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DEVELOPMENT OF SMART WATER METERS FOR APARTMENTS

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Abstract - *Water, being one of the most essential elements for life on Earth, is being misspent to a great extent. The lack of public and administrative knowledge is one of the reasons why this occurs. Therefore, to mitigate the rising challenges of water usage and conservation, a variety of adaptive strategies are required. Considering Apartments as an initial step in this process for taking action, individual metering for houses using Internet of Things (IOT) promotes water conservation and curbs unregulated and inefficient usage of water. The purpose of this study is to develop a smart device to measure the amount of water used by the households and help them keep a track of their usage of water through two combined ways. One is through the data stored in cloud (database) which can be accessible through their computers/laptops and second is getting alerts on mobile phones through SMS in case of excessive usage. This is done by using two modules i.e., the Wi-Fi and GSM module. With the prior knowledge of the consumption, one can try reducing their water usage which was excess when they were not aware about it. In addition to encouraging a sustainable lifestyle, saving water often has a direct financial impact. A detailed information of the smart meter and its implementation is shown in this paper.*

Key Words: Smart meter, Wi-Fi module, Microcontroller, Hall effect, GSM module, consumption

1.INTRODUCTION

One of the most vital and essential natural resources on the earth being water, is one of the primary elements responsible for life. Water is a primary living need and is necessary for agriculture, industry, etc. Throughout the society, water conservation plays an important role. Water wastage is an international issue. In order to avoid water wastage, it needs constant monitoring. The lack of public and administrative knowledge is one of the reasons why this occurs. To be protected for the future generation, it ought to be carefully and efficiently handled. One among the various water related issue is the problem about a common meter being fixed for the entire building/apartment through which a common bill is generated would be divided equally among the houses, where they may be charged more than what actually is to be paid. There are numerous forms of water monitoring system present, but it has to be manually operated. The optimal management of water is the focus of this project. So, there is a need of a system in which the charges are based on how much water is consumed. That is possible with the help of Internet of Things (IOT). The Internet of Things identifies a number of interconnected objects (things) embedded with sensors, software, and other technologies to communicate and share information over the Internet with other systems and devices. Smart water meters are the solution for the issue mentioned where the smart water meters can be installed for every house in apartments to keep a track of the individual consumption. With the knowledge of the consumption, one can try reducing the water wastage which was excess when there was no specific information about it. The methodology adopted is showcased further in the study. For this project, microcontrollers and sensors are used. Using a small fan/propeller shaped rotor that is positioned in the water flow path, the Hall Effect is used in the flow meter. The water presses against the rotor fan, which causes it to spin. A Hall Effect sensor is attached to the rotor shaft. The Hall effect sensor is used as our water flow sensor which is used to measure the rate of the water flowing through it. It is usually used at the inlet end to detect the amount of flow. The hall effect sensor outputs the corresponding pulse signal which is detected through the rotating of the propeller to the microcontroller. The microcontroller then processes and sends the information to the customer/residents. The information will be received in two ways i.e., through SMS (using GSM module) and accessible on cloud (using Wi-Fi module). Therefore, while installing the smart water meter the issues shall be kept in mind and make it useful for the residents as they can save both money and water once they realize how much they consume and try reducing the wastage of water based on the information provided to them.

2. LITERATURE REVIEW

Prof. Yuvaraj T et al [2] points out the identification of leakages. their main objective was to develop a leak and water monitoring system, using the concept of IoT and flow sensor that can be used for detecting the leak and solenoid valves placed in different parts of pipeline which can obstruct the water flow until the defective part of the pipeline is repaired.

Prajakta Ajay Dhane et al [3] has spoken about the piezoelectric sensor which transforms the vibrations caused by the flow of water within the pipe into an electrical signal. With the assistance of an op amp, this low electric signal is processed and amplified. The peak detector and Schmitt trigger are supplied with an amplified signal. The positive peak value of the voltage is detected by the peak detector, which is dependent on the frequency. The microcontroller is
provided with digital output.

T. Deepiga et al [12] have covered the topics under Water monitoring systems such as tank water level sensing monitoring, water pollution monitoring and water pollution monitoring are used in this thesis to describe monitoring of water pipeline leakage sensing. This prevents the enormous amount of water being wasted by unregulated usage of large
apartments/offices by using Wireless Sensor Technology.

