forms via mechanizing modest undertakings. Decision support apparatuses, for example, predictive hydraulic modelling, valve activity recreation, request expectation demonstrating and pipeline disappointment examination, help to enhance arrange evaluations and arranging.

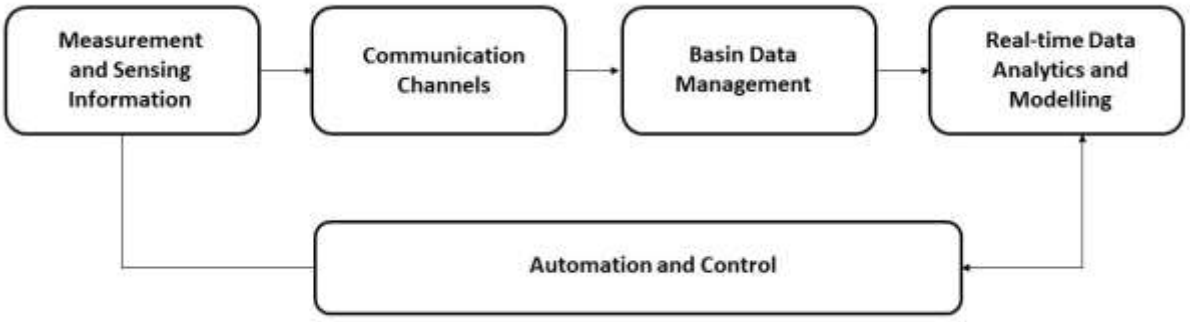

Fig. 2: Flow of modern water grid system

Saving water is essential idea of Smart water Grid. Flow of modern water grid shown in figure 2 which involves ultrasonic sensors to monitor the levels of water in a users' tank, and fill it up if the water is low. The filling up also stops if the tank is full, allowing no wastage of water. Use of IoT to monitor the ultrasonic sensors and thus provide real-time feed about the ongoing process. The tanks have been fitted with sensors that are connected to Wi-Fi modules. These Wi-Fi modules collect data from sensors, like water level, whether motor is ON or OFF and indicates when it is low. This helps to monitor the water levels and be ahead of our needs and conserve water through real-time monitoring.

2. Literature survey

2.1. Internet of Things enabled real time water quality monitoring system

In this paper the authors describes a new concept at are being developed in the smart water monitoring which gives some easy solutions to monitor the in-pipe water quality using the Internet of Things Technique with an efficient power usage. By developing a model where the sample water and then the data which was collected are uploaded to the internet using the IoT (Internet of Things). Also analysing the data using this IoT. Additionally there is an added remote to the model which is used to alert the user. This work predefined the standard values for the quality of water in the system, if there is any difference in the water quality compared to the standard values then the remote will alert the user. Finally this paper provided a water quality monitoring system which has a less manufacturing cost.

2.2. *Smart Water Grid: The future water management platform:*

In this particular paper the authors explains the method called 'how to use Smart Water Grid in the water scarcity area's'. Communication technology and information technology plays a big role in the world. The Smart Water Grid project is connecting these two things in a water management system. Also explaining about that Smart Water Grid is the good technology for solving the water storage and water monitoring related problems. This paper deals with the important research related topics that

should be integrated in the Smart Water Grid. It should have a good platform configuration, intelligent control, better water infrastructure management and most importantly the efficiency of energy. Finally concluded this paper with, how to integrate these things to smart water grid and make the best water management platform for future.

2.3. *Researches on Smart Water Grid*

In this paper the authors explains the necessity of Smart Water Grid research. How it combines the two technologies, which are, communication and information in a single system and how it efficiently monitors the water supply and how it also used to detect the climate change. All of these things are explained in this paper.

