STUDY ON THE SMART WATER SYSTEM BY USING SMART METERS AND IoT

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Abstract— As of today, countries are experiencing rapid urbanization, It is assumed that urbanization will raise in the future and will become up to 6 billion population by 2045. This significant increase in urban population will increase the demand for energy, water, and other services in the city. So, cities are becoming smarter in the provision of urban services and infrastructure. As considering urban services and infrastructure, water is valuable and highly in demand by the people in the urban cities.

Water is fundamental to life, livelihood, and sustainable development for a smart cities. The cities present a depressing scene of shortages of water and power, rivers turning into drains, and pollution. Water will be a critical issue and a major problem in urban areas. To conserve, monitor, to analyze (the quality and quantity of water) and reduce the water challenges, a new trend is emerging that is digitalization with an increase in demand for sustainable and efficient water urban services. This digitalization helps in interconnecting the urban services, infrastructure and the consumers to make a smart city workable. Thus, it provides the IoT system approachable to make a smart water management in the concept of a smart city.

This research paper will present the application of smart water management system by using IoT which includes a solution for water quality, water quantity, water monitor and control, leak detection, pressure, water recycling and flow, etc. This research also includes how the IoT systems including sensors, monitors, etc can be implemented in smart water management to reduce the current water management challenges for a successful transition of developing cities to smart cities.

Keywords— Smart Cities, Smart Water Management, IoT, Automation system.

I. INTRODUCTION

Cities are complex, dynamic and growing due to migration of people from rural to urban. As a result, the urbanization increases with that basic facilities, services and the infrastructure also growing. The concept of smart city get more popular in all over the worldwide where many cities are being planned as well as some existing cities also retrofitting to become a smart city. The growth of urbanization facilitate towards to develop the cities into a digitalization one and which known as the smart city. In India, the smart city concept is infancy as the government is pushing for development of several smart cities. Also, it's very complicated to design an existing city as a smart city than to design a new one. So, there are many more challenges in designing and planning a smart cities. To design a smart city with consideration of challenges, there are various number of components which help in creating the city smarter such as smart education, smart governance, smart security, smart healthcare, smart energy, smart town planning, smart water and sanitation, smart transportation, mobility and smart infrastructure. There are the smart solutions to make these components feasible and operational in smart city.

As urbanization or population growth increased, the cities are also growing, the demand of services, facilities and infrastructure additionally growing with respect to development of the cities which makes it very challenging for planning a smart city. A large and costly interventions were undertaken to augment the capacity of centralized infrastructure systems to provide drinking water and sewer services. So, we need a smart solution for it. If we look for the various components of the smart cities, then the smart water system is one of the major challenging component. Basically, there are numerous smart key solution to make the smart water system operational such as smart meter management, leakage identification, water quality and quantity monitoring, analyzing and controlling. These deals with the new emerging trend of solution that is digitalization. The digitalization technology based effective solution of smart water system primarily relies on smart meters, sensors, ICT, IoT, SCADA, smart control system, smart operation, GIS, software etc.

The smart approach for water supply system plays a major role and it must be an automated system which can convert the conventional water system into smart system with the help of instrumented, interconnected and intelligent system. This all changes can be done through Digitalization that's IoT based technology. IoT has a major role in smart water supply system as it gets the data from the source and gives the command through the system. The monitoring of smart water relies on the sensor availability but the communication through the centre server relies on the advanced communication protocols ICT and IOT system. Basically, IoT acts as ensuring for communication system between the source and operator.

The main objectives of this research on smart water management systems are like increasing the efficiency, managing water demand, promoting water conservation, reducing the energy requirement for the electricity, and

improving overall water management by using advanced technology that is IoT and smart meters.

II. SMART WATER SYSTEM approach

The concept of smart water system utilizes advances in information technologies for system monitoring data and to achieve greater efficiency in the resources allocation.

