International Journal of Computational Intelligence Research
ISSN 0973-1873 Volume 13, Number 10 (2017), pp. 2391-2406

http://www.ripublication.com

A Novel Method to Smart City's Water Management System With Sensor Devices and Arduino

R. Priya[1], G.P.Rameshkumar[2]

[1]Ph.D Part-Time Scholar, Department of Computer Science, SNR Sons College, Coimbatore–6,

[2] Professor & Head, Department of Computer Science, Government Arts College Aiyarmalai, Kulithalai, Karur

Abstract:

Smart city is an upcoming era, there are many houses in which high and middle class people can have facilities according to their comfort. Based on the people population, season, etc, the usage of water is varying. So, water supply management is very much needed and it should be maintained properly. In existing method, corporation may not know how much water is used and the wastage. To avoid the wastage of the water, the proposed system has been developed for water supply management with sensor devices.

Keywords. Challenges of smart city, smart city water supply management, sensor devices, IoT devices, database management system, Arduino, stepper motor function

1.INTRODUCTION

There are many challenges in the Smart city. One of them is water management. To overcome the water problem, the proposed model has been developed for the water management. Water is most important for our life and man cannot live without water. Already, the water management system exists for finding the leakage of water in the pipelines and also the pH level of water. The monitoring system has been designed with sensors. Readings from the sensor are processed with microcontroller and communicate through computers or wireless networks [1].

1.1Smart City

Let us see, what the 'smart city' means. Nobody can say the correct meaning of the word "Smart City". But, commonly saying, Smart city has been developed for human life for comfort and convenient. In foreign countries used such as Europe, America and Asia, Smart city is a well established and world class technology has been used. It is based on advanced urban cities with civic amenities. Smart City may vary based on the countries, cultures, life styles, technology, environment and also needs of society. Smart city is an enhanced city with smart designs in method of housing, infrastructure, mobility, technology, security system, transportation etc. The conceptualization of Smart City, therefore, varies from city to city and country to country, depending on the level of development, willingness to changes and reforms, resources and aspirations of the city residents. A Smart City would have a different meaning in India than in Europe. Even in India, there is no clear way of defining a Smart City [2].

In the recent trends, different technologies have been used to convert a city into a smart city. This smart city era brings different ideas and innovations through information and communication areas. The present scenario, it is used in various fields like networking, energy platforms, decision making system, service architectures, power grids etc to establish the full equipped cities for the future. Not only in these fields, but also used in conversion of traffic system to energy management system, e-governs and emergency management. For this, the ICT technologies are used frequently [3].

In cities, the population is very high and also industry, schools etc, which are affected by the services. Cities have a many infrastructure, services and group of peoples both public and private. These groups are separated into many groups and are interconnected. They share their ideas. A smart city has complex structure that shares space and buildings with stakeholders and service providers. It is an extension of city to allow the use of resources to improve the quality of human life in urban areas. There are different challenges to be focused in conversion of smart cities. For example, traffic management, waste management, smart parking etc. [4].

Smart city is where all the people are offered to live with all the amenities such as,(1) adequate water supply,(2) assured electricity supply, (3) sanitation, including solid waste management, (4) efficient urban mobility and public transport, (5) affordable housing, especially for the poor, (6) robust IT connectivity and digitalization, (7) good governance, especially e-Governance and citizen participation, (8) sustainable environment, (9) safety and security of citizens, particularly women, children and the elderly and (10) health and education.

internet of things

Internet of Things (IoT) is used for communication that may be helpful in future development, in which the objects like micro-controllers, transceivers may be used for future. The IoT aims to making Internet even more immersive and pervasive by enabling very easy access and interaction with a variety of devices like home appliances, cameras, monitoring systems, actuators, displays, vehicles, home automation, smart grids, automotive, traffic management and so on. Mobile communication technologies has beenwell established with "Anytime, Anywhere" access to information and related services. The Internet of Things (IoT) is an environment in which objects, animals, peoples or birds are provided with unique identifiers and the ability to transfer data over a network. IoT has developed from the convergence of wireless technologies, micro - electromechanical systems (MEMS) and the Internet. This may also be called as Internet of Everything. IoT was used in heart monitoring system, a farm with animal biochip transponder, automobile with sensor devices to alert the driver when vehicle tire pressure is low etc. It is also associated with machine-to-machine (M2M) communication.