2.4. *Case Study: A Smart Water Grid in Singapore:*

In this paper, a system called Water wise. Because the old water distribution systems are not efficient nowadays because of the increased frequency of usage. So there is a need for a system that has an integrated system which also monitors the water flow, the available percentage of water and quality of water. Because a Smart Water Grid means it should monitor the leakage of water and control the leakage, and it should optimize the operation. Water Wise is a perfect platform which is having an integrated and real-time monitoring. So by this way, monitoring the Water Grid in Singapore in a Smart and an efficient way.

2.5. Smart Water Grid for smart cities: A sustainable prototype demonstrator:

In this paper, a prototype of smart water grid for the smart cities. Because the main aim of smart cities is that all things should work in a smart and efficient way. Also these smart cities have the best communication technology and good network protocols. In this paper, demonstrated a prototype that has water monitoring technology, network sensor for the water height measurements and a smart meter which monitors the total usage of water. By using a Wireless metering bus network at a frequency between 120 Hz to 200 Hz. Finally given the results by simulations and some other experiments.

2.6. Need of Smart water systems in India

In this paper, in India due to the shortage of the water and how we can give better solution for these water shortage problems using the smart water system technology. The reports say that half of the population in the world will go under shortage of water. Especially counties like India, Bangladesh are developing countries. So these countries will definitely face water scarcity. In this paper, a low cost smart water management system to reduce the water scarcity in India. Because within 30 to 40 years India will go through water scarcity and half of the people in India will leave the Indian cities.

3. Analysis and Proposed Technology

Idea of the project mainly tells by using IOT (Internet of Things) as the platform to transmit the information which can be accessed from any place at any point of time. An app called blynk in Google play store with its own cloud. NODE MCU-ESP8266 module is used to transfer water level values to the cloud from where it can be accessed through internet.

This module enables microcontrollers to interface with a Wi-Fi system. It mainly helps to monitor the level of water in centimetres. Once uploading the values into the cloud is done, for the question of getting the values from cloud is done with the help of ultrasonic sensor. An ultrasonic sensor is a gadget that can quantify the separation by utilizing sound waves. It allots a separate by sending a sound wave at a particular recurrence and tuning in for that sound wave to reflect back. By recording the time passed between the sound waves being created and the sound wave reflect back, it is conceivable to figure the separation between the sonar sensor and the water level.The last thing in this project is to monitor and switch on the motor through the Blynk app. The level monitor is set as an analog meter and a switch is placed in the app. The novelty of this project is planned to next level by

designing a water smart grid project. Finally, we designed our project in such a way to measure the level of water in three sub tanks, a main tank and ground water level from where water is pumped. At first level the sub tanks are measured when it shows the solenoid valve of respective tank opens and water flows from the main tank to the sub tanks. Then the water level in the main tank is measured and when it is less than a threshold value, the motor is switched on with the help of a switch in the app. Whether the motor switches off or on depends on the level of water in both the tanks and the ground water level at that region.

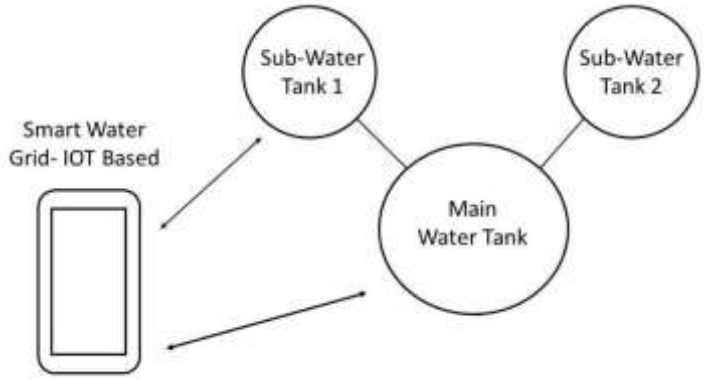

Figure 3: A architecture of IoT based smart water grid system

As shown in figure 3, system works automatically to refill the main and the sub tanks when the water level goes below a threshold value. And on filling the water back, once the water reaches the brim of the tank it stops flowing into the tanks because of another limiting value is set so as to stop the supply of water once the tank gets loaded in order to avoid overflow of water from the tanks.
If in case, there is a shortage or no presence of water even in the underground source, the motor wouldn't even start to supply waters so as prevent the motor from malfunctioning and causing any harm. Only if there is a sufficient amount of water in the Underground source will the motor start working in order to supply the water to the main tank and thereby to the other two sub tanks.

