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Smart Water Supply using Internet of Things

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Abstract: With more than 7.56 billion people living on the planet Earth, approximately 80 million people are increasing per year, and the population is estimated to exceed 10 billion by 2050, the global water needs are set to grow more urgently. Recent reports for the water situation in India gave the ranking of India at 120th position among 122 countries in the water quality index. India is confronting its worst water crisis in history, which is only expected to become worse since the country's water requirement is projected to be twice the available supply by the year 2030. Transformations in lifestyles and eating habits in recent years are demanding more water consumption per capita. There have been attempts to manage the water resources, but they have been majorly on the consumption side rather than supply. Our paper proposes a unique way of conservation of water targeting the supply of it, keeping in mind the necessities of people based on per capita.

Index Terms **- Internet of Things, Smart Water Management, Water supply system, Water conservation**

I. INTRODUCTION

Current methods to evaluate the state of household water insecurity focus mainly on water quality, availability, affordability and at times accessibility. It misses out on the aspect of per capita requirement of the people. There have been implementations of smart water metering systems to assist users in obtaining real-time analysis through live data. Smart water meter systems increase time efficiency and adequacy of water management, since the bills are delivered on time and with accuracy (Mudumbe, Abu-Mahfouz - 2015). Smart water analytics can change the manual systems by bringing the real time data in front so that the analyst can spend time on analysis and actions in short time and at low cost. Smart water management systems include real-time monitoring of water levels, identifying leaks in distribution systems, monitoring and maintaining water quality (Mohammad Shahanas, Sivakumar - 2016). There has been automation in many systems using the Internet of Things (IoT). Many innovative ideas have been implemented in this domain aiming to effective water management. Systems that could be easily installed in residential societies, which would eventually monitor the sensors placed inside the household tanks for measuring water levels (Wadekar, Vakare. Prajapat, Yadav, Yadav - 2016). Other than keeping a track of the quantity, the quality of the water could also be taken care of. Some systems made of ultrasonic and turbidity sensors have been developed so as to maintain basic quality features of water (Gupta, Kulkarni, Magdum, Baldawa, Patil - 2018).

Water management projects are complex and have various aspects to be considered while development like the nature of the problem, technical challenges, scope and sustainability. Project Management Specification Models (PMSM) provide a good approach in developing such systems (Bernhardi, Beroggi, Moens - 2000).

Approaches to water conservation have been majorly from the consumption point of view till date. If these aspects were broadened and the supply part would have been looked into, the water management would have been utmost effective. This research project aims to limit the flow of water received by each household on a daily basis to conserve water. Therefore, the three main aspects to be considered in this project are - pumping water to the specific house, measuring the water flown, and accordingly controlling its flow. The architecture of the model is based on the water supply system which is seen mostly in many residential apartments.

II. RELATED WORK

Water sustainability and management has become of utmost importance in today's age for which we have considered the idea of water meter systems in monitoring water consumption (Mudumbe, Abu-Mahfouz - 2015). Smart water meters (SWM) integrate complex systems and measures to track, control and regulate water resources, usage and quality. It, apart from many other advanced sensors and services, is one of the censorious requirements in smart water management (Shahanas, Sivakumar - 2016).

Water demand is growing high day by day with the increase in population in most of the areas. To maintain the supply and demand ratio, it is important to have systems that reduce water loss and so we have designed an IoT system with which we can plan usage of water according to the available quantity (Wadekar, Vakare, Prajapat, Yadav, Yadav - 2016). Looking at the current manual operation in housing societies, IoT could be handsomely used for automation through sensors. The various aspects like water distribution and availability, can be kept track of with the help of sensors and further be notified to the people through their smartphone application. The various parameters

from sensors will be collected and stored to the cloud, the real time data will get updated which in turn will get reflected in the application (Gupta, Kulkarni, Magdum, Baldawa, Patil - 2018).

There are a lot of limitations to the resources which give access to information related to water management hence we relied on the research project to help in understanding the nature of the issues faced and technological challenges and the basic idea of Project Management Specification Models(PMSM) (Bernhardi, Beroggi, Moens - 2000). After understanding the planning part comes the scope of any project, this paper highlights that the concept of smart water supply can also help in developing smart homes where IoT plays an important role in energy and utility management. By implementing the research project, the carbon footprint of water usage will decrease and so make water supply sustainable upto a larger extent (Koo, Piratla, Mathews - 2015).