IoT contains many types of applications such as fitness trackers, health monitoring system, sensor devices in agricultural field etc. Embedded system shares a typical challenges and disadvantages like ultra-low power supply, sensing, actuation, low pressure cycles, low power wireless devices[5]. The new technologies in Internet of Things (IoT) are enabling the citizens to participate in sensing, sharing the collection of data, monitoring process that cannot be easily measured by an individual [6].

2. EXISTING METHOD

Water supply Management

A large fraction of the World's population around 1.1 billion people - does not have access to improved sources of water. A growing population to projected drying trend in our climate means that in addition to focusing on using the water efficiently, we will also need a broader range of water supply sources.

Structure of Water-Supply Systems

Water supply system is used to deliver water with appropriate quality, quantity and pressure and it is used to describe the facilities to water supply. Quality of water should not deteriorated in water pipes. So, water supply system should be able to supply water at all the intended places with sufficient pressure and requisite amount of water during any fire accident [7]. Figure 1 shows the basic structure of water distribution system.

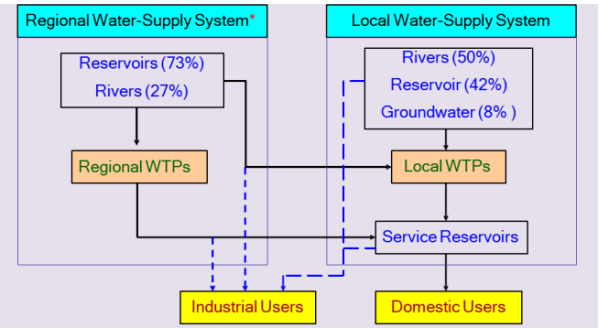

Figure. 1. Structure of water supply management system

It is contaminated drinking water produces health risks in human and animals by the microbes and other sources. This must be avoided to improve microbial quality of drinking water which also controls diseases [8]. Due to fast growing demanded of water supply, the water management has become more complex. The process of the system are influenced by pressures and keep the cost as minimum to the public [9]. There are three major problems in urban water supply system such as

- rapid urbanization
- depletion of water resources
- deteriorating water distribution

Sometimes, water resources brings in threats to the public by means of natural disasters and malicious attacks. The fresh drinking water are also affected by the wastage from factories and industries to the great level. Ensuring the safe and clean, reliable water supply to the cities requires many new technologies and new investments. The best with these new technologies are water treatment and desalination plants which are efficient and lower cost. The water quality management and leaks in pipelines are also monitored in this new technologies [10]. Sustainable Urban Drainage Systems (SUDS) is a method which provides management for improvement of the quality in green-space and environment. It aims to maintain storm water, reducing the volume of runoff and filtering rates of water by collecting / temporarily storing [11].

Drawback of existing system

(1) There are unnecessary usage of water : When people wash their vehicle or water their plants, there are possibility of using the water more than they need, which leads to unnecessary of water.

(2) Leakage of water is inevitable due to faulty pipes over time.

(3) The corporation does not know if there is any water overflow in any of the houses.