The conventional approach system for water management is not so advanced. It requires skilled at times, operative practices depends in the experience person, operation and monitoring have been inefficient with traditional practices specially aging infrastructure, monitoring of pressure and flow from source to consumer end, monitor of reservoir level, leak detection, pipes cracks, water quality and quantity monitoring etc are very difficult to achieve at frequent time scale, without adequate technological support.

The smart technology can change conventional water management into smart way by incorporating the instrumented, interconnected and intelligent system. Basically, these system functions as such are:
a) Instrumented – ability to detect, sense, measure, and record the data.
b) Interconnected – ability to communicate and interact with system operation and managers.
c) Intelligent – ability to analyze the situation, enable which response and optimize troubleshooting solutions.

The Smarter system relies on the putting up intelligent decision which is based on the form of data collected at several at different stages. These all the data gathering from the source to till communicating with the advanced system, all could be done with wire or wireless system or internet cloud. This all can be possible with the help of IoT and ICT system.

The Smart water management is the very important component of an overall smart city. The aim of smart water system in building is to provide a smart solution to the water management. The key solution for smart water system are like the smart meter, leakage identification, prevention, maintenance and water quantity and quality monitoring by using IoT. This is the practice that should be adopted to change the conventional approach to the smarter approach for managing the water supply infrastructure.

The smart approach water management supply system which includes the water source which has to monitor at the beginning of water supply through IoT controller. The IoT system is the advanced technique which gets all the data for monitoring from all the points of water supply system such as filter bed, flow meter, flocculate, chlorination, then the pumping system etc. all the information collected and communicating with a system which kind is assembling and getting all the data. This process can be done through wire system or this could be done after through internet cloud which known as wireless system. After treatment of water then it goes to the storage reservoir and then it goes to the distribution area. The information from each system gets control by a controller that is either internet of things based controller or ICT based system which put it on the cloud, then it communicates to a major server room where all data is collected, analyzed and processed. After this the decision making might take there or can be communicate back. This helps in the two-way communication will be there between the source and management. Here, the IoT plays an important role to take it further operational. Additionally, decision making could be done through IoT based controller and

system. It may be automated to make a smart decision making water system.
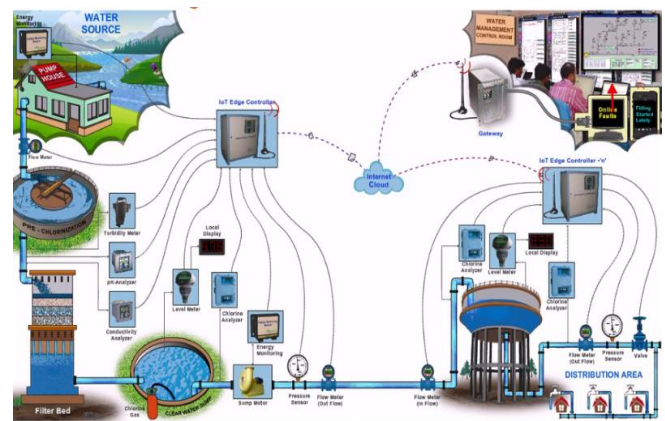

Fig. 1. Smart Water supply system by using the IoT device.

A smart water network is an integrated set of products, solution and system that enables utilities to remotely and continuously monitor and diagnose problems, prioritize and manage maintenance issue and use data to optimize all aspects of the water distribution network.

The smart water system features are like to improve efficiency, longevity, and reliability of the underlying physical water network by better measuring, collecting, analyzing, and acting, upon a wide range of network events.
- Measure smarter way – all the parameters should be measure in a smarter way,
- Communicate better- whatever data collected that communicate better way, not relying upon the manual communication.
- Analyze easier- there has to be a soft computing system which analyze the data which receive.
- Improve revenue- the billing system, revenue collection system has to be proper.
- Increase efficiency

The use of smart water system to improve the situation of many networks characterized by degraded infrastructure, irregular supplies, and low levels of customer satisfaction or not proportional bills to actual consumption.