A. L. Sonderlund et al [14] highlighted the importance of feedbacks in encouraging water saving actions. To minimize the increasing threats to water protection, a variety of coping strategies are needed. Feedbacks help close the gap between the consumption of perceived and actual water consumption.

Hyeonje O et al [16] is a Korean patent which talks about the amount of water demanded by the city and the amount supplied. A smart water meter was installed in the city water supply reservoir to keep track.

Ding L et al [17] is a Chinese patent that talks about a passive intelligent water meter which runs without a battery/external power supply instead a water flow generator generates and supplies power to it. The passive intelligent water meter is equipped with an electronic paper display that consumes very little electricity, allowing the user to easily check metering and charging performance.

3. DATA COLEECTION

As a part of data collection process, a general mini survey was initially conducted among three builders and few residents of an apartment complex regarding their knowledge about the present water meters and of the smart water flow meter. After this process it was understood and arrived at a conclusion regarding their issues and also expectations regarding this product. By brain storming an initial idea was originated on what issues to highlight and also understood the need of making a product suitable for all the residents in the upcoming future. Making sure it is cost-effective, a comparison of the cost analysis was made between the two water meters i.e., the present manual water meters and the smart water meters.

3.1 Cost Analysis

The table below shows the calculated total cost of the present water meter and the proposed smart water meter. The complete cost of the present meter was estimated to be around Rs.2800 and the cost of the smart meter is around Rs.4000. When installed, smart water meter creates an awareness to the consumers about their monthly water consumption and helps reducing the same with mindful usage of water. This in turn reduces their expenditure on water bill.

Table - 3.1.1: Comparison table of present and proposed water meter

Cost of the present Water meter

Component	Cost
Mechanical Water meter	Rs.1700 - Rs.2000
Installation Charge	Rs.800
Total Cost	Rs.2800

Cost of the proposed smart water meter

Component	Cost
Connecting wires	Rs.50
Microcontroller	Rs.500
Wi-fi Module	Rs.350
Water Flow sensor	Rs.1000
LCD	Rs.150
12 V Adapter	Rs.200
GSM Module	Rs.800
Total Components cost	Rs.3000 - Rs.3050
Installation Charge	Rs.1000
Total Cost	Rs.4000

4. METHODOLOGY

This section talks about what the smart water meter is composed of and how every component plays its role. The functioning of the meter is also explained further. Using the water flow sensor and Arduino Uno microcontroller board embedded with Arduino code, a solution for monitoring water utilization has been proposed. Using Arduino software, codes have been developed to determine water flow rate and quantity of water used. Then this data will be sent to the cloud and to the phones of the user indicating alerts, so that the customers can monitor water usage data anytime.

4.1 Components

a. Arduino Uno Microcontroller:

It is an open-source microcontroller board fitted with 14 digital and 6 analog input/output sets of pins. These pins can be interfaced with other circuits and programmable with the Arduino IDE. The acceptable range of voltage is between 7 and 20 volts.

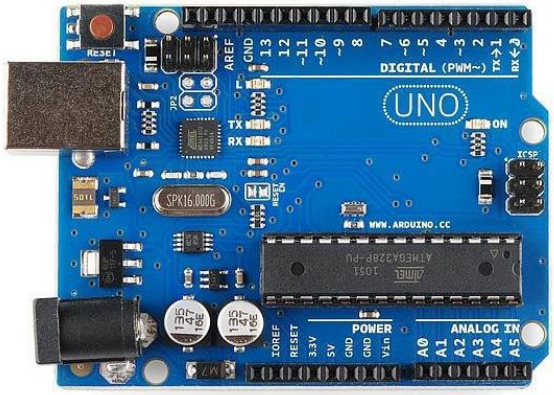


Fig - 4.1.1: Arduino Uno Microcontroller

b. Water Flow Sensor:

This sensor is used to measure the rate of liquid flowing through it. It is a small turbine which gives a series of digital pulses. The frequency of the pulses generated in the sensor will be equal to the rate of flow of water through the sensor. The main components of this sensor are plastic valve body, water flow rotor components and hall components. As the water flows through the rotor, the rotor begins to roll due to the water pressure. As the flow rate of water is varied, the speed of the rotor also varies. Using a small fan/propeller shaped rotor that is positioned in the water flow direction, the Hall Effect is used in the flow meter. The water presses against the rotor fan, which causes it to spin. A Hall Effect sensor is attached to the shaft of the rotor. It is an arrangement of a flowing current coil and a magnet attached to the rotor shaft, therefore as this rotor rotates, a voltage/pulse is generated.