(4) The amount of water used by the houses are not known to the corporation

3.Proposed Design For Smart City Water Supply Management System

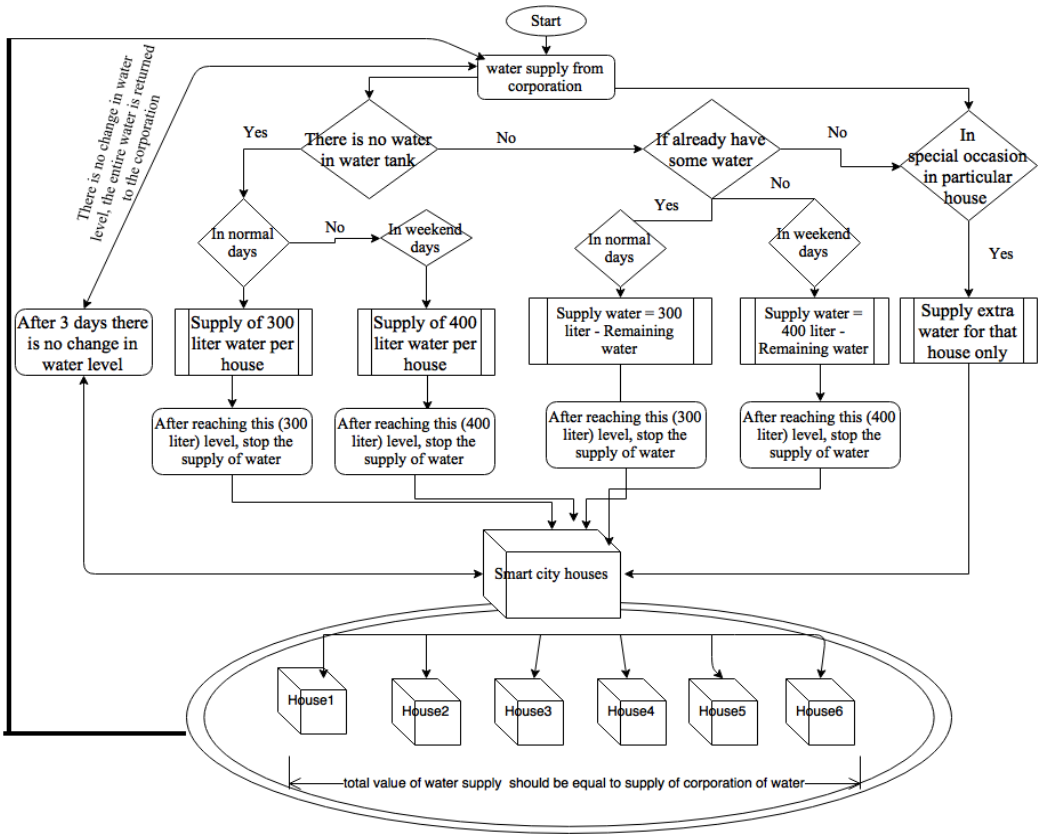

Figure. 2. Flow diagram for proposed system

In a Smart city, there are many houses. Water is an essential thing. The usage of water in each house is different depends on their user's need. According the season, water usage is varying. Particularly, the water usage is increasing on Sundays like washing clothes, cleaning houses etc., where female partners also going for work. Similarly, in summer season, water necessity is more. In winter and rainy season, water is used in lesser. Based on these reasons, user should be take control over water management. So, the proposed model has been developed for water management, it was controlled by sensor devices. This system should be such that any user would not be without water during repair of any portion of the system. For example, each house

needs 300 liter of water approximately. Generally, the Corporation will supply a sufficient amount of water for a smart city, it is regulated by a sensor device. The sensor device is controlled 300 liter water for one house. The volume of the water tank is 500 liter. After reaching the level of 300 liter of the tank, automatically, it should be directed to a next house. Each 100 liter can be marked in the water tank. There are 100 liter water is there, it if filled in the first line. In each water tank, there was the sensor chip, which used to sense the water level in the tank. If already 100 liter of water is remaining in the tank, then balance 200 liter must be filled in to the tank. This can be controlled by the sensor chip.

Such as on weekend days, the amount of liter must be increased for each house as 400 liters. Because, the usage of water is high for that particular days. As like that, if a particular house needs a large amount of water due to their personal occasion, then the particular house must be filled with extra water as they required. But the extra amount of water also supply by the same pipe, it is maintained by a sensor chip. Similarly, there is no change in the water level in the tank of smart city houses after three days, a total amount of water in the tank is redirected to the corporation. It is slightly complicated, because of this process is reversible.

