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Multi-Agent Systems for Control and Monitoring of Dams

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Abstract:

In AI, Multi Agent System (MAS) approach is used by many applications such as in robotics, communication network and in vehicles management. In this paper, author proposed a model of intelligent agents to assist the operator in analyzing the level of water in a Dam, and helps in supplying of waters towards power station or lake. The problems which are encountered in development, working, controlling and monitoring of large Dams are: cost, manpower and assessment of level of water. In this paper, the working of proposed MAS is represented in two fold; firstly Assessment Agent, analyze the level of water in lake according to define validation rules and secondly data is collected from water supply agent and power station agent. This model helps to improve and synchronize the management and control process of water of different Dams.

Keywords: Cost, Control Process , Multi Agent System , Intelligent Agent

1. Introduction

In Artificial Intelligence, an Intelligent Agent is anything that can be viewed as perceiving its environment through sensors and acting upon that environment through effectors [7]. In AI, intelligent agents are used in many disciplines. The multi-agent systems presents fancy structure for a decentralized control system, with special attributes like autonomy, an adaptively and communication. The multi-agent system comprises on number of agents, which perform its own function and communicate and interact with each other. Dams are built to irrigate agriculture, domestic use, generate hydropower and controlling floods.

The last century saw a rapid increase in large dam building. By 1949 about 5,000 large dams had been constructed worldwide, three-quarters of them in industrialized countries [5]. Number of manpower is needed to operate the working of Dams and control the supplying of water and generation of hydropower. The purpose of proposed research work is to reduce the manpower cost and synchronize the control and monitoring process of Dams.

2. Intelligent Agents

In AI, Intelligent Agent is used to observe and act upon an environment to achieve some predefine goals. Intelligent agent may have ability to learn from its environment. In computer science, an intelligent agent is referred to as software agent while in economic it is referred as agent. A simple agent is also known as agent function which maps every possible percept percepts sequence to a possible action. Agents are classified as physical agent, temporal agent, spatial agents, processing agents, learning agents, decision agents and believable agents. The environment of an agent can be define in different way such as observable or partially observable, deterministic or stochastic, episodic or sequential, static or dynamic, discrete or continuous and single agent or multi agents [6].

3. Multi-Agents System

The Multi-Agent Systems (MAS) presents newly structure for a decentralized control system, with special attributes like autonomy, an adaptively and communication. A MAS is combination of loosely coupled network of problem solver (agents) that interact with each other to solve a problem. The characteristic of a MAS are [4] :

- Incomplete information to solve a problem
- No global control.
- Decentralized Data
- Asynchronize computation

4. Introduction of Dams

Dams are built for irrigated agriculture, domestic use, generate hydropower and controlling floods. The last century saw a rapid increase in large dam building. By 1949 about 5,000 large dams had been constructed worldwide, three-quarters of them in industrialized countries [5]. The surrounding issues of Dams are actually reflection of

surrounding of issues of water. The issues of Dams are river flow, right access of water and river resources. Economic growth has two implications for water demand. The first is that increased economic activity will increase the demand for water-related services and the second is that both the development brought about by economic growth and the technological changes.

Dams are considered as an important means of meeting perceived needs for water, and energy services and as long-term, strategic investments with the ability to deliver multiple benefits, such as large public infra-structure projects.

As compared to others, hydropower is considered as clean, low-cost, renewable source of energy that relies on proven technology. The problems which are encountered for large Dams are cost, physical transformation of river, ecosystem impacts and manpower [5]. The working of Dam is related with two main issues which are: Validate the need for water and energy services and identifying the preferred development plan [1].

5. The architecture of suggested MAS

The architecture of proposed MAS comprise on three agents: Assessment agent, Water supply agent and Power station agent. Figure-1 represents the general architecture of proposed MAS.

The sensors of Assessment agent receive inputs periodically, and analyze the level of water in lake according to defined validation rules.

When level of water becomes high , then assessment agent search for inputs of power station agent. If there will be any request from power station agent side, then assessment agent will cooperates with it and flow of water will be toward the power station otherwise assessment agent will cooperate with the power supply agent and flow of water will be towards lake.

The steps to represent the whole working functionality of MAS are:

i. Assessment Agent use sensor to assess the level of water in lake through some validation rules.
ii. If it is high then Assessment agent cooperates with the power station agent otherwise no cooperation.
iii. If there is a request from Power station Agent then Assessment Agent cooperate with it otherwise Assessment agent cooperate with Power Supply agent to reduce the level of water in lake.