Fig - 4.1.2: Water flow sensor

d. Wi-Fi Module

This module is used to provide internet connectivity for devices or projects. It can act as both station and access point. Therefore, using this module one can easily upload and fetch data on the internet making IOT as simple as possible. In this model, using cloud platforms on Internet, water consumption data is sent to the cloud and the user can monitor the water usage details using Wi-Fi.

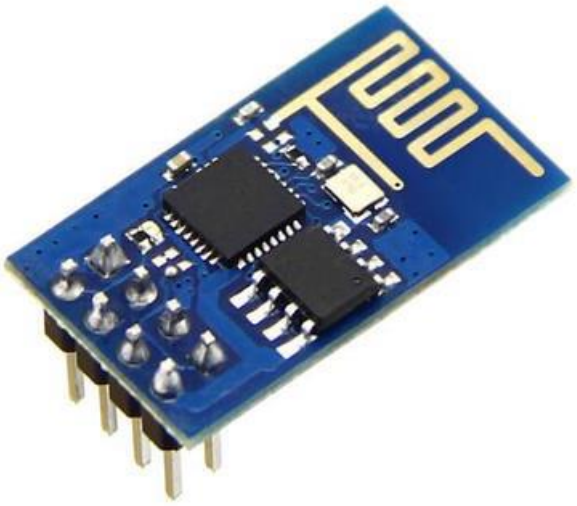


Fig - 4.1.4: Wi-Fi module

c. GSM (Global System for Mobile Communications) module

It is designed to define the 2nd generation (2G) digital cellular network protocols used by mobiles and is now a default global level mobile communication standard. Using this module as a medium for output, an SMS notifications of water usage data is sent to users. This module facilitates the user to check their usage without any internet connection.

Fig - 4.1.3: GSM module

4.2 Concept Generation

When water from the overhead tanks flows through the water pipe, it flows through the sensor that is attached to the pipe internally before the water inlet pipe of each house. As the water flows through the sensor, the rotor present in it rotates once it feels the water pressure. The rotor speed varies with the flow rate of water. There is also Hall Effect sensor present in the water flow path. This sensor generates pulse as the rotor rotates. This pulse signal is in the form of analog data. There are three output wires from the water flow sensor. The 5V Vcc (red), the ground wire (black) and the pulse line (yellow). This pulse line carries the analog data. The analog data is received by the microcontroller analog input where using the Arduino program and formulas, the water flow rate can be calculated and quantity of water consumed by the user.
This data is now in digital form and can be shown a serial monitor and also sent to cloud and stored using Wi-Fi module, from where the users can see their water usage details and compare their usage on a daily, weekly, monthly and yearly basis on their laptop/computers.
Another function of this prototype is sending the consumer a SMS alert regarding the overconsumption of water. By this the consumer gets alerted and can try to control his/her usage. This is done by the GSM module.

The microcontroller, being the heart of the prototype controls the functions of all the components connected to it. It is fed with the Arduino codes, which makes the components work as expected. The Arduino coding involves two major functions: 'void setup' and 'void loop'. Void setup is a function which is written first to initialize the components i.e., water flow sensor, Wi-fi module, GSM module etc. Once the components are initialized, they have to run in a loop to give us continuous data. This is done by the function Void loop, which runs the code in a closed loop. Once the code is completed, it is fed to the microcontroller through a USB cable. Once the codes are fed to the microcontroller, the code is executed. During the execution, all the components attached to the microcontroller through jumper cables are initialized and start working giving the output.