3.1 Block diagram for proposed water supply management system in Smart city

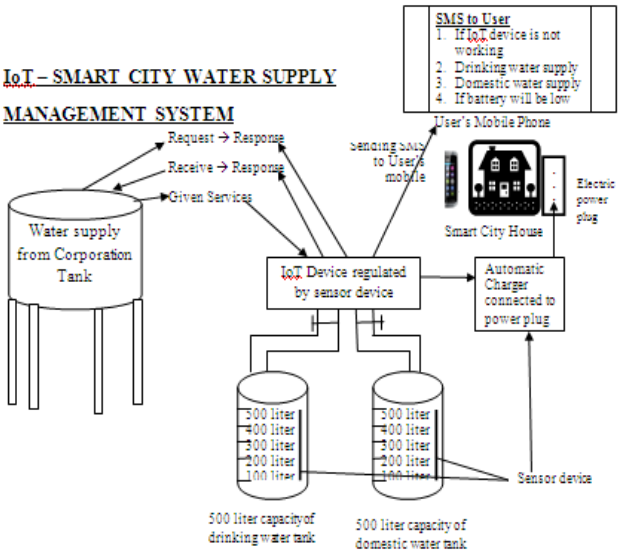

Figure. 3. Block diagram for proposed system

In the smart city, each house contains an IoT device in the water tank for sending message to user's (people residing in this house) mobile phone, if any fault in pipe line such as overflow, leakage etc and water supply details as sour water or drinking water. The corporation checks if there is any leakage in the pipe lines through IoT devices. IoT device also controls the water flow to the tanks of drinking water and

sour water respectively through valve [Figure 3]. The IoT device is connected with automatic charger directly and this charger is connected with power of the house.

3.2 Algorithm for Proposed Model

```
corp(){int supplyqty, watersupply, extra, pipelinelength;
supply( );}
days(){char normaldays, weekend, specialdays, others;}
watertank(){int waterlevel, sensordev_level;
sensor_device( );
//100 liter can be marked in the water tank
}
define watersupply()
{//water supply from corporation
if (supply to all houses)
{if (water tank is empty) then
  write: water supply to smart cities house
  if (normaldays) then // in normal days
  read corp.supplyqty
  corp.supplyqty=300 liter
  supply 300 liter per house
  else if(weekend) then
  corp.supply(watersupply) = 400 liter
//supply 400 liter per house
  end if
//after reaching that level
  sensor_device( ) triggered
  write: watertank. sensordev_level
  stop corp.supply()
 // stop supply of water
else              //already have some water
  read watertank.waterlevel
```

if (normaldays) then // in normal days

supply(){corp.watersupply = 300 – watertank.waterlevel}

else{ corp.watersupply = 400 – watertank.waterlevel}

end if

//after reaching that level

sensor_device( ) triggered

write: watertank. sensordev_level

stop corp.supply()

end if}

*else {//***supply to particular house**

if (specialdays)

{read houseno;

corp.houseid =houseno;

sensor_device() triggered;

corp.watersupply= supply(extra)

write: watertank.sensordev_level

end if }

//after three days, there is no change in water level in water tank

{read houseno;

corp.houseid=houseno

sensor_device() triggered

watertank.sensordev_level=watertank.nochange

return watertank.water}

pressure( ){int lengthofpipe;

char length, high, low, medium;

read length;

if corp. pipelinelength= length

{if (lengthofpipe<length)

print "high pressure"

supply(watersupply) = high;

else if (lengthofpiple > length)

supply(watersupply) = low;

print "low pressure"

else {supply(watersupply) = medium;

print "medium pressure"

end if}

verify(){if(corp.houseid=houseno)

{corp.watersupply=sum(corp.houseid(watertank.sensordev_level))

print "total water supply"

}else{print "check the amount of water supply"}}

3.3 Finding water level - algorithm

Power supply 5 V

Arudino pin for ground to GND, trigger to pin2 and echo to pin4

Use HC-SR04 ultrasonic sensor to find the water level of tank. In this process, the pulse send and return back leads to find water level with the difference of tank level and water level.

In circuit

VCC connection of sensor attached with Power supply 5 V

GND attached to arduino ground

TRIG attached to arduino pin 2

ECHO attached to arduino pin 4

Waterlevel()

{int trigpin, echopin;

Setup(){create serial communication}

Loop(){Long duration, inches, cm;

Pinmode(trigpin, write output with HIGH)

Delay();

Pinmode(trigpin, write output with LOW);

Delay();

Pinmode(echopin, write output with HIGH);

Delay();

Pinmode(echopin, write output with LOW);

Delay();

Microsecond to inches(){73.756 microseconds=1 inch}

Microsecond to cm(){29microsecond = cm}}

Table 1. Comparative statement of Existing and proposed design

Particulars	Existing method	Proposed system
Greening plants maintains	People wants water their plants, which leads to usage of water more than they need	Watering plants can be done by corporation to maintain greening plants.
Leakage of water	There is no way to find out any leakage in pipeline.	Find out the leakage and sending message to user's mobile phone
Water overflow	Corporation does not know if there is water overflow in the houses	IoT device can easily find out any water flow in the houses and intimates to corporation immediately.
Usage of water level	The amount of water used by the houses are not known to the corporation	Corporation is only decide the amount of water will supply to the particular house

3.4 Advantages of the proposed model

- Controlled flow of water supply management was maintained by corporation.
- Can reduce the wastage of water.
- Supplies specific amount of water to the particular house.
- Based on the specific water supply, water tax can be easily calculated.