III. TECHNOLOGIES Of WATER SUPPLY SYSTEM

The Automation Services for a Smart Water Supply are like AMR/AMI systems for domestic and bulk water metering o ESR, GSR monitoring, WTP automation, Water quality monitoring, Flow monitoring, Control valve automation , Pump: Energy monitoring and automation, Leakage detection, Water and Energy audit, Water metering solutions, Remote Terminal Units (RTU) with built in PLC, SCADA software, data storage and analysis software.
Elements that are incorporated in achieving a effective solution for a water management system primary relies on –

a) **Smart meters and sensors (AMR/AMI) -** Water meter which monitors water usage. It provides facility of online bill payment system. Communication enabled water meters, pressure gauges and water quality sensors for real time monitoring water flow, supply pressure and water quality.
b) **Smart communication** – information and communication technology (ICT) and Internet of Things for wireless data and command, communication and transmission.
c) **Smart decision making**- soft computing tools for data analysis and decision making.

d) **Smart Control system** – Supervisory control system based on data processing.

e) **Smart operation-** Automated operation control devices.

f) **Smart knowledge and information dissemination** – Data management and processed information dissemination platform.

The components that requires for the smart water management system other than IoT are -

i. **Digital output instruments**- which purpose is to collect and transmit the information in real time.

ii. **Supervisory control and data acquisition (SCADA) systems –** the purpose of this component is to process information and remotely operate and optimize systems and processes.

iii. **Geographic information (GIS) – this purpose is to store, manipulate and analyze spatial information.**

iv. **Software –** this purpose is to store, use and report data for modelling infrastructure and environmental system to improvedesign, decision making and risk management.

v. **Cloud computing-** Distributed computing utilizes an outer registering power capacity which is outside the limit of a client's own particular foundation, to run projects or applications.

IV. SMART METERING AND SENSING DEVICES

The major aim of a Smart sensing in smart water system is mainly relies on the accurate and updated information is being available for a systematic operating of a system. The purpose of informed decision making is that to have a data and the data being collected through smart meters and sensors. The smart meter and sensors that collects the information from the source, analyze, monitor and transmit the information to local and wide area network that uses by wireless communication that is by IoT. The smart meter and sensor are the heart of the smat water network. This reduces the manual requirements for monitoring and controlling.

The water quality sensors are like PH meter, TDS and conductivity meter, turbidity meter, oxidation reduction potential meter, dissolved oxygen probes, Chrolophyll content sensors. The sensors collects the data or information in which there are two types of collecting the data that are non-smart way and smart way of data collection. But here we will discuss the smart way data collection, monitoring and controlling.

The smart meters are similar to the standard meters but it performs the same function and additionally its ability of intelligent communication system. As this is the smart way to collect the data that means no manual work required as it required in the conventional metering. To make the smart meter, it requires to attach with a conventional devices that allows continuous electronic reading, storage, display and transfer of measured and recorded data. Basic function of a sensor is to measuring the parameter like monitoring the water quality and quantity as in same way as in conventional but as it attached to additional device which is automatic system that allows the data reading, data storage, data display and data transfer through some protocol to a data station or server. The smart sensors are smart monitoring devices helps in water conservation or influencing water pattern that just because they are providing the information.
These smart meters monitors the data and fetch the information from the devices. Then transfers the information

