Study on the Intelligent Monitoring System of Dry Type Water Meter Based on the Technology of Non Magnetic Pulse Acquisition and Spread Spectrum Communication

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ABSTRACT: In this paper, the important role of intelligent monitoring system of water meter in water supply industry is introduced, and the necessity of the research on the intelligent monitoring system of water meter is pointed out. Then, a kind of intelligent monitoring system of dry type water meter based on the technology of non magnetic pulse collection and spread spectrum communication is introduced, and the composition of the system is described, including intelligent water meter and concentrator, community management and management center. The characteristics, functions and performance indexes of each component of the system are described in detail. Finally, the practical application effect of the system is given.

KEYWORDS: Non magnetic pulse acquisition; Spread spectrum communication; Two stage reducer; Eccentric variable speed drive; Dry type water meter; Intelligent monitoring system

1 INTRODUCTION

With Chinese vigorously promoting water conservation and the gradual implementation of pricing ladder, the intelligent water meter monitoring system will be increasing demand. At the same time, the system requirements are also getting higher and higher. At present on the market, the intelligent water meter monitoring system are the following: smart IC card prepaid water meter[4], RF card prepaid water meter and remote water meter. Because of the poor operating environment, the existing intelligent water meter monitoring system mainly has the following problems:

a. Inaccurate readings, vulnerable to interference, and more abnormal readings;
b. The seal of the wet structure is not good, the failure rate of the electronic part is high, battery power consumption is too fast, and maintenance costs is increased;
c. The product does not have the network function, or the communication is very much. Information could not be transmitted;
d. IC card water meter and RF card prepaid water meter could not achieve the ladder pricing function.

In order to solve the above problems, a new type intelligent water meter monitoring system with multi functions and networking communication needs to be developed[5][6][7]. In this paper, the intelligent water meter monitoring system is realized in order that water companies can remotely accurate and timely read meter, implement the ladder meter, can monitor user water information.

2 SYSTEM DESIGN

The system is divided into four stages, as shown in Figure 1, respectively:

a. Indoor equipment: intelligent water meter;
b. Concentrator: using wireless communication between the concentrator and the indoor equipment, and collecting the water meter information of a building or a unit (including meter reading information and alarm information);
c. Community management machine: using RS-485 bus communication between the community
management machine and the concentrator, a community management machine hanging multiple concentrator. The community management machine receives information from the concentrator, also communicates with the management center through the built-in DTU (wireless data transmission module) by wireless long distance (GPRS) technology.

d. Management center: the management center is responsible for analyzing, storing, displaying the information from all the subsystems, and assisting the dispatcher to make decisions and perform the related linkage measures.

3 SYSTEM COMPONENTS

3.1 Intelligent water meter

3.1.1 Mechanical part design
3.1.1.1 Movement design
Adopting new structure, has the following characteristics:

a. As shown in Figure 2, the two-stage reducer technology of the industrial water meter is applied to civil water meter. The central axis of impeller box through the wet type and dry type two-stage reducer transfers the power. The wet reducer is soaked in the water, and meshing speed is achieved depending on the gear in water. The buoyancy of water and lubrication ensures the water meter with high sensitivity.

b. As shown in Figure 3, the wet type reduction box is output to the eccentric shaft at a lower speed, and then the eccentric shaft is transmitted to the dry type reduction box with magnetic, and the final transfer to the word wheel turns to reflect the reading of the water meter. The eccentric variable speed drive technology is adopted to eliminate the phenomenon that the overload flow demagnetization of traditional dry type water meter leads to the impeller does not turn.

c. As shown in Figure 4, the lead is protected by using extruded cables and silicone rubber sealing.

d. As shown in Figure 5, the metering mechanism adopts the high quality silicon rubber sealing ring, pressing, pressing ring tight pressure way to prevent leakage.

3.1.1.2 Valve design
The design has the following characteristics:

a. Switching valve torque is not greater than 4.0kgf-cm when the water pressure is not greater than 1.0MPa.

b. When the water pressure is 0.2MPa ~ 1.0MPa, the valve switch acts 1000 times, and the valve is in the closed state, the leakage of water meter is in accordance with the relevant provisions.

c. In the valve drive system, DC motor is used as the switch of the driving valve of power gear reduction system.

3.1.2 Electronic part design
The system block diagram of electronic parts is shown in figure 6:
3.1.2.1 MCU selection
Basic requirements: low power consumption, ESI interface, LCD driver, ferroelectric storage. By comprehensive considering, MCU is selected as MSP430FR6989.

3.1.2.2 Fault detection and alarm
The control unit has the ability to diagnose a variety of fault conditions and to alarm by closing valves, displays, etc. All the fault information can be fed back to management center.

3.1.2.3 Display interface
The control unit is provided with a button and a liquid crystal display two human-computer interaction means.

3.1.2.4 Calendar clock
The control unit for the accurate realization of the communication window, has the real-time clock. Real time clock directly use MCU built-in clock. At the same time, the system uses a variety of ways to carry out the school, to prevent the disturbance of the clock disturbance, such as meter reading when school, etc.

3.1.2.5 Valve control
The control unit, according to the control command of management center, and the power supply voltage, etc., can effectively and reliably control valve switch, and accurate feedback valve state.

