# STUDY ON THE APPLICATION OF DIGITAL IRRIGATION AREA SYSTEM

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*Abstract*: The aim and meaning of study on digital irrigation area are discussed at first. Then the author puts forward the need and feasibility. Taking XueYe reservoir as an example, the software and hardware of digital irrigation area are analyzed and designed, while researching and developing on the key techniques and automatic regulation supervision system. The digital irrigation area software is mainly composed of five modules, which are floodgate control, agriculture-use water management, life-use water management, flood discharge and electricity generation. The hardware system includes the hardware which are installed at the information control and transaction center of chief regulation center, and the systems of floodgate on-off remote sensors, floodgate on-off degree remote sensors, water depth, water quantity and water level remote sensors, electricity generation quantity remote sensors and industry water supply remote sensors. We also designed the software function framework, the hardware constitution, general floodgate flux and distribution of electricity flux, flood discharge flow chart, floodgate on-off degree remote sensors structure chart, floodgate on-off remote sensors structure chart and water depth water quantity remote sensors charts. On this base, the key techniques of digital irrigation area are discussed. Also, we bring forward multi-goal case evaluation method, auto make and inter make method, database technology and modularization management functions. With dynamic supervision on rain and project instances, we can issue alarm information ahead of schedule, and provide supports for scientific decision-making, as while as saving abundant water resource and improving management level.

The project was applied in XueYe reservoir of LaiWu in Shandong Province and achieved good effects.

*Key- Words*: digital irrigation area, data auto-collection, regulation supervision

## FORWORD

It has been a long time since reservoir became main source of agricultural water. But with rapid development of country economy and society, the conflict of water supply and consume stands out increasingly. The lack of water resource has touched our foodstuff directly. The foodstuff output reduces 700 hundred million to 800 hundred million every yeah due to lack of water (Science Publishing Company , 2004). As population increase, industrialization and city boost, the contradiction of water lack will be more outstanding. So saving agricultural water is imperative under the situation, while rebuild conventional management measures and irrigation establishments are essential instruments to realize water saving.

Excessive irrigation water waste, great manpower expenditure and civil bothers due to dated management measures have been difficulties all along. The advent of information age affords opportunity for reservoir irrigation area management. The concept of digital irrigation area is put forward under such background. The aim of digital irrigation area is to actualize dynamic, real time optimize collocation and regulation with the technologies of computer, multimedia, modern communication and scientific computation, starting with auto collection, transmission, storage and disposal of weather, rain, water and water supply (Cui Weihong, 1999). To actualize digital irrigation area construction is certain result from water conservancy acclimation of age development, is main content of information-based water conservancy, is also the only way from traditional water conservancy to modern water conservancy and continuable development (Liang yong, 2002).

In digital irrigation area, digital management measures are used from farmland weather information collection, to irrigation water flux information collection, regulation and operations management etc. By solution of key technical problems for auto inspection and control, real time and dynamic watch is processed on real time rain and water circs and water supply. According to real time circs, alarm information is issued ahead, to provide a platform and supports for experts and leaders decision (LuoYunqi,1999).

We take Xueye reservoir irrigation area as an example in the study. Xueye reservoir irrigation area is one of the large irrigation areas in Shandong Province. It is in the northwest of Laiwu city, span 9 villages and towns and

offices. It is 21.6 km long in south-north, 20.8 km wide in east-west. The designed irrigation area is 305 thousand mu, effectual area is 223 thousand mu. With the bound of Yingwen river, it is divided into two parts: one is from northern hill to Yingwen river, controlled by the west channel, ground slope 1/30～1/600；the other is from Yingwen river to Changbu mountain range of Muwen river, controlled by the east channel, ground slope 1/50～1/200. The constructions include chief channel, east channel, west channel, branch channel, dou channel and farming channel, in which the chief channel is 3.1km long, with 14 constructions; east and west channel are 61.2km long, with 401 constructions; the 10 branch channeles are 48.63km long, with 541 constructions. There are 7 Baxieer water weirs, 8 non-throat water weirs, 2 standard water weirs, 1 farming diffluence water measure meter. The entrance of chief channel is flume. While east and west channel, Hebei management station, the area from Qiguanzhuang management station to Heguanzhuang management station, the area from Heguanzhuang management station to Huzhai management station, the area from Wenshi management station to Gushan management station, the area from Gushan management station to Yuchi management station are all Baxieer water weirs. The area from Kouzhen management station to Qiguanzhuang management station and the area from Yangshan management station to Wenshi management station are all standard water weirs. Other management stations and dou channel entrance are all non-throat water weirs.