to the central server. So, basically the smart meters sensors are the tools that measures the water use, pressure or quality. These are the high frequency information from these meters and sensors that is used is used to make the appropriate decision on the management level. There is additional cost for smart metering in water supply system though it gives the benefits in term of energy saving and water saving, also helpful for the utility.
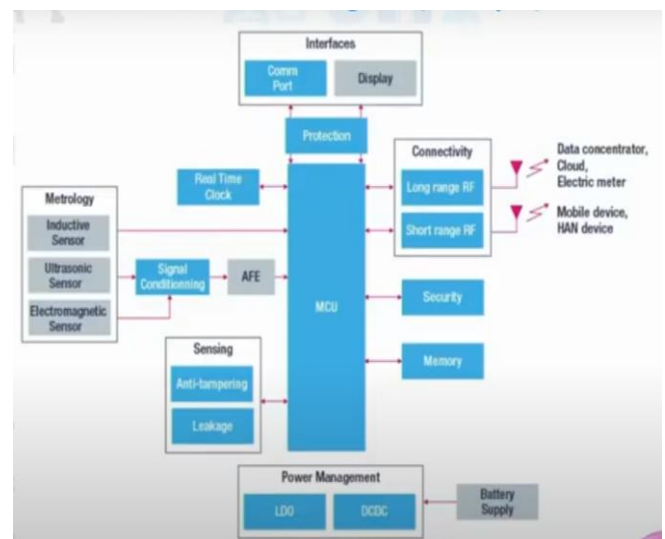

Fig. 2. The systematic representation to show the smart meter operation in smart water system

There is the central server unit in the center, then signal controlling, real time clock, sensing the different parameters, power management that fed by the battery supply. So, they are mostly like low power requirement units, this meters requires high power and many time operate with a battery. They will have also memory, security, and connectivity as short or long radio frequency and also have display in which has command port. So these are the various interfaces. Assembling of all this devices, then it becomes a smart water system.

A. Smart Data collection methods -

This is usually developed with the Automatic meter Reading (AMR), smart meter or smart grid system.
a) Cellular and mess: data recorded and communicated to cellular network, from where it can be transmitted to anywhere. SIM is fitted in the meter and then the data collected and recorded in the same and through message it transfers to the data centre.
b) Long range wireless: works on capabilities of the wireless system and enabling meters to form a sensor network for the water utility that can allow almost continuous monitoring. Whatever the data recorded in the meter that comes directly to the server centre through wireless system.

B. Advanced water metering infrastructure –

There are two different types of the advanced water metering that helps in recoding and transferring the data by intelligence way; such as:-

a) Automated Meter Reading (AMR) – the system that collects the metering data automatically and then its transfers its data to the central database for analysis and decision making. AMR water meter also known as smart meter. Additionally, AMR system consists of one way communication with utility. The recorded data communicated in one way at regular times. AMR is the subset of the AMI which helps in billing and metering.
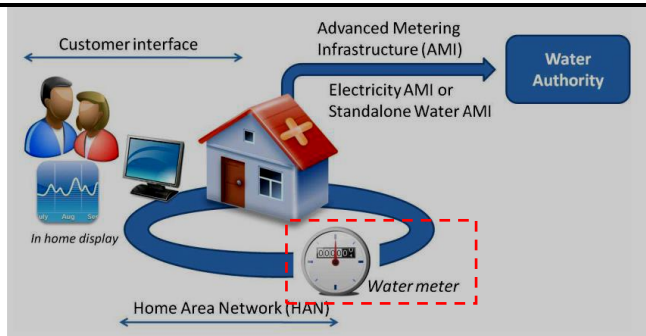
Fig. 3.   The different metering system in a building

b) Advanced Metering infrastructure (AMI) – these system are the two way communication between the meter and utility; also between the meter and consumer with the smart meters. It can be control by wireless devices as such mobile, tab etc. This makes the automatic billing and customer management, including detection and protection against the tempering attempts. It can help in planning, operation, engineering, customer service, asset management, billing, metering, Dispatch, demand management etc. Utility communicate the AMI system to meters and all other devices.

c) Smart metering and the smart Grid – it is based on AMR and AMI. It is two way of communication cross transmission and distribution. It enables intelligent control by the utility and the consumer side.

Benefits of AMR /AMI are like its reduces the meter reading cost, battery accuracy, allows more frequent billing, resolution of bill disputes, easier identification, control of sources of leakage, meter errors, damages etc, conserving the water, timely detection of use of water.

C. How smart meter works in the building?

The smart meter works in a building to measures and records the building's water usage. The data is transferred at hourly interval of time and updated every four hours. The water consumption data is made available to the consumers through the IoT based system on the mobile, tab or computer. That's how customers can monitor their household water usage and set budgets and give them a alert to control the spending o wastage of water.

