# House Intelligent Water Network Leakage Prevention System

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## Abstract

At present, there is still no economical and reliable water leakage protection device for the home water network system. To solve this problem, a home intelligent water network leakage prevention system is proposed. The system is divided into two parts: software and hardware. The hardware part includes flow sensor and single chip system, power system, software is a mobile phone program. The intelligent water network system allows users to know the water usage of their homes at any time. When the system judges the water pipe leakage phenomenon through real-time data analysis, it automatically opens and closes the valve and promptly reminds the property and users through GSM SMS or APP to avoid loss. The device can effectively reduce the waste of water resources caused by forgetting the faucet, the water pipe bursting, etc., the volume is small, the power consumption is low, the cost performance is high, and the utility model has strong practicability.

**Keywords:** water leakage detection, remote control, MCU, data analysis, intelligent identification

## I. Introduction

With the rapid development of China's economy, the improvement of people's living standards, and the increasing supply of water, the safety of water use is of great significance. Therefore, optimizing the water safety with modern technology and eliminating its hidden dangers has become an important task for China in the future [1].

For example, when we go out, the water pipes in the home are too large or the water pipes are aging, and the accident of water pipes ruptures can happen at any time. This not only wastes a lot of water resources, but also causes people to suffer economic losses [2]. At present, although the domestic smart home technology is developing at a high speed, this situation has not been monitored. If the hidden dangers break out, there are no mature products that can control or even solve such situations. Existing products can no longer meet the needs of people's lives and intelligent development requirements. Based on the above problems, this paper focuses on the home smart water network leak prevention system to make up for these shortcomings.

With the development of computer networks and the expansion of control systems, remote data management, remote resource invocation, and detection, operation, and control of remote devices have become possible. At present, intelligent machines have fully penetrated into all levels of industry and society, such as intelligent robots with dedicated new sensors, continuously monitoring the mining status, in order to detect the aura of accidents, take appropriate precautions; password recognition of smart wheelchairs, To help people with disabilities; intelligent vehicle autopilot brings convenience to people.

In the field of intelligence, the development of a new generation of emerging technologies provides powerful technical support for the intelligent water network leakage prevention system. The sensor monitors the water flow, analyzes the data with cloud computing, big data, etc., and uses the already mature single-chip system to control, so that the hidden danger that prevents the water pipe from bursting and is unknown and cannot be controlled in time is released. The research on the household intelligent water network leakage prevention system is also beneficial to people's enjoyment of life.

## II. Backdround and Motivation

The domestic market also has a lot of thinking in the field of water seepage prevention. For example, the pipeline leakage analyzer developed by Hunan Puqi Geological Exploration Equipment Research Institute collects sound data through wireless probes and processes and identifies them through the host [3]. Shenzhen Xiang Wei has limited measurement and control technology. The company uses point-type or copper wire short-circuit detection; similar to the US-based Raychem Tracetek leak detection system, the management system used in the water seepage field is controlled by a liquid leaking sensing cable and a controller [4]. Composition. When a leak occurs, the liquid hits the sensing cable, and the sensing cable sends the signal to the controller, which is processed by the microprocessor to display the

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leaked position and alarm; and TTK, Paris, France, TK provides three kinds of detection cables [5]. To detect different liquids: FG-EC detection cable: for water and alkaline liquid leakage detection, FC-AC detection cable: for pickling and corrosive chemical detection, F-OD detection cable: Suitable for liquid hydrocarbons and non-conductive solvents [6].

The main problem of the current technology is that the detection of the leaking system is too complicated and complicated. Whether it is judged by sound or the cable, it needs to be laid close to the pipeline, so it needs to be carried out during the decoration construction process[7]. The factory can be directly placed near the pipeline, but in the residential building, it is difficult to supplement the construction in the later stage. At the same time, because of the large area of paving, the length of laying is long, the amount of engineering is large, and the price is limited to precision manufacturers such as chemical plants[8]. The laying of reverse osmosis water systems for ordinary residents is inevitably stretched in economic terms[9].

In recent years, foreign anti-leakage devices have developed rapidly, with more comprehensive functions and more accurate sensitivity, but they are more expensive and less popular. Such as a macc submarine leak-proof device, can detect water leakage, and prompt users to repair through the mobile phone app, the price is about 359 US dollars, equivalent to 2513 yuan; and a protects leak-proof system, the price is about 3,500 RMB. The price is not suitable for the consumption of target groups such as the working class.

Some devices with lower domestic prices can only be roughly detected, can't be connected, and the battery consumes fast power. It can't realize humanized and intelligent settings and functions. The other part only uses plastic materials, which is easy to damage and has functional functions limitation.