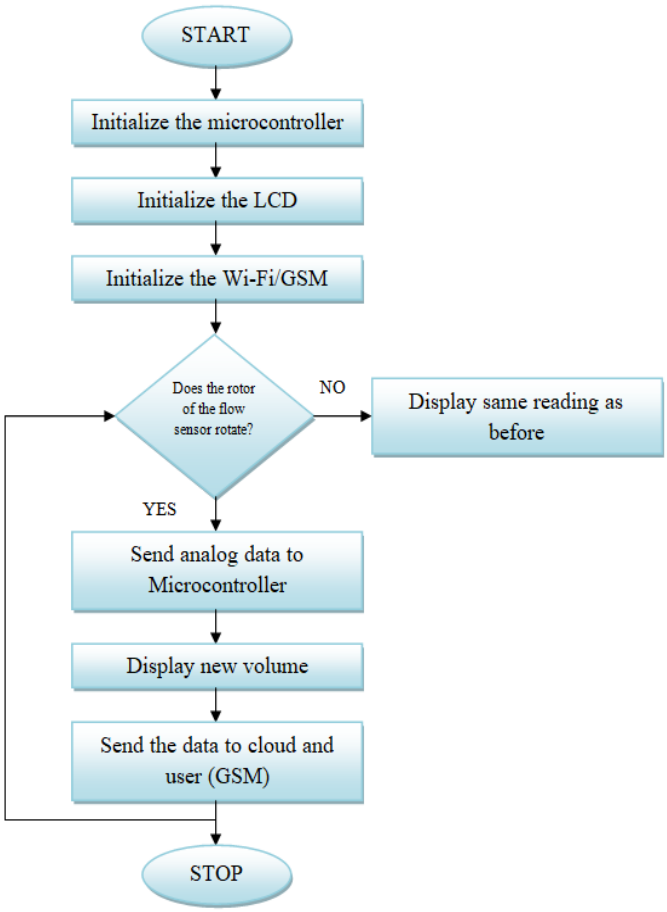
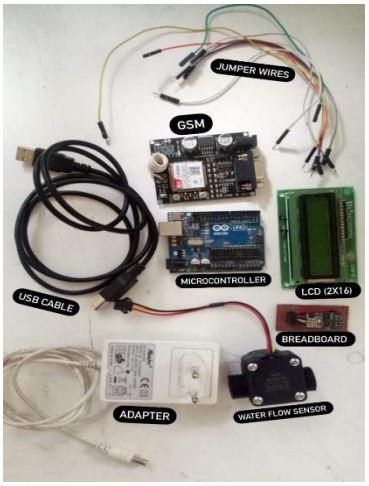


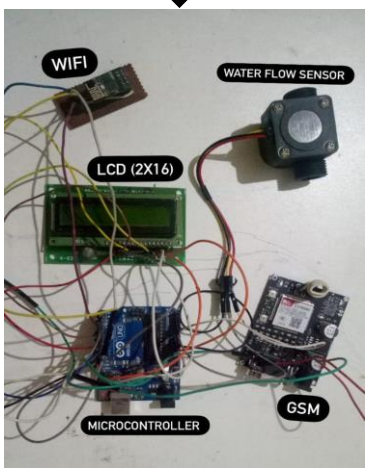
Fig - 4.2.1: Flowchart of the process

5. PRODUCT DEVELOPMENT

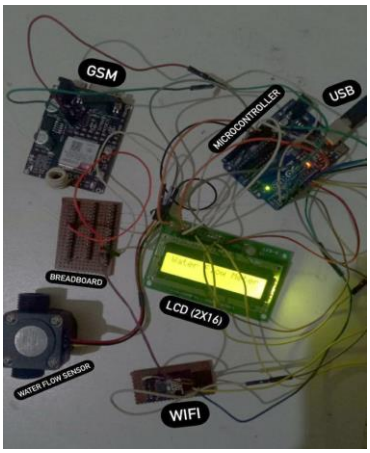
The stages of developing the product are shown below (Figure 5.1):



a. All the components used for the prototype



b. Components connected to the microcontroller



c. When Arduino codes are fed to the microcontroller

Fig - 5.1: Stages of Product Development

As and when the consumer consumes water, the data is being recorded in the database which is displayed in our local host (website). The below picture displays the sample data of water consumption details in KPS Apartments (made-up).