Water consumption patterns also vary a lot depending upon the number of people residing in a household which are used for various purposes like drinking and personal hygiene, kitchen and all other household activities and considering this we have made class distribution depending upon the number of people in a household and propose the amount of water to be provided accordingly (Fan, Liu, Wang, Ritsema, Geissen - 2014).

Designing an effective algorithm used in the code which ultimately drives the IoT devices or the flow of the system is very necessary. Also considering the threats by cyber crime as the system would be majorly depending upon the Internet for automation (Grammatopoulou, Kanellopoulos, Vamvoudakis - 2018).

Various sensor technologies like motors and relays are used in IoT which help in developing the system that is versatile from both hardware and software aspects (González, Pérez-Iglesias, Fidalgo, Ribas, Fernández-Caramés - 2015) As a part of our hardware system of the research work we used motor-driver to start and stop the pumping motor from supplying water, similar to what was used in this paper with regards to irrigation, where water is supplied in adequate amounts(Angelopoulos, Nikoletseas, Theofanopoulos - 2011). The research project not only aims to save water but also encourage people to minimize wastage by incorporating a monetary scheme which depends upon the amount of water a household saves and hence rewarding them for it with something useful which would motivate them to use water responsibly (RamGurunga, Stewarta, Bealab, Sharma - 2016).

Apart from water management another important enhancement is asset, leakage, demand and automatic tariff management which is also identified by our project in terms of future additions to our system sensors (Gosavi, Gawde, Gosavi - 2017). These smart water meters (SWM) have a lot of usage which contain accurate data related to water from digital flow meters and which will be individually installed in households to help in understanding real-time operation in terms of water usage and in an effective manner (Vamvakeridou-Lyroudia, Kapelan - 2014). With the help of the software interface which is used in the research work the people are easily able to monitor their water consumption and hence manage the usage (Kossierisa, Panayiotakisb, Tzoukaa, Gerakopouloua, Rozosa, Makropoulosa - 2014). As a result of effective management principles the water which is supplied is consumed by limiting the unnecessary wastage of water and ensures that everyone gets their fair share in water consumption (Robles, Alcarria, Martín, Morales, Navarro, Calero, Iglesias, Lopéz - 2014).

III. METHODOLOGY

This research work is designed on the basic concepts of the Internet of Things (IoT), integrating the hardware components to the software end with necessary logic.

The hardware that we have implemented in the model is the pumping motor to supply water, a motor driver to control the pump, a digital flow sensor to keep track of the supply, and most importantly Raspberry pi 3 to integrate all those components to the software.

The model plan can be split into three parts:

- A circuit to establish a proper connection between all the hardware components.
- A database to handle input data feed as well as the resultant data, for future analytics.
- A logical code driven to ensure proper functioning of the circuit based on the information in our database.

The unique approach that we have inculcated in the research project is that of making the supply biased to the number of members present in the family. To ensure this, there was a generalized approach and hence various classes, or ranges were formed accordingly, Table (1). These classes would have their range of both members as well as the maximum water supply limit based on per capita requirements.

Table (1) Class distribution for water supply

Class name	No. of Members	Water limit
Class A	0-2	200L
Class B	3-5	450L
Class C	6-9	800L
Class D	10-15	1500L

Based on the classes the motor driver has to monitor the task of turning the pumping motor ON/OFF. If for a particular class, the value of water limit has not been satisfactorily supplied then the motor keeps pumping water.

The Fig. (1) exhibits the logical flow of this model.