4. WORKING METHOD FOR PROPOSED MODEL

The process of water supply through the proposed system is measured with sensor devices. For example, In a smart city there will be a main stations, with supplies water to 5 sub stations for instance, each of these sub-station will supply to 5 individual houses. Each houses is supplied with 300 liter of water. So, Corporation should be supply of 7500 liter of water per day. But based on this proposed design, if already have some water in the individual houses, which is detected by the sensors will be updated to the sub-stations by the proposed system with these updated values. In this situation, the corporation supplies the remaining value of the water to the individual houses.

Table II provides the water supply details of 25 houses in smart city corporation from 16.05.2016 to 22.05.2016. For example, let us consider that for a house 300 litres of water per working day and 400 litres of water for weekend days has to be supplied. In the proposed model, if some amount of water already exists in the tank, then the corporation provides only the balance amount of water. If there is 100 litres of water exists in the water tank, then the corporation provides 200 litres of water only for that day. By following this method,

Let us consider a water tank of capacity 500 litres and 220 litres of water is already available in the tank, in the proposed model only 80 litres of water will be supplied. The sensor device fixed in the water tank stops the water supply to that tank if it is filled with the sanctioned amount of water. But, in the existing model, the corporation will not take into the account the available water and supplies 300 litres of water. Since 220 litres of water is already available and the capacity of the tank is only 500 litres, the excess amount of 20 litres water is overflowed. Similarly, in each house there may be overflow of water every day. To avoid this problem, the proposed model has been developed. Based on Table II, In working days, the corporation supplies 7500 litres of water per day. Most of the water tank in house contains some water, the corporation has to provide only the remaining water.