## 1. THE SOFTWARE DESIGN OF DIGITAL IRRIGATION AREA SYSTEM

The software of digital irrigation area is composed of five function modules which are floodgate control, agriculture water management, life water management, flood discharge and electricity generation. By the interface with the hardware of the system, the software can realize flux measure, flux control to every floodgate and water weir in the irrigation area. And it may analyze and collect flux data gathered, and realize the aims of agriculture water scientific control, water rate income with flux analysis and statistic modules. Figure 1 is the general framework of the function modules of the software.

### 1.1 Floodgate control management

The floodgate control management module includes chief floodgate control and floodgate status. In chief floodgate control module, water flux is controlled by unlock degree controller of chief floodgate, at the same time,

the corresponding electricity generation sets are turned on according to water flux. In floodgate status module, the open-close command is sent by the software to floodgate according to real time supervision on all floodgates in the area. The distribution of water flow between water gates and corresponding electricity is showed in figure 2.

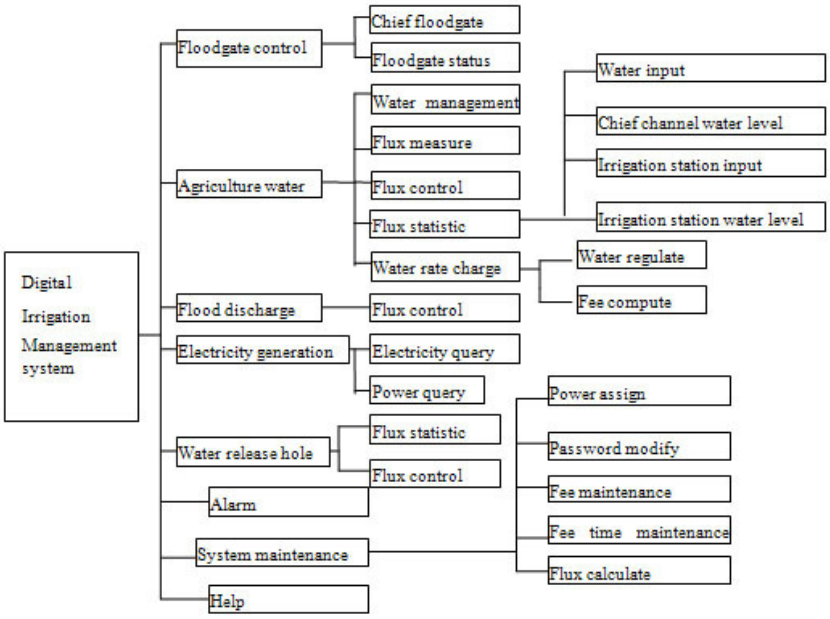


*Fig.1* General framework of the function modules of the software

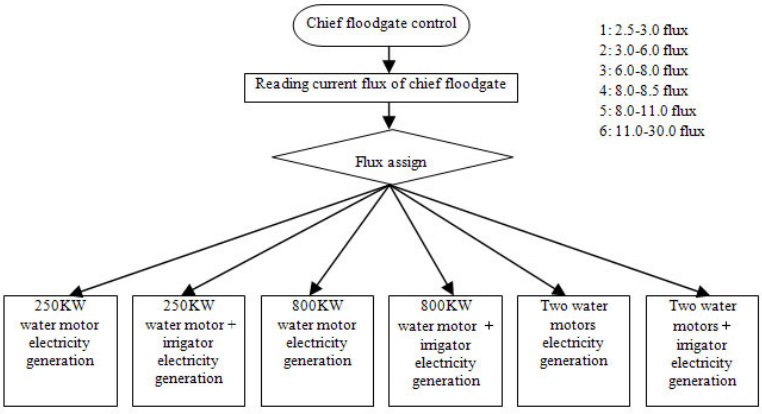


*Fig.2* Distribution of water flow between water gates and corresponding electricity