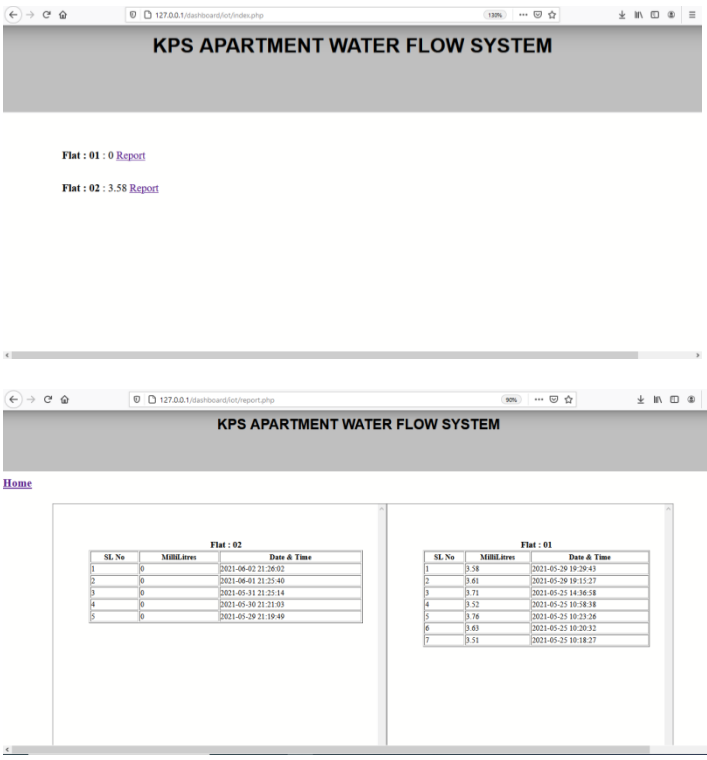


Fig - 5.1: Website showing consumption data

To alert the consumer about crossing the threshold limit (if any) set by the apartment owner, the GSM module send a SMS notification to the user's mobile phone. The below picture displays the SMS alerts.

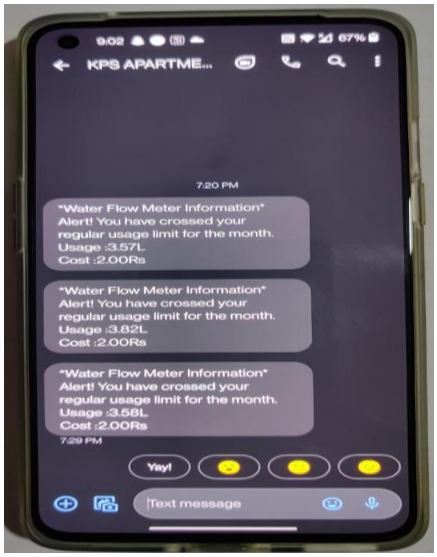


Fig - 5.2: GSM SMS alert sent to user

6. ADDITIONAL APPLICATIONS

One of the advantages of this model is its flexibility. It can be installed with other sensors as per the customer's requirements in apartments. Sensors which can be used are:

Smoke sensor: This sensor automatically detects the presence of smoke which is a core indicator of fire and sends a warning message and alerts the building occupants to take necessary action and evacuate the building.

Moisture sensor: It measures current soil moisture and aids in gardening without using excess amount of water which otherwise leads to unmonitored wastage of water.

Considering the end result of this model as water conservation in apartments, rain water harvesting can also be implemented with this. So, rooftop rain water harvesting is an effective method of harvesting and saving rainwater. In apartments, with the help of rooftop rainwater harvesting, it can be used to divert the collected rainwater into storage tanks or recharge pit with the help of down-pipes connected to terrace. This collected water can be used for gardening, cleaning walkways, car washing etc. It also promotes water and energy conservation and saves money on water bills. It is also easy to implement and maintain.

7. CONCLUSION

In this project an effort has been made to develop a smart water meter to enable the householders to monitor and keep a tab on their water usage. Through this approach, it has been tried to introduce a social consciousness of excessive usage and wastage of water in the society. A small survey was conducted with the builders and residents, which showed the need of this system in apartments to save water and as well as money. As the users get real-time, accurate data of water usage online through this system, they can avoid inefficient use of water. At the same time they can pay water bills only for the quantity of water each household has utilized instead of getting a common bill and dividing it by the number of households where they are usually charged more than what actually has to be paid based on their water usage. Also, the traditional data collection method is sometimes inaccurate as there may be tampering of water meters and the process is labor intensive.