Some family-oriented leak-proof facilities are not intelligent enough, and the effective working environment is single, and cannot handle various unexpected situations [10]. Intelligent water network leak prevention through data analysis can detect various leaks, intelligently identify leaks and normal water use.

The traditional water leak detection is generally applied to industry, there is no leak detection for the average household, and most of the water consumption in life is people's domestic water. Studying the intelligent water network leakage prevention can make up for this deficiency [11]. In this paper, the intelligent water network leakage prevention system can monitor whether the water pipe leaks or bursts, which is in line with the development requirements of China's water conservation, and realizes the monitoring of water supply demand and safety hazards and the improvement of people's living standards. It is of great significance.

# III. Leak Detection Technology

## 3.1 Mean Leak Detection Technology

At present, the frequently used leak detection techniques include: flow balance method, listening leak detection method, flow rate measurement method, pressure difference method, flow balance method, passive leak detection method, active leak detection method, infrared photography method, and the like. Various leak detection methods usually monitor signals such as sound, flow, and light to identify whether there is water leakage. Among them, the listening monitoring method is most commonly used [12, 13].

Hearing leak detection method: When a water leak occurs, the water rubs against the leak, and its frequency vibrates within a certain range, thereby generating a water leakage sound. The types of water leakage sounds are: leakage noise, medium impact sound, medium friction sound. Mainly captures the friction of the leak. The listening leak detection method is divided into two types: valve plug listening and ground listening. The former is used to find the clue and range of water leakage, and the latter is used to determine the position of the leak point. When the pipeline hears the sound of water leakage, in general, the leakage sound generated by the large water leakage point is larger than the leakage sound generated by the small water leakage point, but the leakage point is so large that the leakage sound is small, so it cannot be considered to be heard. The sound of water leakage is large, and the amount of water leakage is large, and sometimes the actual situation is just the opposite.

Pressure difference method: It is identified according to the change of pressure in the pipeline before and after the leak. This method is only suitable for leak detection of large leaks. Moreover, the pressures in different areas are different, the environmental noise is too large, and the interference parameters are too many, and it is impossible to accurately and uniformly identify whether there is water leakage.

Partition leak detection method: System test, network network condition analysis, early signs of water leakage can be found, but the steps are cumbersome. First, the valve needs to be closed. One end of the pipe is connected to the fire hydrant at one end to connect the flow meter, and the flow meter is used to detect whether water is leaking.

Related leak detection method: The advantage of the relevant leak detection method is that the position of the water leakage point can be detected. It is the continuous irregular vibration sound generated by the correlator through the sensor installed at the two ends of the leakage pipeline, according to the distance between the two sensors. The data such as the time difference of the sound arrival and the vibration sound propagation speed are correlated and the position of the water leakage point is obtained.

Flow balance method: The principle of the flow balance method is to install a flow sensor at each end of the pipeline. By comparing the flow sensors to detect the flow, the flow balance method is simple in structure and can detect whether there is water leakage. However, large-diameter pipes are not easy to measure and are suitable for small-diameter pipes. The flow balance method is simple and economical and is very suitable for monitoring household water networks.

## 3.2 The Detection Technology Used in the System

The home smart water network leak prevention system uses a flow balance method to detect whether there is water leakage.

The listening leak detection method is only for the leakage of water with a special leaking water, and the sound signal such as leakage is weak and cannot be recognized. Moreover, household water leakage also accounts for a large proportion, and the cost is relatively high. This method is suitable for public underground pipeline monitoring and enterprise leakage detection is not suitable for large-scale popularization, so no listening monitoring method is adopted.

The pressure difference method is not very realistic. The water pressure varies with the height of the floor. There is no universality. The MCU program cannot intelligently identify the water leakage.

The zone leak detection method is more unrealistic for household leakage detection. The zone leak detection needs to close the valve and then introduce the water flow. It is suitable for factory leak detection and is not easy to realize automation and intelligence.

The above several leak detection methods are costly and are not suitable for large-area promotion, and cannot be identified for some special leakage conditions.

The reasons for using the flow balance method in this paper are:

(1) Principle and structure are simple. Only need to collect the flow of two places, through data analysis, data comparison can determine the presence or absence of water leakage.

(2) Economy, suitable for large-scale promotion. The flow balance method is suitable for water networks with small pipe diameters, and the home water network happens to meet this feature.

(3) The flow signal is easy to collect, which is convenient for data analysis and comparison. The data processing can be realized by programming to realize the intelligence of the system, which makes the user more convenient and manages the system.

