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The Agricultural Irrigation District Information System Based on Multi-Agent

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Abstract

Irrigation district informative construction is an effective way to improve the management and to rational allocate and effectively utility irrigation water resources. This paper is directed against the characteristics such as large-scale monitoring data amount, complex data types, high real-time requirement, strong spatial correlation, etc. combine Multi-Agent theory with irrigation district information system together, and use GSM communication network as the communication network of system, established an agricultural irrigation district information system based on Multi-Agent and GSM, which can full utility intelligent of Agent and the good communication coordination of Multi-Agent system, so to provide comprehensive technical support for irrigation management and decision making.

Keywords: *Multi-Agent; GSM; agriculture irrigation; information system*

1. Introduction

Irrigation district information has developed for decades, and has realized the modernization of the irrigation district management [1] in different extent. However, the irrigation district information still has some problem such as insufficient water resources information monitoring, information resource sharing difficulties, standard specification for incomplete, the lack of spatial information technology application, lower management efficiency, etc. make scientific and accurate decision-making of irrigation district management is greatly reduced [2].

This paper is directed against the characteristics such as large-scale monitoring data amount, complex data types, high real-time requirement, strong spatial correlation, etc. will combine Multi-Agent theory with irrigation district information system together, and use GSM communication network as the communication network of system, establish an agricultural irrigation district information system based on Multi-Agent and GSM. Thus can integrate and improve agricultural irrigation district information system, complete the overall sharing and depth application of all kinds of water conservancy management of data irrigation area, realize the irrigation gate monitoring, pump station monitoring, water rate collection and other automation management, so as to provide comprehensive technical support of irrigation management and decision making.

2. The Agriculture District Information System Based on Multi-Agent and GSM

2.1. The Target and Task of Constructing the Agricultural Irrigation Information System

The irrigated district information construction is an important content of the construction of water conservancy information. The irrigated district information is to use modern information technology, in-depth develop the information resources of irrigation district management, realize real-time information collection, transmission, storage and processing, and make timely feedback and prediction accurately, and provide scientific basis for decision-making for the irrigation management department, so as to improve management efficiency, reduce management cost, promote the realization of scientific and high efficiently management process of irrigation district [3]. The overall structure of the irrigation district information system is shown in Figure 1.

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The goal of Agriculture irrigation district information construction is to use advanced data acquisition, transmission and processing methods, establish an water conservancy management information system that can improve management level of irrigation district, promote the optimization and upgrading of irrigation district technology and improve the efficiency of water use, put forward quickly scheduling scheme for the optimal allocation and high utilization of irrigation water resources, flood forecasting and warning, safety measures taken of fighting against flood, and provide support for flood control decision-making. The task of system construction is as follows:

(1) Establish irrigation information monitoring, acquisition system;
(2) Establish database and management system of irrigation district;
(3) Establish water rate management system of irrigation area;
(4) Establish video monitoring system of important gate and hydraulic structures of irrigation district;
(5) Establishment automatic control system of gate;
(6) Establish irrigation district e-government information management system;
(7) Establish irrigation district public information service system.

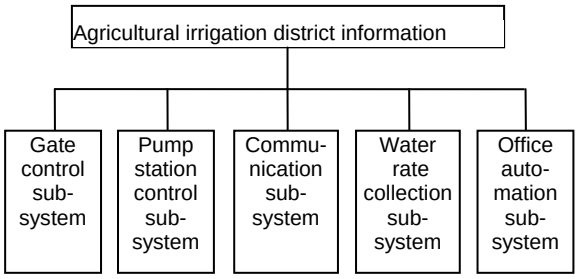

Figure 1. The Structure of Agricultural Irrigation District Information System

2.2. The Construction of Agricultural Irrigation Information System Based on Multi-Agent and GSM

2.2.1. The System Model of Agricultural Irrigation Information System Based on Multi-Agent and GSM

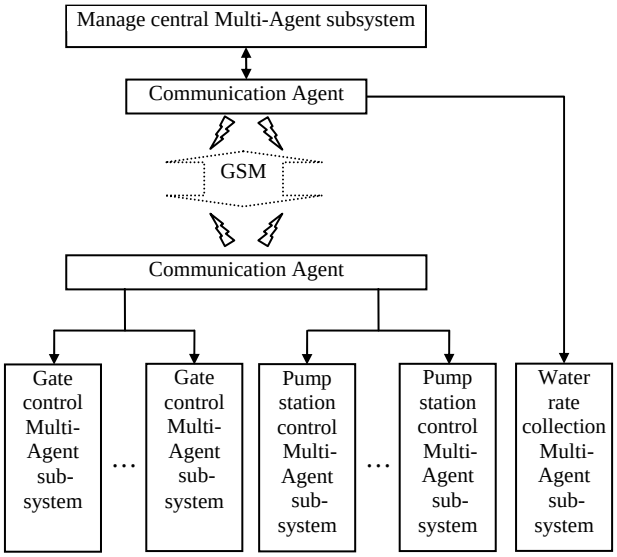

Figure 2. The Structure of Agricultural Irrigation District Information System Based on Multi-Agent