This is mainly controlled through an internet host which connects both the sensor modules and the reception through a mobile or any other internet accessible device. By sensing the level of ground water through the ultrasonic sensor module HC-SR04 the pump will be switched ON provided the ground water condition HIGH and main water tank LOW. This main water tank gets fill only once the two sub tanks gets condition FULL. Pump remains OFF in cases like both ground water and main water tank is LOW & also only when the ground water is LOW. A NODE MCU module has been set in each sub tank & the main tank so as to send the signals to the control system i.e to the host and the operational module which in turn starts recognizing either the shortage or surplus of water which would be prevented from happening.

All such controls and operations can be monitored and also controlled from anywhere through the one thing which would be always with us which is our handheld devices or our mobile phones or laptops through which we can access the internet and by that be able to see these operations. Algorithm of operating conditions has been shown in figure 4.

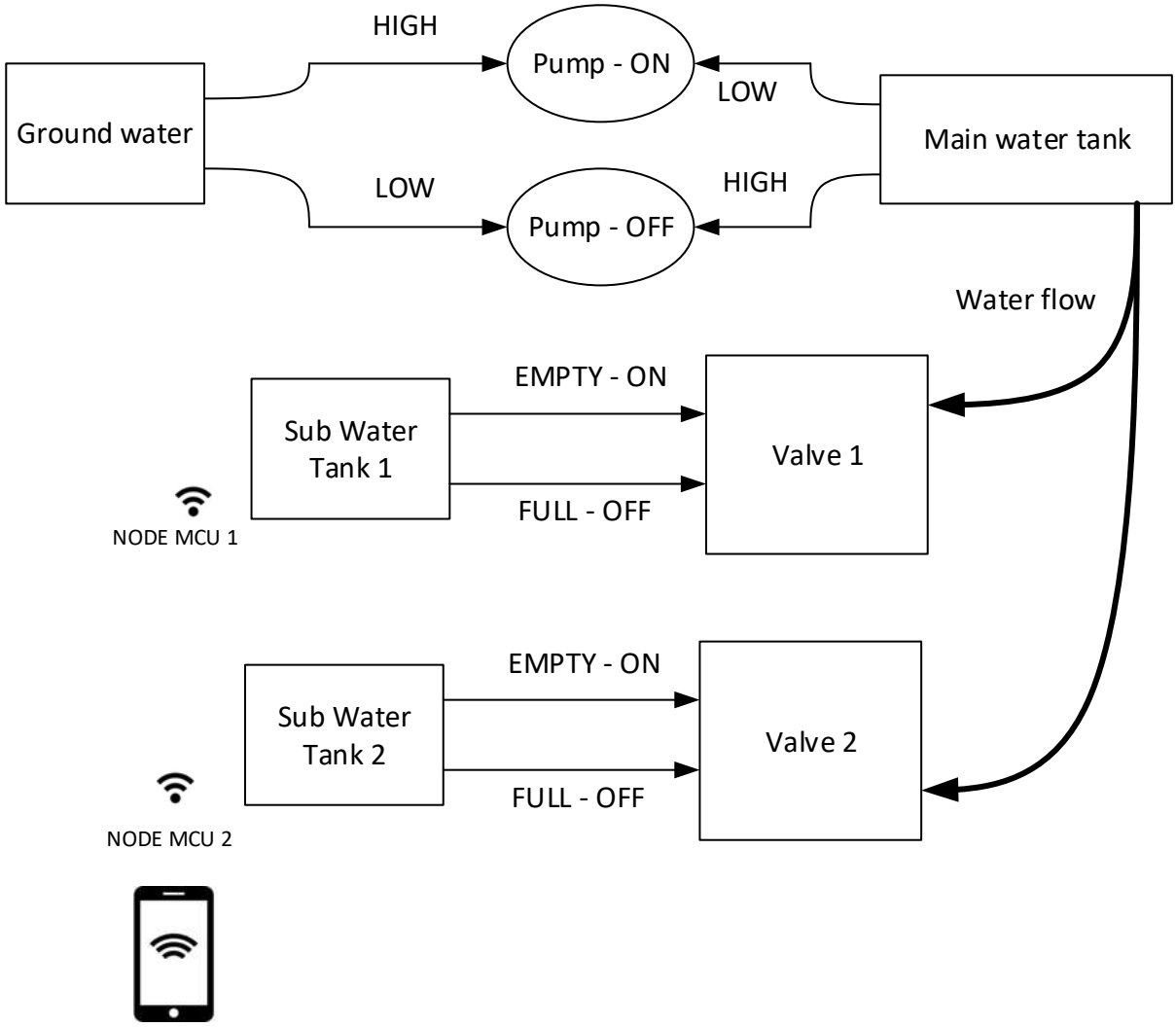

Figure 4: Algorithm for smart water grid technique

4. Design of smart water Grid system

Relay module with optocoupler used in this design is about 250V AC,10A relay contact current capacity where this can be used for controlling various appliances & other equipment with large current ratings. Arduino water level sensor also called as soil hygrometer module which used to measure the ground water level where the two stripes plated with copper of it will be start conducting by forward biasing the NPN resistor when it touches water. It has 3 pins consists of 5V supply. ground and an analog output pins.

Main-tank is used to feed water into the sub-tanks around it. To feed water its water level is to be checked beforehand so that the water is available for sub tanks. Water to the main tank is pumped with the help of ground water pump. As precautionary measure ground water level is also measured so that the water pump does not get switched on. Ground water level is measured with the help of soil hygrometer module. When the water level in the main tank is measured with the help ultrasonic sensor and it is low water ground level is checked and when this is measured to be low nothing changes but if it is measured high water pump is switched on as shown in control circuit diagram figure 5.