V. IoT in Water Supply Management

Besides smart water meters, IoT can optimize water distribution in other ways too. Internet of things system which capable of detecting and displaying level of water in the storage tanks and used for managing and planning the water use. This system works on the basis of sensors and wireless system. The monitoring of automation system relies on sensor level and its availability. But the communication through the centre server which then relies upon the advanced communication protocols ICT and IoT system.

The IoT has a lot of role in smart water management system. Additionally, the IoT gets the data from the sources of water and give the command through the system. The concept of automation water supply system that primarily relies on the communication system. So, the communication system which can bring the information from the system to the server and send the command from server to the sensor. IoT is major tool for ensuring this for the communication between the system and server.

The Applications of the IOT in water sector are like water metering, irrigation technology, river flood detection, water leak detection, water monitoring, wastewater management, water recycling, chemical leakage detection etc. all this

operation can be operated with the help of IoT. It will help in the developing the protocol which can record the data , put then it's give the command from server again through cloud computing the command and information can be sent to the sensors.

Fig. 4.   The application of IoT in the smart water system

The major requirements for making the smart water to be automated is installation of sensors and controlling tools at strategic locations within the system .As it very difficult to do monitor and control by physically or manually. This helps in the monitored and controlled. Basically, monitoring is done using programmable logic controller (PLC), Internet of things (IOT), ICT, Supervisory control and Data Acquisition (SCADA) and Global system for mobile communication.
The scope of the smart water supply system with help of IoT are like to

- Monitor and control the raw water extraction at source
- Monitoring water treatment, water levels in clear water reservoir and control the pumping treatment.
- Estimating the chemical doses and controlling the dosing system.
- Monitoring the water distribution network system by controlling the pumping system, valves operation, water quality monitoring distribution.
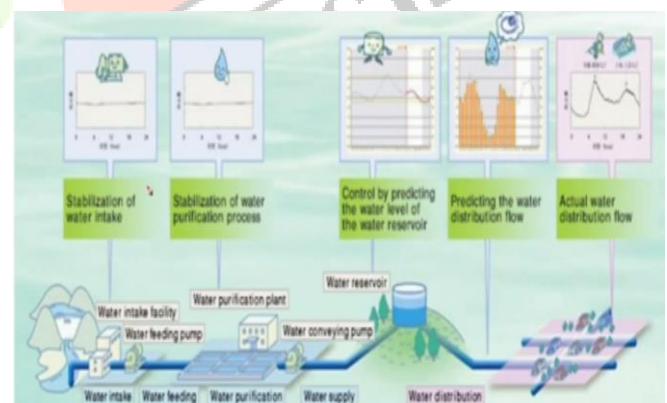

Fig. 5.   IoT stabilization in smart water system

The water supply and distribution automation system helps in the stabilization of water intake, stabilization of purification process, predict the water level in the reservoir, predict the water distribution in the pipe network and also get to know the actual water distribution pattern.

As IoT plays a very key role in automation. If there will be combination of IoT , big data and SCADA system, then it will achieve a full automated smart water system for a building. This technique could be applied for a water treatment, distribution and raw water extraction etc.
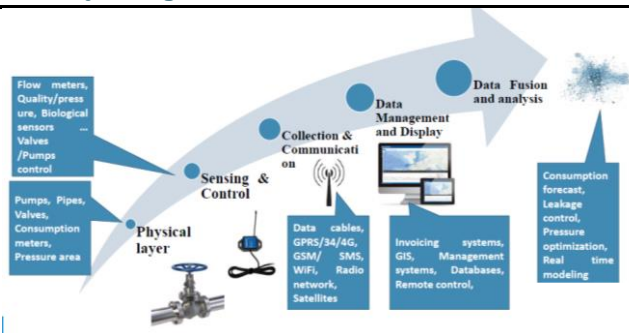
Fig. 6. IoT operational process in smart water management