According to the function of agriculture irrigation district information system, agricultural district information system based on Multi-Agent and GSM can be constructed as shown in

Figure 2. The agricultural irrigation district information system based on Multi-Agent and GSM is composed of three levels. The top layer is the management center Multi-Agent subsystem; The middle layer is the communication layer, which is composed of two communication Agent and GSM network, the lower layer is the gate monitoring and control Multi-Agent subsystem, pump station monitoring control Multi-Agent subsystem and water rate collection Multi-Agent subsystem [4, 5].

2.2.2. The Structure Model of each Subsystem

(1) Management Center Multi-Agent subsystem

The management center Multi-Agent subsystem lie in the top layer of whole system, mainly used to realize the communications between this system and upper irrigation district management department, at same time, manage and coordinate other Multi-Agent subsystem to realize the dispatcher task of irrigation district. The management center Multi-Agent subsystem is composed of a central control management Agent (CCM-Agent), human-computer interaction Agentm (HCI-Agent), data storage Agent (DS-Agent), information storage Agent (IS-Agent). The structure is shown as Figure 3. CCM-Agent realize the coordinated management of the entire subsystem, and to establish contact with the outside world; HCI-Agent realize interactive function between the operator and the computer, provides the service for the operator to carry out the operation and control; DS-Agent analysis, deal with and storage the information data from every lower subsystem; IS-Agent storage relevant information such as all gates, all pump stations and other monitoring facilities in irrigation district.

(2)The water rate collection Multi-Agent system

The water rate collection Multi Agent subsystem lie in the lower layer of the whole system, mainly use to realize the task of irrigation water rate collection, which is composed by water rate management Agent (WRM-Agent), water rate calculation Agent (WRC-Agent), water rate storage Agent (WRS-Agent), water rate inquire Agent (WRI-Agent), water rate collection Agent (WRCo-Agent), water rate online payment Agent (WROP-Agent), WRM-Agent mainly realize the coordinated communication between internal Agents of subsystem; WRC-Agent calculate corresponding water rate according to the water using information and water price information; WRS-Agent storage water rate and its collection information according to the water rate that WRC-Agent has calculated; WRCo-Agent realize the collection of water rate; WRI-Agent can provide the water rate inquire service for user, WROP-Agent can meet the demand of network payment. The concrete structure is shown as Figure 4.

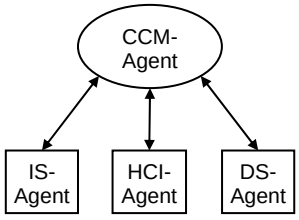

Figure 3. The Structure of Management Center Multi-Agent Subsystem

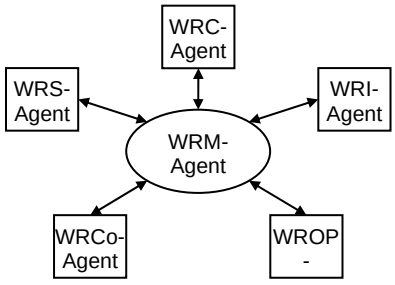

Figure 4. The Structure of Water Rate Collection Multi-Agent Subsystem

(3) Communication layer

Between management center Multi-Agent subsystem and the lower gate monitoring Multi-Agent subsystem, pump station monitoring and management Multi-Agent subsystem is the communication layer. The communication layer is composed of two communication Agent and GSM communication network, the main task is to implement communication between management center Multi-Agent subsystem and other Multi-Agent system at lower layer.

(4) Gate monitoring Multi-Agent subsystem

The gate monitoring Multi-Agent subsystem lie in the lower layer of whole system, mainly realizes the monitoring and control functions to the irrigation district gate, which is

composed by gate management Agent (GM-Agent), gate monitoring Agent (GMo-Agent), gate control Agent (GC-Agent), optimization calculation Agent (OC-Agent), information storage Agent (IS-Agent), data storage Agent (DS-Agent). GM-Agent realize the communication coordination functions to the whole sub system; GMo-Agent realize the monitoring function to the gate, monitoring the running status, and extract the corresponding data; GC-Agent carry on the real-time control to gate according to the control information sent by GM-Agent; OC-Agent calculate the real-time optimization scheduling scheme according to the water yield dispatching information sent by GM-Agent; IS-Agent store relevant information of gate; DS-Agent store relevant scheduling information between gate opening and water yield. The concrete structure is shown as Figure 5.