Considering the overall consideration, the flow balance method suitable for the household water network pipeline is finally selected to monitor the household water network.

The water network pipeline in the family is abstracted as shown in Figure 1. In the figure, T1, T2

and T3 represent the flow sensor, and the large arrow indicates the water network pipeline. According to the position of the sensor, we divide the water network into blocks, and T1 to T2 and T3 are divided into pipeline areas. The T2 and T3 sensors flow down into water systems, and we divide them into water zones.

## IV. The System Principle of House Intelligent Water Network Leak Prevention

Urban household water nets are generally delivered by public pipes, and each family leads branches to kitchens, toilets and other sub-systems.
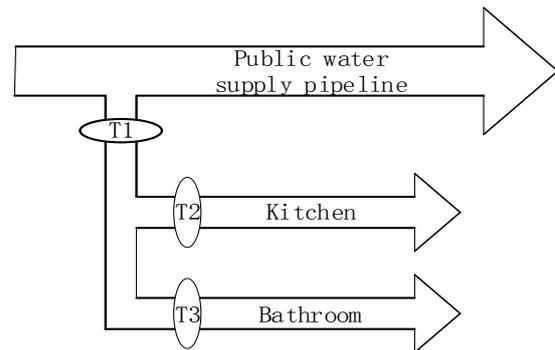


**Figure1. Household water network pipeline diagram**

Water network leakage will affect the building, waste water resources, and cause safety hazards. Water leakage and normal water use can be judged by data analysis. Normal water is characterized by a constant water flow rate and is generally known. When the water valve is closed, the flow rate is reduced to zero and the flow signal does not always exist.

The water network leaks water in different situations, with small-scale leakage, leakage caused by tight joints of general scale, leakage caused by large-scale water pipe bursting, and forgetting to turn off the faucet. One of the characteristics of water network leakage is that the flow signal will always exist. Among them, the small-scale leakage is characterized by a small flow rate; the leakage caused by the general scale leakage and large-scale water pipe burst is not easy to distinguish from the normal water leakage, and we use the flow difference method to judge. Forgetting the faucet is one of the most difficult situations to judge. We can take the pre-value method to solve the problem of forgetting the faucet.

First solve the most common problem: water leaks between water pipes. The leakage between water pipes is generally a problem in the pipeline area. In this paper, the flow difference method is used to determine that the flow rate of the flow sensor T1 is equal to the sum of the flow sensors T2 and T3 under normal conditions. If the flow rate monitored by the flow sensor T1 is T2 and T3 total. If the flow rates are

not equal, there is a leak in the pipeline area. The flow chart of the single-chip microcomputer system when the water pipe leaks is shown in Figure 2 below:
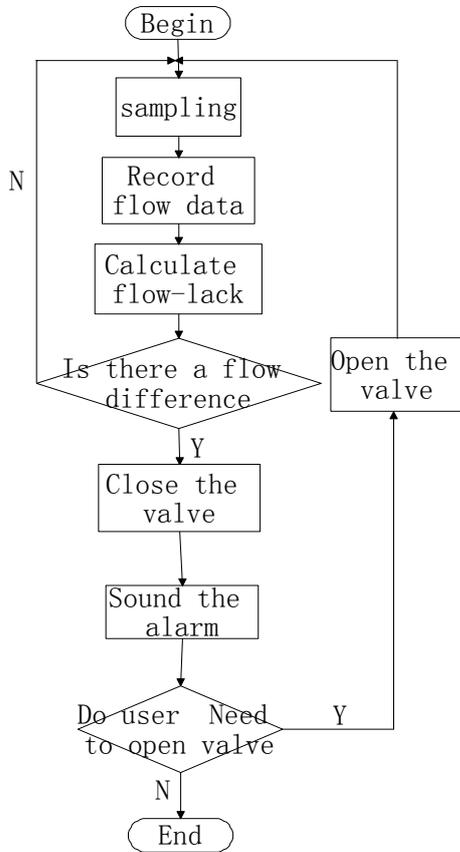