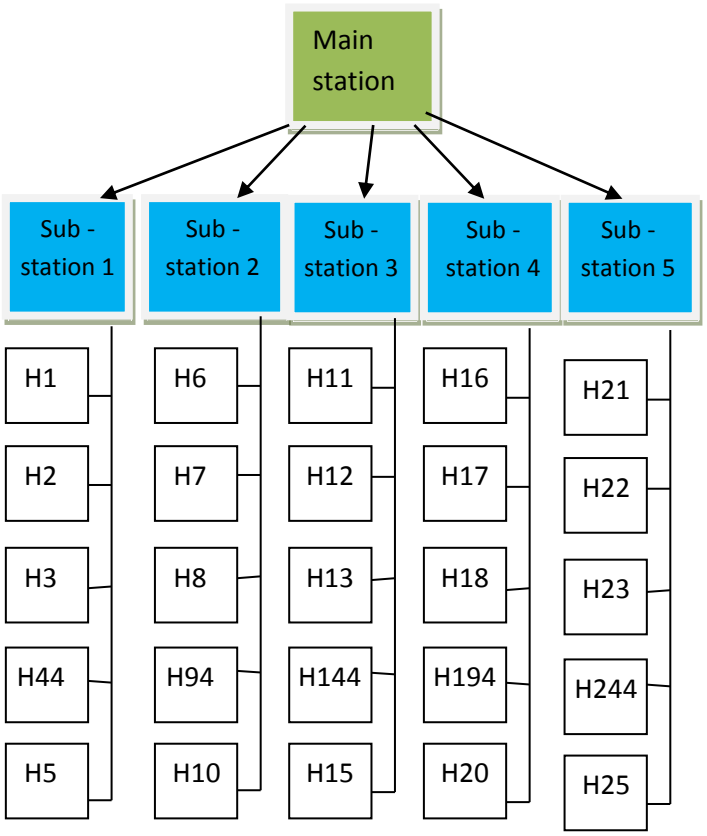

Figure. 4. Block diagram for proposed model

4.1 Circuit connection of proposed system

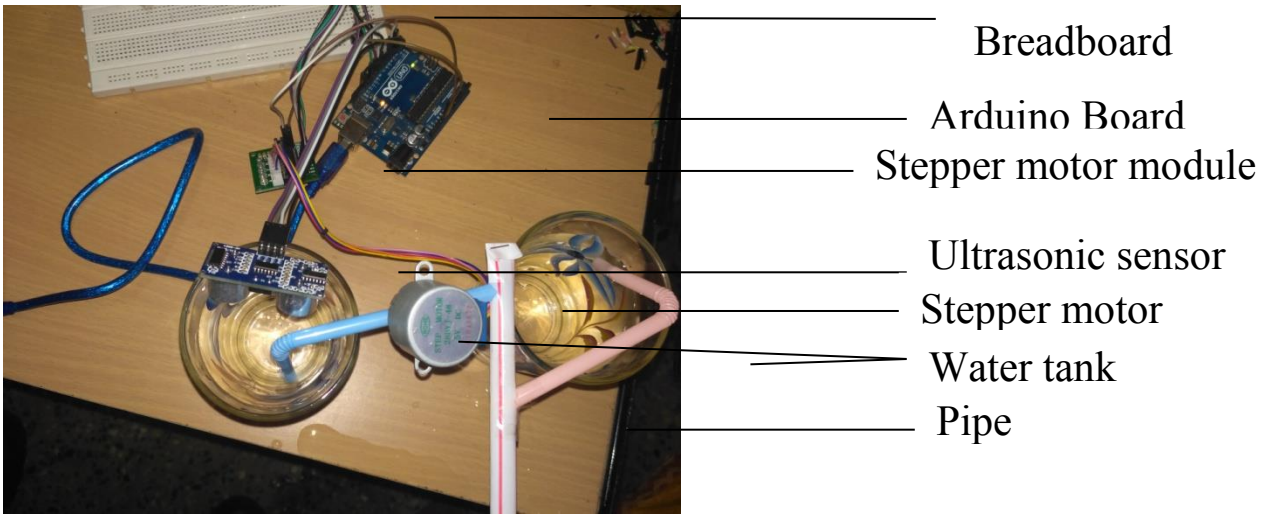

Figure. 5. Circuit diagram for proposed system

In this circuit, the Arduino board was connected to the computer system through cable.

Then another side of the Arduino board is connected with Stepper motor module with the help of breadboard. Stepper motor and Ultra Sonic sensor needs 5 V power supply. But, In Arduino board, it has only one power supply pin (pin 5). So, this circuit is connected with breadboard. Then the connection is separated two both the ultrasonic sensor and stepper motor module. Ultrasonic sensor is connected with arduino board. Ultrasonic sensor is used to deter the level of water in house tank. The main tank water is supplied to a various house tanks.

In this figure testing is made only with 2 water tanks. The water is supplied from the main water tank and filled in the first house water tank. After the particular water level is reached, automatically the stepper motor is used to turn the water flow to the next house tank.

Figure. 6.1

Figure. 6.2

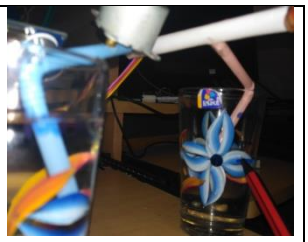

Figure. 6.3

Figure 6.1 shows that the water is flowing from the Main tank and supplied to the first water tank through pipe. After the certain level has reached the water is sensed through the ultra sonic sensor and supply of water is stopped using stepper motor (**figure** 6.2). Now, the flow of water turned to next water tank (**figure** 6.3).

4.1 Result of water level detection

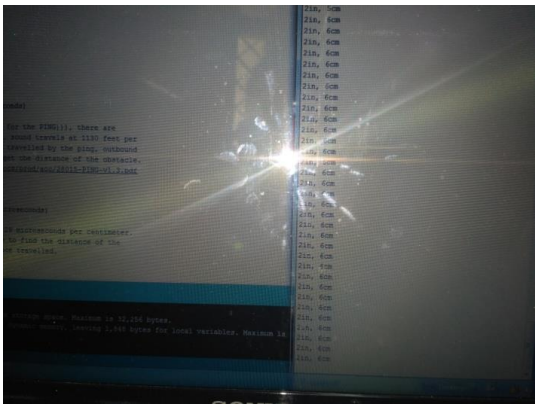

Figure. 7. Measurement of ultrasonic sensor detection

This figure shows the measure of water level between the ultrasonic sensor and top of the water level. The figure indicates 6 cm of the gap between the sensor and final water level. The distance between the sensor and top of the water level decreased, when the volume of water is increased. When there is distance of 2 cm between the sensor and top water level, stepper motor automatically turns the flow of water to the next water tank.