(5)Pump station monitoring Multi-Agent subsystem

Pump station monitor Multi-Agent subsystem is lie in the system layer, mainly realizes monitoring, management, control function to irrigation pump stations, which is composed of the pump station management Agent (PSM-Agent), optimization calculation Agent (OC-Agent), information storage Agent (IS-Agent), data storage Agent (DS-Agent), water pump monitoring Agent (WPM-Agent), water pump control Agent (WPC-Agent). PSM-Agent realize the communication coordination function of the subsystem interval; OC-Agent carry on optimal calculation among all pump units according to the task of water diversion that M-Agent issued; IS-Agent is used to store the relevant information of internal pump units; DS-Agent is used to store the optimization calculation results data and related data that pump station operate and control; WPM-Agent is mainly used for monitoring running state of each pump unit, and extract the corresponding data information; WPC-Agent carry on control to each pump unit according to the scheduling control information that calculated by OC-Agent. The concrete structure is shown as Figure 6.

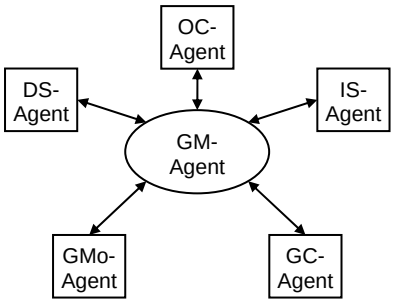

Figure 5. The Structure of Gate Monitoring and Control Multi-Agent Subsystem

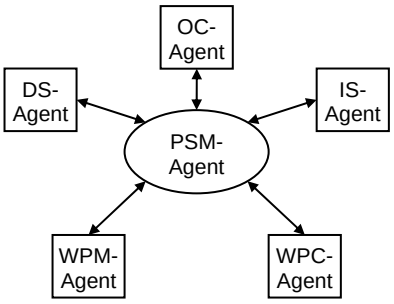

Figure 6. The Structure of Pump Monitoring and Control Multi-Agent Subsystem

2.2.3. The Classification and the Internal Structure of the Agent in System

According to the system structure, all Agents can be divided into three categories, one category is management Agent, namely CCM-Agent, WRM-Agent, GM-Agent, PSM-Agent four Agent. Management Agent's task is mainly through coordination all the function Agent within the subsystem to realize the whole system task; The second category is the communication Agent, there are two communication Agents in the system, which sent the layer data information reorganized to management central Multi-Agent at first, on the other hand, analyzed and classified the data information from management central Multi-Agent subsystem, then send them to lower layer corresponding Multi-Agent subsystem; The third category is the function Agent, namely HCI-Agent, DS-Agent, IS-Agent in management central Multi-Agent subsystem, WRC-Agent, WRS-Agent, WRI-Agent, WRCo-Agent, WRIP-Agent in water rate collection Multi-agent subsystem; GM-Agent, GC-Agent, OC-Agent, IS-Agent, DS-Agent in gate monitoring Multi-Agent subsystem; OC-Agent, IS-Agent, DS-Agent, WPM-Agent, WPC-Agent in pump station monitoring Multi-Agent. Each function has its own function need to realize separately. According to the task of every Agent, need to build every Agent's internal structure. Each Agent internal structure generally includes several function modules and one data model, each function module is responsible for the realization of the corresponding function, data model used

to store various information of Agent itself and the entire system. The general internal structure of Agent as is Figure 7 shows.

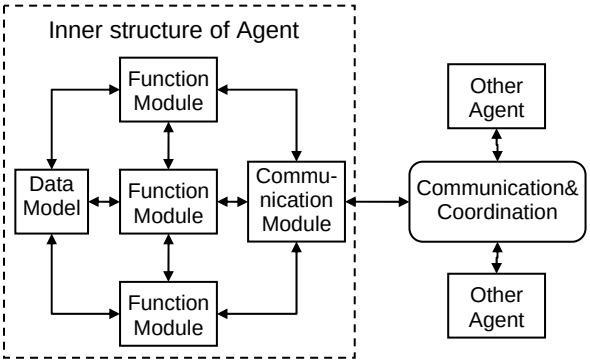

Figure 7. Inner Structure of Agent

2.2.4. The Realization Procedure of System Function

According to the ensemble structure of system and the structure of every subsystem, the realizaiton precedure of agriculture irrigation information system function based on Agent and GSM are as follows:

S1: The CCM-Agent of Management Center Multi-Agent subsystem accept water resources scheduling information from the upper level dispatch center control, then sends the information to the communication Agent ①;

S2: Communication Agent ①, through GSM network, sends the scheduling information accepted to the communication Agent ②;