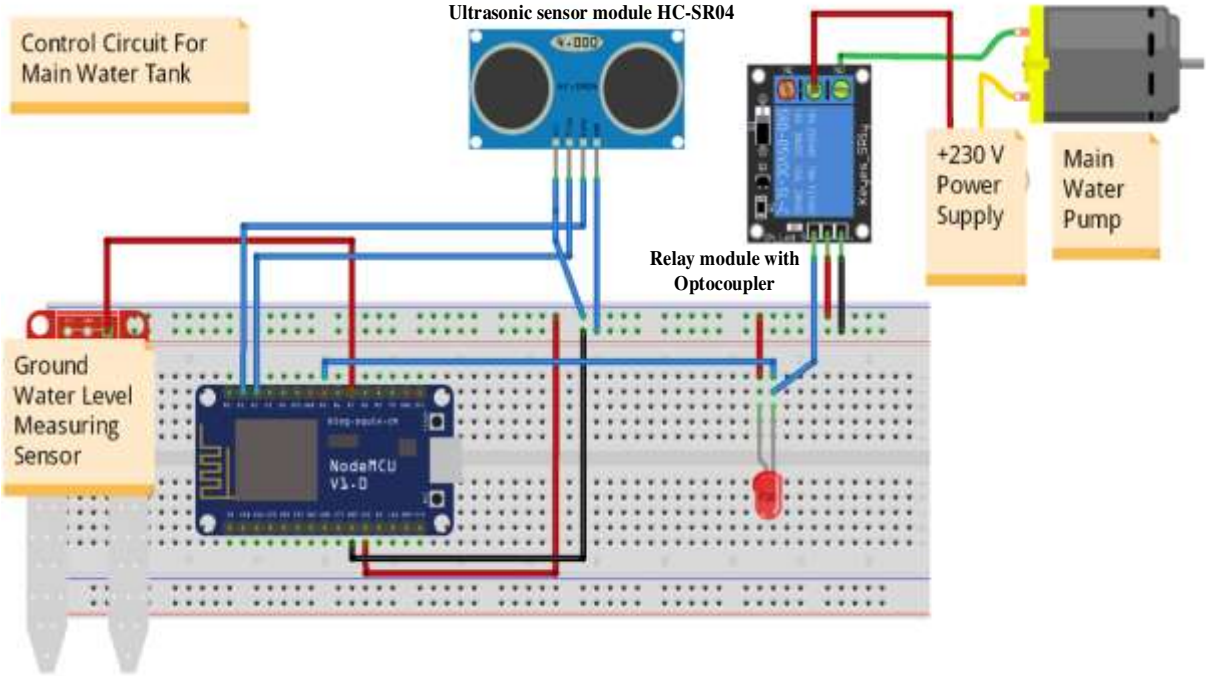

Fig 5: Main Water tank Circuit Diagram

Main Tank is connected to the Sub Tank through a pipe with an electrically operated solenoid valve. Water is initially stored in main tank. From figure 6, water level in the sub tank is measured using ultrasonic sensor and if it is found to be low the solenoid valve is electrically opened .When the water level is high the solenoid valve is electrically switched off. The Diode D2(1N4007) shown in Figure 6 is connected parallel to solenoid to dissipate the energy where it tries to continue forcing the current downward when the solenoid gets off.