The water usage data collected can also be used to manage water efficiently at an apartment level. By adopting this method, it can drive towards a smarter city and smarter building management which helps to achieve higher level of sustainability. Here a water flow sensor i.e., Hall effect sensor is used to detect water flow and flow rate in pipes and then send the pulse signal to microcontroller to calculate the water consumption and send it to the user through cloud using Wi-Fi module. An SMS alert is also sent through GSM module to the consumers to avoid over usage of water. This model has an advantage of being flexible because of the additional features that can be added. As per the apartment resident's/owner's choice, the model can be improvised by adding more sensors like moisture sensor, temperature sensors, smoke sensors and so on.

8. REFERENCES

1. Vijaya S. Patil., Dr. G. S. Sable., "Review on design and development of low-cost electromagnetic flow meter", International Research Journal of Engineering and Technology (IRJET), Volume 7, Issue 6, PP 4665-4667, June 2020.

2. Prof. Yuvaraj T., Nithin Krishna., Poojary Manish., Priya Naik., Varsha. P., "Review paper on water monitoring and leakage detection", International Journal of Research and Scientific Innovation (IJRSI), Volume 6, Issue 3, PP 31-32, March 2019.

3. Prajakta Ajay Dhane., Dr. A. B. Kakade., "Contactless running water flow detection and water flow measurement system", International Journal of Engineering Research and Technology (IJERT), Volume 7, Issue 4, PP 385-389, April 2018.

4. Francisco J. Arregui., Francesc J. Gavara., Javier Soriano., Laura Pastor-Jabaloyes., "Performance analysis of ageing single-jet water meters for measuring residential water consumption", Multidisciplinary Digital Publishing Institute (MDPI), 2018.

5. Janhavi Sawanth V., Lourd Mary J., Madduleti Vidya., Mounika D. V., "Smart water flow control and monitoring system", International Journal of Engineering Research and Technology (IJERT), Volume 6, Issue 13, 2018.

6. Gowthamy J., Chinta Rohith Reddy., Pijush Meher., Saransh Shrivastava., Guddu Kumar., "Smart water monitoring system using IOT", International Research Journal of Engineering and Technology (IRJET), Volume 5, Issue 10, PP 1170-1173, October 2018.

7. Anna Soderberg., Philip Dahlstrom., "Turning smart water meter data into useful information", KTH Royal Institute of Technology and Faculty of Engineering Lth, Lund University, August 2017.

8. Sajith Saseendran., V. Nithya., "Automated water usage monitoring system", International Conference on Communication and Signal Processing, PP 99-103, 2016.

9. Anif Jamaluddin., Dewanto Harjunowibowo., Dwi Teugh Rahardjo., Egy Adhitma., Syamsul Hadi., "Wireless water flow monitoring based on android smartphone", 2nd International Conference of Industrial, Mechanical, Electrical, Chemical Engineering (ICIMECE), PP 243-247, 2016.

10. Peter Mwangi., Elijah Mwangi., Patrick M. Karimi., "A low-cost water meter system based on the global system for mobile communications", International Journal of Computer Applications, Volume 142, Issue 12, PP 7-12, May 2016.

11. Rahul Ramesh Iyengar., "The water flow monitoring module", International Journal of Engineering Research and General Science, Volume 4, Issue 3, PP 106-113, May-June 2016.

12. T. Deepiga., A. Sivasankari., "Smart water monitoring system using wireless sensor network at home/office", International Research Journal of Engineering and Technology (IRJET), Volume 2, Issue 4, PP 1305-1314, July 2015.

13. A. Merchant., M. S. Mohan Kumar., P. N. Ravindra., P. Vyas., U. Manohar., "Analytics driven water management system for Bangalore city", 12th International Conference on Computing and Control for the Water Industry, PP 1137-1146, May 2014

14. A. L. Sonderlund., J. R. Smith., C. Hutton., Z. Kapelan., "Using smart meters for household water consumption feedback: knowns and unknowns", 16th Conference on Water Distribution System Analysis (WDSA), PP 990-997, December 2014.

15. Ria Sood., Manjit Kaur., Hemant Lenka., "Design and development of automatic water flow meter", International Journal of Computer Science, Engineering and Applications (IJCSEA), Volume 3, Issue 3, PP 49-59, June 2013.

16. Hyeonje O., Jincheol J., Jinhong J., Jaehyung K., Jiyoung K., 2016, Device for predicting demanded quantity and deciding supplied quantity of municipal water using all-in-one smart water meter, 1020110137699.

17. Ding L., Jiang Z., Feng Y., Zhang H., 2014, Passive Intelligent water meter, 201320537506.