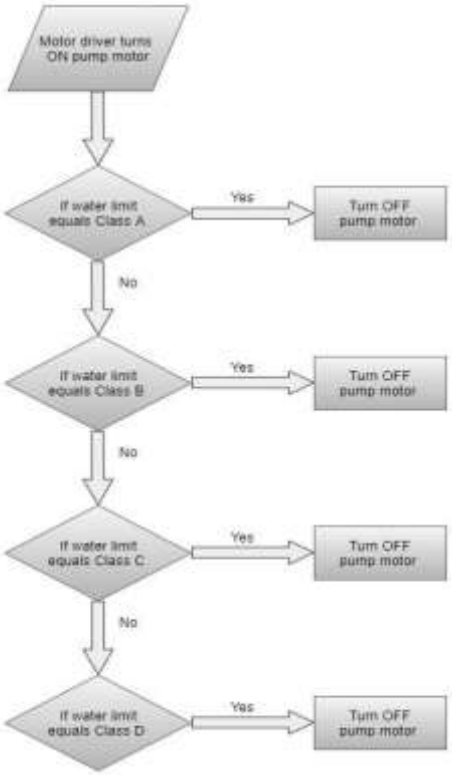

Fig. (1) Flowchart of proposed model

The circuit diagram of the model has all the hardware components integrated over a single board computer device- Raspberry pi 3. It monitors the working of the motor driver. The pump motor is controlled by the motor driver whenever the digital flow sensor detects the water limit. The Raspberry bi 3 is connected to a local computer which has the necessary database available on it. It also has the logically driven code for checking the limits of various classes. Any preferred language can be used to write the code, it should be compatible with the Raspberry pi.
The Fig. (2) illustrates the circuit diagram of the model.

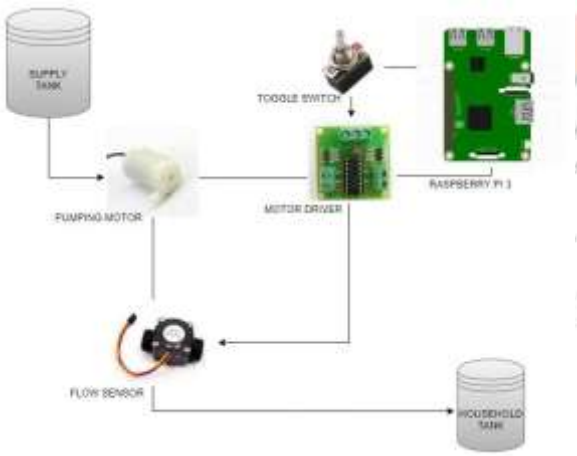

Fig. (2) Circuit diagram of proposed model

IV. RESULT

The model is based on a smart water supply system using IoT. It was implemented on a small scale by using two one litre tanks. The digital flow sensor tracked the continuous flow of water through it. The limit was set at a lower value for the demo version, the pumping motor stopped supplying water once that limit mentioned in the code was achieved.
The Fig. (3) illustrates the flow of water for the demo model.

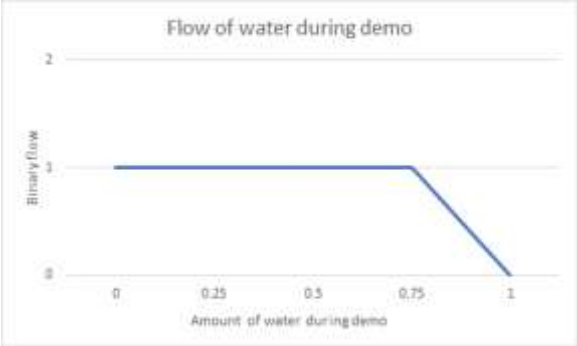

Fig. (3) Flow of water through digital flow sensor

The result achieved was the total amount of water supplied, the number of people for which it was supplied and the binary view of the digital flow meter for the time that water passed through it.
This model helped to illustrate the concept of controlling water supply on a discrete household basis.
The Fig. (4) shows the values of water supply for varying members in a household.

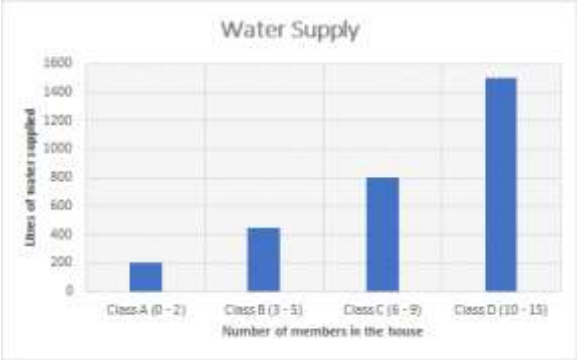

Fig. (4) Water distribution according to classes

V. CONCLUSION

Water conservation is a primary concern for the governments, industrialists as well as inhabitants. Everyday millions of gallons of water get wasted in residential complexes and housing societies due to various challenges. It is a challenge to implement an effective system that will deal with the problem at the individual level. The main purpose was to eliminate the need for water cuts by time and instead introduce the idea of supplying as per need.
This research paper describes a simple solution to track the amount of water supplied per household. It describes a model for limiting the supply at a basic level by employing IoT and embedded system technologies ensuring that the users are cautious and avoid wastage.
Thus, technology such as IoT enables us to make mundane tasks smarter and reduce depletion of sources by building sustainable systems.

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