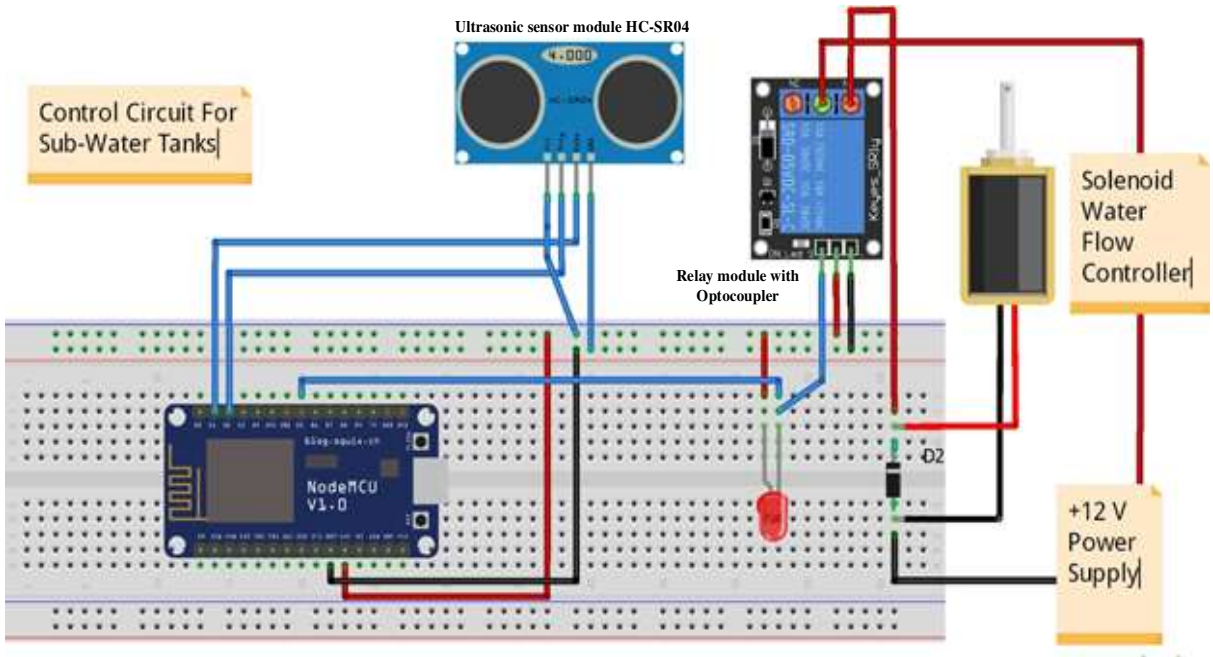

Fig 6: Sub Water tank Circuit Diagram

5. Experimental implementation & Investigation

The problem of Water Scarcity can be limited by realizing this project in either a small scale or even for a large scale area or locality. The main maxim of our project was to reduce water consumption by monitoring the amount of water utilized in each area and with reference to the data obtained shall regulate just the required amount of water to that area or sector. Neither more nor less. And by bringing about this smart water grid to the real world, to our metropolitan cities and towns shall make the life of people more convenient by letting them control and see the water level at their home or office or any other place from anywhere and anytime. They can also control the motor even through the internet because the project is mainly based on IOT. The user would be able to see the amount of water available or left in real time without any delay by having an interface with android app as shown in figure7.