S3: Communication Agent ② analyze and classify the scheduling information accepted, send to the gate monitoring and pump station monitoring Multi-Agent subsystem respectively;

S4: Gate monitoring and pump station monitoring Multi-Agent subsystem carry on scheduling calculation according to the scheduling information received, the details are as follows:

Gate:

GS_1: GM-Agent receiving scheduling information, and sends it to the DS-Agent;

GS_2: DS-Agent query in the database according to the scheduling information, if there are corresponding scheduling control information of gate, directly transfer and send it to GM-Agent, then execute step PS5; if there is no corresponding scheduling control information, then feedbake the messege of " No" to the GM-Agent

GS_3: GM-Agent sends the scheduling information to the OC-Agent;

GS_4: OC-Agent carry on optimal calculation according to the scheduling information, work out the control scheduling results of every gate, and sends it to GM-Agent;

GS_5: GM-Agent sends the scheduling control information accepted to GC-Agent;

GS_6: GC-Agent carry on the real-time scheduling control to gate, and send the information of "Begin operation" to GM-Agent;

GS_7: GM-Agent sends the implementation monitoring task to GMo-Agent;

GS_8: GMo-Agent start to real-time monitor the operation conditions of the gate, and feedback the monitoring information to GM-Agent;

GS_9: GM-Agent will send the monitoring information accepted to IS-Agent, which memory the information; on the other hand, feedback these information to upper ayer addition to monitoring information feedback to the management center Multi-Agent subsystem by the communication layer.

Pumping station:

PS_1: PSM-Agent receiving scheduling information, and sends it to the DS-Agent;

PS_2: DS-Agent query in the database according to the scheduling information, if there are corresponding scheduling control information of every pump, directly transfer and send it to PSM-Agent, then execute step PS5; if there is no corresponding scheduling control information, then feedbake the messege of “No“ to the PSM-Agent

PS_3: PSM-Agent sends the scheduling information to the OC-Agent;

PS_4: OC-Agent carry on optimal calculation according to the scheduling information, work out the control scheduling results of every pump, and sends it to PSM-Agent;

PS_5: PSM-Agent sends the scheduling control information accepted to WPC-Agent;

PS_6: WPC-Agent carry on the real-time scheduling control to pump, and send the information of"Begin operation" to PSM-Agent;

PS_7: PSM-Agent sends the implementation monitoring task to WPM-Agent;

PS_8: WPM-Agent start to real-time monitor the operation conditions of the pump, and feedback the monitoring information to PSM-Agent;

PS_9: PSM-Agent will send the monitoring information accepted to IS-Agent, which memory the information; on the other hand, feedback these information to upper layer addition to monitoring information feedback to the Management Center Multi-Agent subsystem by the communication layer.

S5: The CCM-Agent of Management Center Multi-Agent subsystem accept the data and information of lower subsystem feedback from communication Agent, and carries on the analysis and classification, sends the pumping station and gate operation information to the IS-Agent, the IS-Agent stores these information; sends the user-water yield corresponding data to water rate collection Multi-Agent subsystem;

S6: The WRM-Agent of the water fee collection Multi-Agent subsystem receives the corresponding user-water yield corresponding relation data, and sends it to the WRC-Agent;

S7: WRC-Agent work out the user should pay the water rate data according to user-water yield corresponding relation data, and then sends it to WRM- Agent;

S8: WRM-Agent sends the data that the user should pay water rate toWRS-Agent, WRI-Agent and WRCo-Agent;

S9: WRS-Agent stores the data that user should pay water rate; WRI-Agent provide the query service for user; WRCo-Agent carry on the water rate collection according to the data that user should pay water rate.

It can be seen from the system function implementation steps, multiple functions Agent perform their tasks at the same time, in each subsystem, multiple function Agent realize the function of the whole subsystem through the coordination and management of management Agent; The management Agent service for function Agent, and realizes own function; Communication Agent provide the communication service between upper and lower layer.

4. Conclusion

Irrigation district information has developed for decades, has realized the modernization of the irrigation district management in different extent. However, the irrigation district information still has some problem such as insufficient water resources information monitoring, information resource sharing difficulties, standard specification for incomplete, the lack of spatial information technology application, lower management efficiency, etc. make scientific and accurate decision-making of irrigation district management is greatly reduced. This paper is directed against the characteristics such as large-scale monitoring data amount, complex data types, high real-time requirement, strong spatial correlation, etc. combined Multi-Agent theory with irrigation district information system together, and used GSM communication network as the communication network of system, establish an agricultural irrigation district information system based on Multi-Agent and GSM. This system fully uses the intelligent of Agent and the good communication coordination of Multi-Agent system, so as to enhances the communication and data management speed of agriculture irrigation district information system, which improves the real-time monitoring and scheduling of irrigation district water resources

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