5. DISCUSSION

Here the proposed system has tested with two water tanks. In future, it will be extended with number of water tank as needed for the usage.

The corporation can fix the water tax according to the usage of water for the particular house. Total amount of water supplied from corporation should equal to sum of required amount of water of each houses in smart city. But there are some constraints or aspects in supplying water are effected to this calculation are as follows:

- ✓ Gravity
- ✓ Average speed
- ✓ Pumping
- ✓ Bends in pipes
- ✓ Distance
- ✓ Temperature / Evaporation

6. CONCLUSION

Water is main resources and basic things for all. But, when using water, user does not know how to maintain properly. Suppose, the user does not waste any water, it leads to the possibility of safeguarding the environment. Water usage may vary based on climate change, water sources, uncontrolled water supply that results inadequate water to users, industries with difficult economy planning and higher investment risks. Thus the proposed system has a cutting edge to the smart city environment in providing the needed water supply to each and every house.

7. FUTURE ENHANCEMENT

- Rain water harvesting can be done with which water supply can be done so that we could conserve water drastically.
- Routine watering of trees, plants can be done in order to avoid wastage of water

by individual watering of their plants or trees.

REFERENCES

[1] F. Ntambi , C P Kruger, B J Silva, G P Hancke, "Design of a water management system", IEEE Xplore Digital Library, INSPEC Accession Number: 15615935, DOI:10.1109/AFRCON.2015.7332012, September 2015

[2] Smartcities.gov.in/writereaddata/What%20is%20Smart%20City.pdf

[3] Giovanni Merlino, Dario Bruneo, Salvatore Distefano, Francesco Longo, Antonio Puliafito and Adnan Al-Anbuky, "A Smart City Lighting Case Study on an OpenStack-Powered Infrastructure", Sensors 2015, 15(7), 16314-16335; doi:10.3390/s150716314

[4] Jose Angel Carvajal Soto, Otilia Werner-Kyt ol a, Marco Jahn, Jaroslav Pullmann, Dario Bonino, Claudio Pastrone, Maurizio Spirito, "Towards a Federation of Smart City Services", International Conference on Recent Advances in Computer Systems (RACS 2015), 2016

[5] Laurynas Riliskis, James Hong & Philip Levis, "Ravel: Programming IoT Applications as Distributed Models, Views, and Controllers", IoT-App'15, November 1, 2015, Seoul, South Korea. C 2015 ACM. ISBN ACM 978-1-4503-3838-7/15/11 DOI: http://dx.doi.org/10.1145/2820975.2820977.

[6] M. Balestrini1, T. Diez , P. Marshall, A. Gluhak and Y. Rogers, "IoT Community Technologies: Leaving Users to Their Own Devices or Orchestration of Engagement?", EAI Endorsed Transactions on Internet of Things 10 – 2015 | Volume 1 | Issue 1| e7

[7] http://www.slideshare.net/bibhabasumohanty/water-distribution-system

[8] Professor Mark D. Sobsey, "Managing Water in the Home: Accelerated Health Gains from Improved Water Supply", Water, Sanitation and Health, Department of Protection of the Human Environment, World Health Organization, Geneva, Ó World Health Organization 2002

[9] Lindeil E. Ormsbee and Kevin E. Lansey, "Optimal Control Of Water Supply Pumping Systems", October 28, 1992. This paper is part of the Journal of Water Resources Planning and Management, Vol. 120, No. 2, March/April, 1994. ISSN 0733-9496/94/0002-0237,Paper No. 2646.

[10] Raja Sengupta Saurabh Amin, Anuradha Annaswamy, Scott Moura, and Vishwanath Bulusu, "Smart Cities and Control", IEEE Control Systems Magazine, 1066-033X/15©2015ieee, Digital Object Identifier 10.1109/MCS.2015.2471040 Date of publication: 11 November 2015

[11] Roshni Jose, Rebecca Wade and Chris Jefferies, " Smart SUDS: recognising the multiple-benefit potential of sustainable surface water management systems", IWA Publishing 2015, article is published in Water Science & Technology 71(2): pp.245-251.