## 1.2 Agriculture water management

The module of agriculture water management is made up of five child modules which are water administration, flux measurement, flux control, flux statistic and water rate charge. Water administration module supervises the times of agricultural irrigation water every year, start time and end time of each water discharge. Flux measurement module can measure current water depth and flux of water weirs in every irrigation station, and statistic current water wastage in the responsible area of every station. Flux control module accommodates current flux of each station by control the floodgates of east and west channels. Flux statistic module carries out statistic and analysis with graphs on total water input, output, wastage, water level and water flux in each irrigation station of the area. Water rate charge module statistics and charges water rate of each irrigation station in the area, according to its wastage in the year and interrelated national policies.

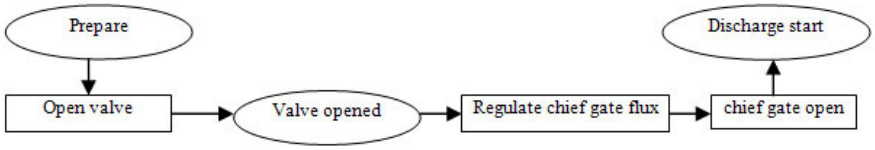


*Fig. 3* Sketch map of flood discharge flow

With agriculture water management module, we can measure, control, statistic and analyze agriculture water so as to realize scientific regulation, reasonable distribution and accurate water rate charge.

## 1.3 Life water management

Life water management module mainly means statistic on city life water flux. Life water flux statistic module summarizes daily water supply and total water supply, according to water consumed which is recorded automatically.

At present, the city of Laiwu is main life water customer of Xueye reservoir, which is about 20% of total input of the reservoir. Life water is principal in water regulation. To analyze history data and arrange the plan reasonably is important measure to ensure life water.

## 1.4 Irrigation area flood discharge management

Irrigation area flood discharge management module is realized by flood discharge flux control module. The flood discharge flux control module supervises current height of flood discharge floodgates and abstention floodgate s. And regulate the height of flood discharge floodgates rationally according to total flood discharge flux of the chief floodgate, to insure that

flood discharge works successfully. Figure 3 indicates the flow of flood discharge.

### 1.5 Electricity generation management

Electricity generation management module includes two child modules, electricity quantity and power enquiry. The module can record electricity quantity of the generators in the area, so that customers can enquire and statistic in time electricity quantity of every generator according to period of time.

The communication part of the software is developed with VC + + language. It can realize effective, reliable rock-bottom data communication and command sending. With wireless data transmission device, the remote sensing points and remote control points are measured and supervised real time. The user interface, which is designed with GUI, expresses the status of floodgate, current water depth and flux of remote sensing points. The interface is kind and convenient for users. Especially, the system is very good at statistic and analysis, so it can query, collect, statistic and analyze water consumed in all periods, and provide supports to scientific and reasonable water regulation.

## 2. THE HARDWARE DESIGN OF DIGITAL IRRIGATION AREA SYSTEM

The hardware system includes the hardware which are installed at the information control and transaction center of chief regulation center, and the systems of floodgate on-off remote sensors, floodgate on-off degree remote sensors, water depth, water quantity and water level remote sensors, electricity generation quantity remote sensors and industry water supply remote sensors. Data is transmitted with wireless signal between information control center and remote sensors. The composition of hardware is showed in figure 4.

Information control and disposal center is composed of prepositive machines, PC and operation desk. The prepositive machine in the center of information receiving and process is processor which transfers in-between data from PC (operation desk) to remote sensing and remote control stations. It is very important in the whole system. It identifies, judges, coordinates and computes wireless data signal sent from remote sensing stations, and send them to PCs. After that, it preprocesses and transfers remote sensing and remote control signal from PC to the remote sensing stations through radio.