There are step wise processes to make a smart city operational. All these steps are connected to each other. So, the first step is a physical layer in which the measuring and monitoring of quantity will be done by the different devices such as pumps, pipes, valves, consumption, meters, pressure area etc. The second step is to sensing and control the water quantity, quality and leakage detection through the devices like flow meter, quality/ pressure, sensors and pumps control. Then, the third process is a collection and communication in which there will be a IoT who plays an important role to communicate this sensing data to the operator or server. Here, requirement of IoT doesn't mean that it will treat the quality or quantity of water; it mean that it helps in transferring the data from the source of water to the customer as well as to the controlling system. This can be done with the help of data cables, GPRS, wireless Wifi network etc. The fourth one is data management and display for that the devices are like invoicing system, GIS, management system, database, remote control. At the last stage, there is the data fusion and analysis of water quality and quantity. This can help in consumption forecast, leakage control, pressure optimization and real time modelling. But IoT impact on smart water management are like that it measure smarter, communicate better, analyze easier, and improve revenue, increases efficiency.

Fig. 7. IoT impacts in smart water management

Sensor wires in the overhead tank will detect the level of water. Single strand wire used as a sensor. Sensing will be done by operating the transistor in switch mode. When a water level will be sensed and corresponding level will be send to Arm cortex. This data on the cloud will be fetched by the android application and will be displayed to the end user. In this android application recent and previous water levels will be displayed along with date and time. When the water level goes below low level, moor will automatically turn on and when water level above high level, motor will turn off automatically. The sensors and IoT devices very important for this whole process. The data from the server which transferred by the IoT and cloud commuting device will be fetched to mobile app. Mobile app will display the water level and time. Along with present water level mobile app will display recent water level.
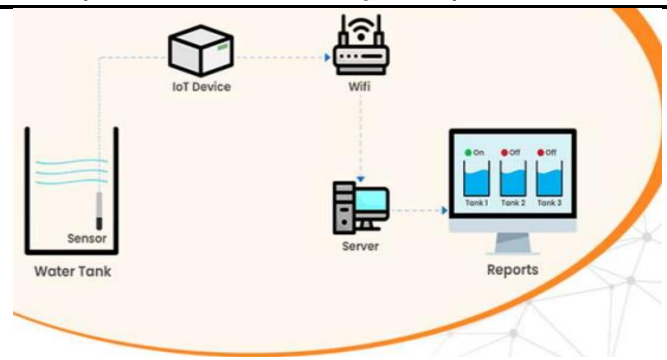

Fig. 8. IoT operation for water storage in the building

Most of the literature on smart water systems guide on architecture that could be used to design a smart system. Reality shows however, that systems are upgraded gradually and new features are added on top of legacy systems, and they are not built from scratch. Therefore, the transformation (migration) from legacy systems to interoperable, efficient smart systems should be accomplished in a step-by-step manner in a given time frame. Big Data and IoT, i.e. the fusion of IT (Information Technology) and OT (Operations Technology), is having a big impact on water networks and is driving many changes to technology and policy. IoT has been boosted by the trends, which have direct relevance to smart water applications, including big data, real time data collection and communication, sensors spread, new communications protocols, and event-driven architecture. But the IoT paradigm will not imply the obsolescence of legacy systems rather it will merge old and new data to make the systems more interoperable and to reduce uncertainty for decision makers.

VI. CONCLUSION

As the conserving the scarce water and recycling used water is major challenge for residences. By adopting the new innovative technology for water conservation helps in built the sustainable residential building. The automated water system with using of IoT and smart meter makes the system smart by monitoring and controlling the system in a smarter way. This helps in reducing the water consumption, makes the water quality better and reduces the electric energy. So, before it is too late, let us all, as individuals, families, communities, companies & institutions, pledge towards using water. Wisely. Intelligence is not in lavishness but in conservation, so that our future generations can continue to enjoy the blissful feeling and touch of water.

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