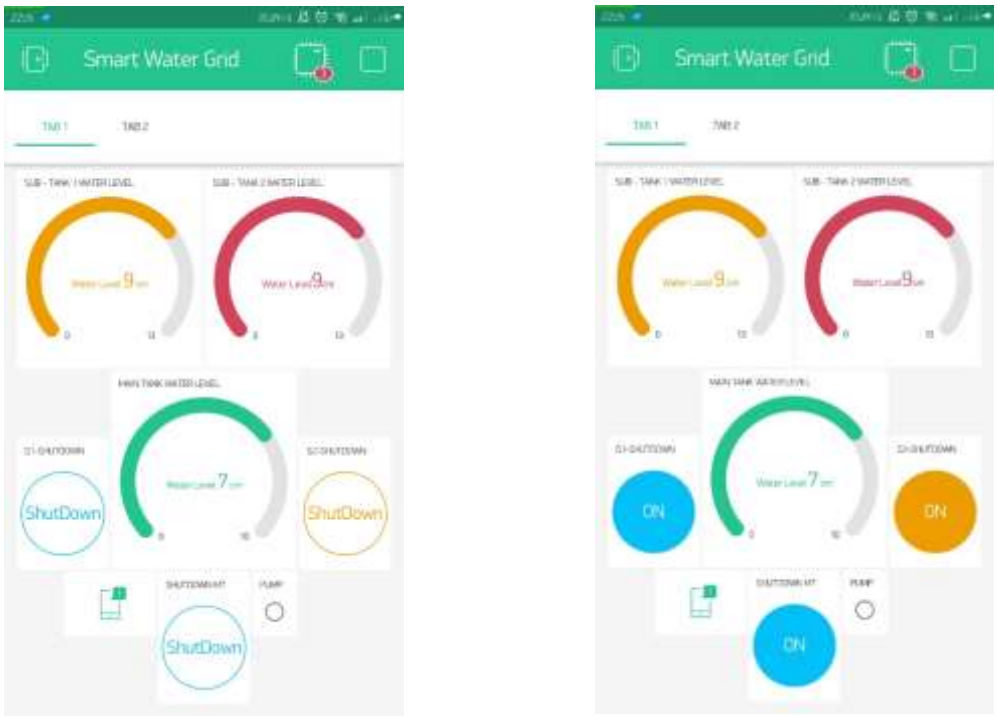

Figure 7: Android app Interface

We have thus made a prototype for this 'SMART WATER GRID' in a small scale level as for this project. It consists of an Underground Water Source, a main tank and 2 sub tanks attached to it.When there is a paucity of water in the sub tanks or the tank, which can be found by the ultrasonic sensor attached to all the three tanks and also to the underground water source, a signal is sent from the system indicating that there is a deficit of water. And hence, thereby the system works automatically to refill the main and the sub tanks when the water level goes down below a threshold value. And on filling back the water, once the water reaches the brim of the tank it stops flowing into the tanks because another limiting value is set for so as to stop the supply of water once the tank gets loaded in order to avoid overflow of water from the tanks.