**Figure2. Flow chart of water leakage system between water pipes**

Secondly, solve the leakage problem. The leakage hazard is also very serious, and it is not easy to be discovered. When people notice that it is very likely to cause irreparable damage to the building, it also has hidden dangers to the home circuit. Leakage can occur in various parts of the water network, either in the pipeline area or in the water area, so it cannot be detected using the flow difference method. Leakage problems can be solved according to the characteristics of less leakage flow, but always existed. The characteristics of household water, industrial water use and leakage flow are obviously different. Household water is nothing more than kitchen water, washing water, bathing water, and washing water. Industrial water flows are also generally known. Neither household water nor industrial water can be a constant flow signal. Therefore, it can be identified from the characteristics of long leakage duration and small flow. The flow chart of the procedure when leakage occurs is shown in Figure 3 below:
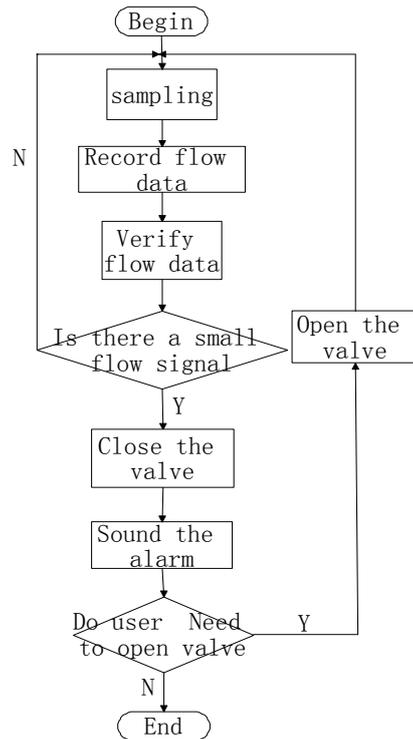


**Figure3. Single chip system flow chart when leakage occurs**

The last insurance, set the threshold, the daily water is basically fixed, by setting a threshold for the single-chip microcomputer, if the water consumption exceeds the threshold on that day, it is determined that water leakage has occurred. This method can also solve the problem of forgetting the faucet. The system flow chart when the water valve is forgotten is shown in Figure 4 below:
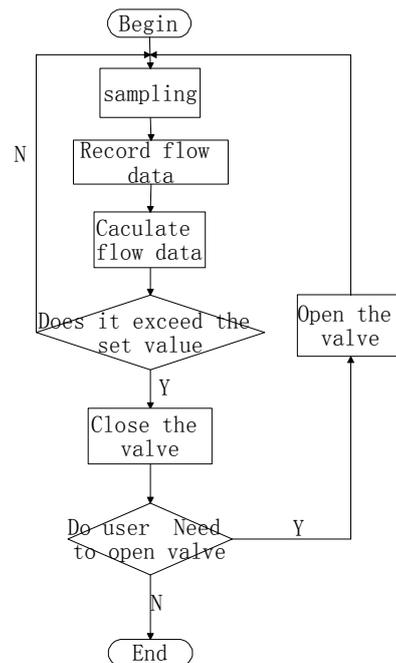


**Figure4. Flow chart of single-chip system when water valve is forgotten**

## V. Innovations of This Paper

The household intelligent water network leakage prevention system designed in this paper adopts automatic switch to control household water to realize real-time control of supply. The property is monitored by the system or monitored by the customer on the mobile APP. The user can remotely control and observe the water consumption. The amount of water used in the home is well known. Each part of the sensor can be used to monitor the specific location of the water leakage and the automatic opening and closing of the valve when the system detects that a water leakage has occurred. This system data collection is more comprehensive, and data analysis is more systematic and intelligent.

## VI. 6. The Future Study

A remote control module can be added. The remote management system is composed of WIFI, APP and users. The one-chip computer is connected with the specific APP by connecting WIFI, and as long as the alarm signal is generated, the alarm message is sent to the mobile phone APP through the GSM short message. At the same time, the user can check whether the water is leaking through the APP, and set the corresponding parameters to convert the parameters into control signals to control the water gate valve. The specific schematic block diagram is shown in Figure 5 below:
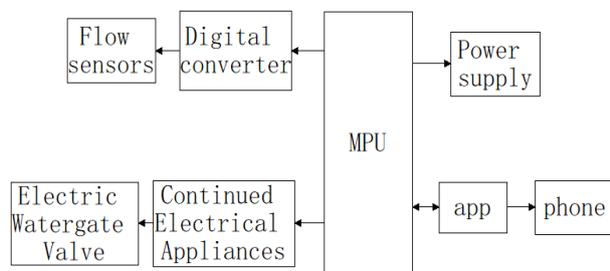


**Figure5. Development and promotion schematic block diagram**

## VII. Conclusions

"If you want to do something good, you must first sharpen your tools." In the process of understanding nature and promoting social progress, people constantly create a variety of tools to serve humanity, many of which have epoch-making significance. As the main development direction of the 21st century, intelligent tools have become inseparable from the production and life of human society. Therefore, it is very necessary to study the intelligent water network leakage prevention system.

## ACKNOWLEDGMENTS

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