PCs mainly complete data store, query and water quantity auto regulation. Operation desk is specially designed for manual operations, on which Chinese LCD screen and operation buttons are fixed. All survey data of the remote sensing and remote control stations can be displayed on the LCD screen to the life. When it needs human to regulate open-close degree of floodgate, all we need to do is to press up or down button. Then we can watch open-close degree of floodgate and change of water level, water flux. At the same time, the change is transferred to PC by prepositive machines so as to deal with the change data.

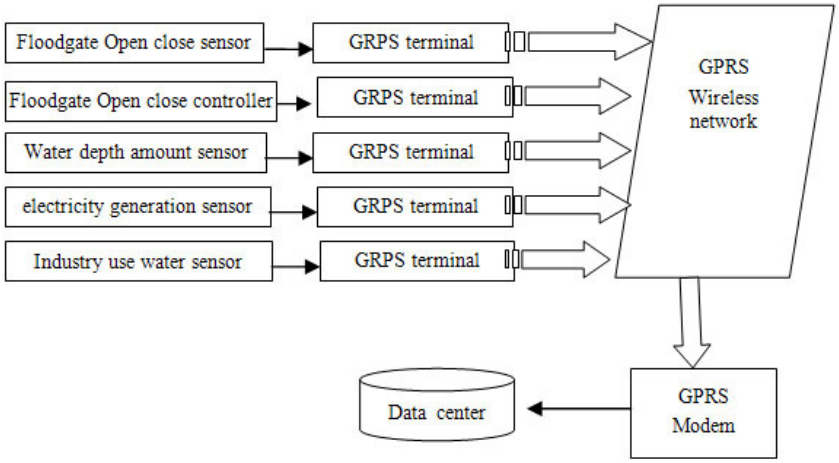


*Fig. 4* Composition of hardware

The main function of remote sensor on open-close degree of floodgate is to convert open-close information detected to digital signal by anti-jamming circuit, and send the data to data center through GPRS wireless data terminal after disposal of data processing circuit. The remote sensor is composed of floodgate unlock sensor, floodgate lock sensor, anti-jamming circuit, data processing circuit, data store circuit, clock circuit, data terminal and etc. Figure 5 is the graph of remote sensor on open-close degree of floodgate.

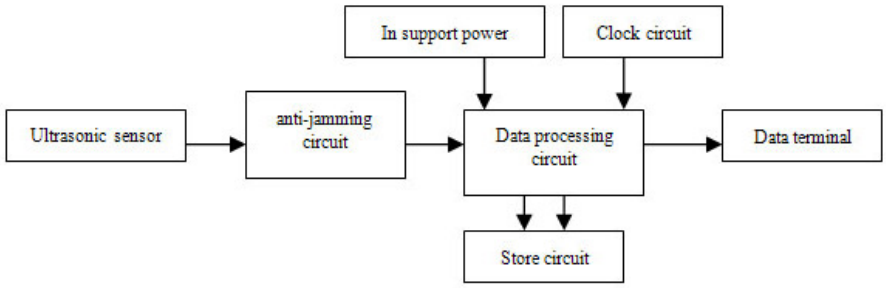


*Fig.5* The remote sensor of the floodgate

The main function of remote controller on open-close degree of floodgate is to receive floodgate control signal from data center and open and close floodgate according to control information. The remote controller on open-close degree of floodgate is composed of GPRS wireless data terminal, data analysis and processing circuit, floodgate up and down circuit, direction shift delay circuit, over load and over flow protection circuit. Figure 6 is the graph of remote controller of floodgate.