3.1.2.6 Power consumption estimation and power supply scheme
The factors affecting the power consumption of intelligent water meter mainly include two aspects:

a. Water meter standby power consumption
   Due to the use of low power series chip, the chip has power saving mode - sleep mode, and considering other peripherals, standby current is calculated at 15 µA.

b. Spread-spectrum wireless communication power
   If sending information communication on once a day, communication time is 2 s, power consumption of sending information is 2.08uA.

   The average current is 17.08 uA (15 plus 2.08). Assuming that water meter once a month on switch valve action, on-off valve required capacity of 10 years is 8.53mAh. For 10 years, maximum capacity required of the smart water is 1.50Ah. According to the lithium battery operation data accumulated experience, the actual amount of lithium is required to be 2.35Ah. According to the above theory calculation and analysis of power consumption, water meter battery model for the ER18505 lithium battery, 3.6A.H, can meet the water meter 10 years of work.

3.1.2.7 Reading scheme
This paper adopts a new pulse readings - low power solution without magnetic pulse readings (double LC no magnetic pulse readings). Double LC sensor principle block diagram is shown in figure 7:

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**Table 1. Spread spectrum wireless communication performance.**

<table>
<thead>
<tr>
<th>Quiescent Current</th>
<th>≤100uA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Receiving current</td>
<td>≤13.5mA</td>
</tr>
<tr>
<td>Emission current</td>
<td>≤90mA</td>
</tr>
<tr>
<td>Transmit power</td>
<td>10/20/50mW, optional</td>
</tr>
<tr>
<td>Maximum open</td>
<td>3.5KM</td>
</tr>
<tr>
<td>communication distance</td>
<td></td>
</tr>
<tr>
<td>Maximum receiving</td>
<td>-148dBm</td>
</tr>
<tr>
<td>sensitivity</td>
<td></td>
</tr>
<tr>
<td>RF modulation mode</td>
<td>LORA spread spectrum modulation</td>
</tr>
<tr>
<td>Antenna type</td>
<td>Built in ceramic or external sucker</td>
</tr>
</tbody>
</table>
3.2 Concentrator

Concentrator receives the reading information and alarm information of the smart meter, uploads the information to the community management machine (or hand-held acquisition equipment), and receives and executes instructions of the community management machine (or hand-held acquisition equipment). Each concentrator can manage 100 largest smart meter. Figure 8 is concentrator.

Figure 8. wireless concentrator.

The concentrator communicates with the smart meter by 470M wireless spread spectrum LORA communication technology. Performance indicators of the concentrator are shown in Table 2:

<table>
<thead>
<tr>
<th>Main technical parameters</th>
<th>index</th>
</tr>
</thead>
<tbody>
<tr>
<td>power waste</td>
<td>4W</td>
</tr>
<tr>
<td>Number of load</td>
<td>Not less than 100</td>
</tr>
<tr>
<td>Communication mode</td>
<td>470M wireless communication</td>
</tr>
<tr>
<td>Communication distance</td>
<td>Not less than 200m</td>
</tr>
<tr>
<td>service life</td>
<td>&gt;10 years</td>
</tr>
</tbody>
</table>

3.3 Community management machine

The community management machine is connected to the management center and the concentrator, and is the middle station of the system data stream. Figure 9 is the community management machine.

Figure 9. Community management machine.

The function of community management machine is mainly:

- a. Transparent forwarding and timeout monitoring of alarm messages or a single command;
- b. Scheduled group reading: At a set time, community management machine kick in Group reading event, and read all water meter rates reading information.
- c. Bulk update event: update events for all or some of the water meter, for example, the price adjustment, set the unit price, and working mode, etc. Community management machine in the update time arrival, start the concentrator to start the batch update events.

Performance indicators of community management machine are shown in Table 3:

<table>
<thead>
<tr>
<th>Main technical parameters</th>
<th>index</th>
</tr>
</thead>
<tbody>
<tr>
<td>power waste</td>
<td>5W</td>
</tr>
<tr>
<td>Communication mode</td>
<td>Using GPRS with the Management Centre (or CDMA 1X), and using RS485 communication or wireless communications with the concentrators</td>
</tr>
</tbody>
</table>

3.4 Management Center

Management center is the central management platform for intelligent water, and using two front-mounted machine (dual backup) communicates with the community management machine, receives water alarm information or meter reading information from each district. Specific implementation features and performance are as follows:

- a. Abnormal flow, owe cost, and without water alarm;
- b. Remote reading of water meter reading, statistical analysis of water consumption of users;
- c. Generating user water records report and arrears users report;
- d. User data Management;
- e. User meter reading, billing, charging;
- f. The cost of query, online reporting, online business applications and complaints;
- g. Equipment management, billing, security, inspection;
- h. Costs prepaid;
- i. Remote valve control;
- j. Remote switch valve < 6 seconds;
- k. Remote meter reading success rate reached 99%, with 100% accuracy;
- l. The users of the management center can reach more than 500000;
- m. The length of a single user information query < 5 seconds;
- n. The number of concurrent queries in system >100.

4 CONCLUSION

At present the system has run in several large water companies, and various performance indexes meet the design requirements. Meter reading success rate
can reach 100%. The system realize the real time monitoring and centralized management of intelligent water meter accounting information and water use information, get extensive praise from customers, ready to use in large quantities.

REFERENCES

[4] Li Xiangming, Jing Junkai, etc. The development of IC card intelligent water meter based on MSP430F413, Micro computer information, No.17, 2017.