If in case, there is a shortage or no presence of water even in the underground source, the motor wouldn't even start to supply waters so as prevent the motor from malfunctioning and causing any harm. Only if there is a sufficient amount of water in the underground source will the motor start working in order to supply the water to the main tank and thereby to the other two sub tanks.

On working this prototype, it has been found that all the systems are working perfectly and the desired output is obtained, which is the live relay of the amount of water available and also the controllability of the each sub tanks and tanks valves so as to supply water even to the individual tanks with just a touch of the finger from anywhere. So if at all, a person thinks that it's going to be a very hot

summer and there is an imminent danger for water, people can choose so as to accumulate the desired amount of water for their use with the help of Smart Water Grid. And by implementing this project as shown in figure 8 (a) & (b) to vast metropolitan cities, it is possible to control water shortage to a certain level and in the process save water up to a certain extent. Which in itself would serve as a result and success of this imperative project for the generations to come.

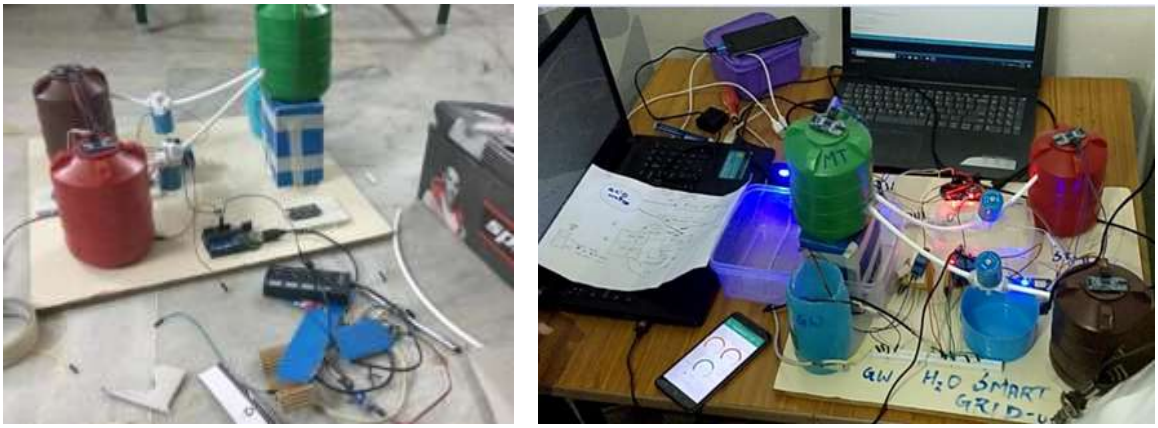

Figure 8(a): Smart water grid & IOT installation **(b):** Working prototype model

6. Conclusion:

This developed project can be used to build a water efficient society. It is very helpful in saving water, electricity and more importantly man power. To make it possible sub-tanks are installed for a smaller region, main-tanks are installed in a place with high ground water level so that it may be used to feed water to these sub-tanks. The beauty of this system is that it can be operated manually and also automatically. Man may make mistakes sometimes so it is programmed to work automatically but still the water levels in the tanks can be monitored from any place and can be controlled if wanted. Future scope is to make an advancement in the system by adding water quantity measuring meter, which will help people to identify the leakages during its transmission. Adding many sensors like PPM sensor and PH value sensors in the main tank will help to identify the quality of water and by analysing all the data such as quality of water, water consumed, water replenished will help the system to take feasibility solutions for the real time water enhancement.

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