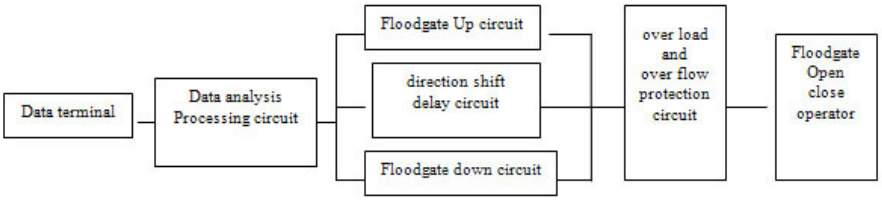


*Fig.6* The remote controller of the floodgate

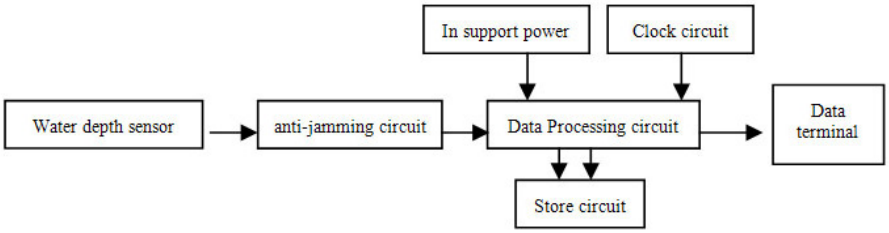


*Fig.7* Remote sensor of water depth and amount

Remote sensor of water depth and amount is made up of water depth sensor, anti-jamming circuit, data processing circuit, store circuit, clock circuit, GPRS wireless data terminal and etc. The structure of remote sensor of water depth and amount is showed in figure 7. The main function of remote sensor of water depth and amount is to measure water depth of the channel by ultrasonic sensor, and calculate flux according to prepared depth-flux curve. It measure every 6 second, and send the change data to data center when water depth changes.

The remote sensor of electricity generation and industry water supply is same as remote sensor of water amount except sensor configuration.

Video monitor is specially designed to improve dependability of the system. Video monitors are installed at important places such as east offset, west offset, chief channel, east channel and west channel. When operate the floodgates of these places, cameras record the operation signal, and transfer it to supervisor in information processing center, which enhances fidelity of the system.

# 3. KEY TECHNOLOGIES OF DIGITAL IRRIGATION AREA SYSTEM

## 3.1 Multi-aim plan evaluation method

Multi-aim plan evaluation method adopts multi-aim fuzzy optimized decision-making model. Considering experiences, regulation decision-making people confirm power of qualitative aim with duality, and evaluate multi-aim regulation project quantificationally with the model. The model combines traditional optimize technology and the new theory fuzzy mathematics so as to consider multi-aim in decision-making.

Multi-aim project regulation decision-making model, considering the complexity of different water situation and customers of auto control and regulation for the irrigation area, analyzes water supply aims in all phases of auto control and regulation to confirm power value of the phases. After that, it synthesizes the supply aims in all phases as one aim, and gets optimal regulation plan. The main characteristic of the method is that the decision-making model is more theoretical and effective, because it confirms power according to fuzzy theory.

## 3.2 Auto created and alternating created regulation project

The system investigates two ways, auto created and alternating created, to provide auto inspection regulation project. Auto created project is created automatically according to real time course of water supply. Alternating created project can regulate according to water supply in period of time and alternating open or close water supply devices. It is very convenient and visual to create a project. When a new regulation project is created, regulator only needs to fill a form on the screen. When a regulation project needs to be modified, regulator only needs to fill a form on the screen too.

## 3.3 Database technology and modularization management function

The irrigation area auto supervision and regulation system is on the base of database. With multi user system in network, the system should be able to suit all complex situations. Modularization management can be realized only when the problem of water supply regulation is solved effectively. While the only effective way to solve the problem of water supply regulation is to design and manage database aboratively. When designing database, we

should consider real banausic need fully and make full use of potential of database function.

## 4. CONCLUSIONS

At present, the auto supervision and regulation system of reservoir irrigation area, designed and researched independently according to above advanced technology and theory, is put into practice and achieved good effect. Nowadays, the technologies of information auto collection, database, simulation, computer and other high techs are developing rapidly. Taking the characteristics of water supply into account, we design and research the hardware and software according as standardization. Aiming at influence of real time water supply error, the system can modify real time in self adapt way. The efficiency of system design is improved. The measure precision of the system is assured. The system has important effect on scientific and reasonable regulation decision-making of reservoir irrigation area.

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