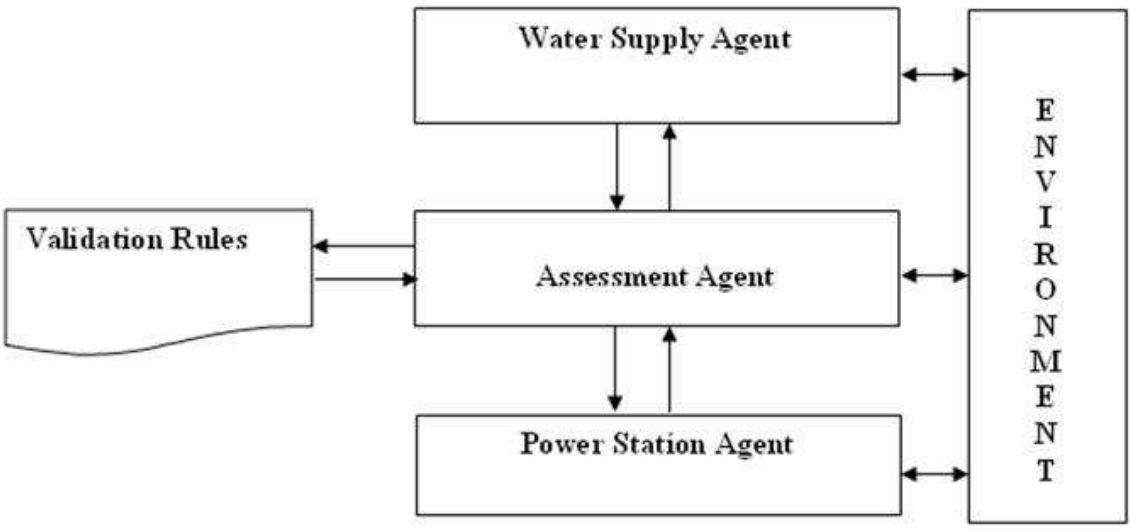


Figure-1: Architecture of Suggested MAS

The cooperation flow of information among agents of proposed MAS is represented in Figure-2.

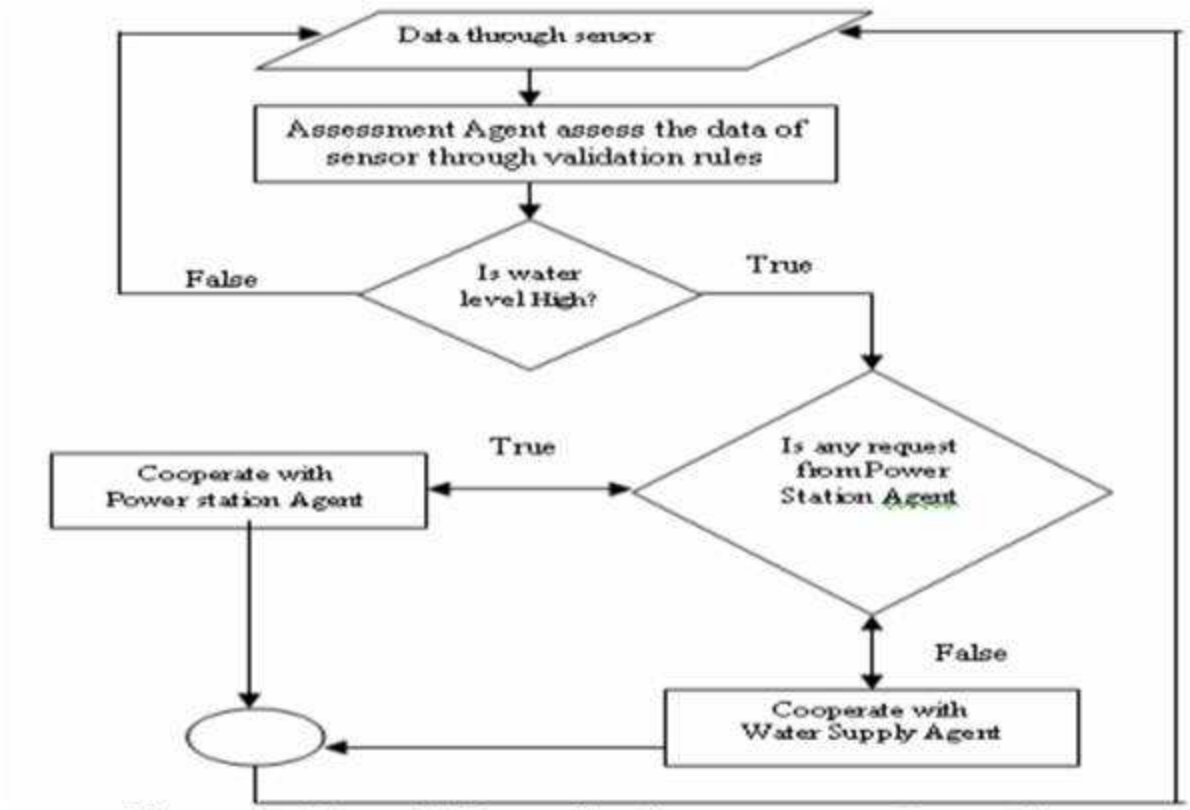


Figure-2. Flow of information from one agent to another

5.1 Assessment Agent:

The assessment agent operates in a manner designed to be very user friendly. It maintains the agent list, remembers the role of each agent and controls all of the agents. The assessment agent use sensor to assess the level of water in lake (Water Reservoir) through some validation rules which are defined in the database. When the level of the water becomes high, then the assessment agent searches for inputs from power station agent. If there will be any request from power station agent side, then assessment agent will cooperates with it and flow of water will be towards the power station, otherwise the assessment agent will cooperate with the power supply agent and flow of water will be towards canals.

5.2 Water Supply Agent

This agent operates when user request the water supply to the specific canal. It then requests to the assessment agent for cooperation. It also maintains records about water supply to canals, lake and power station.

5.3 Power Station Agent

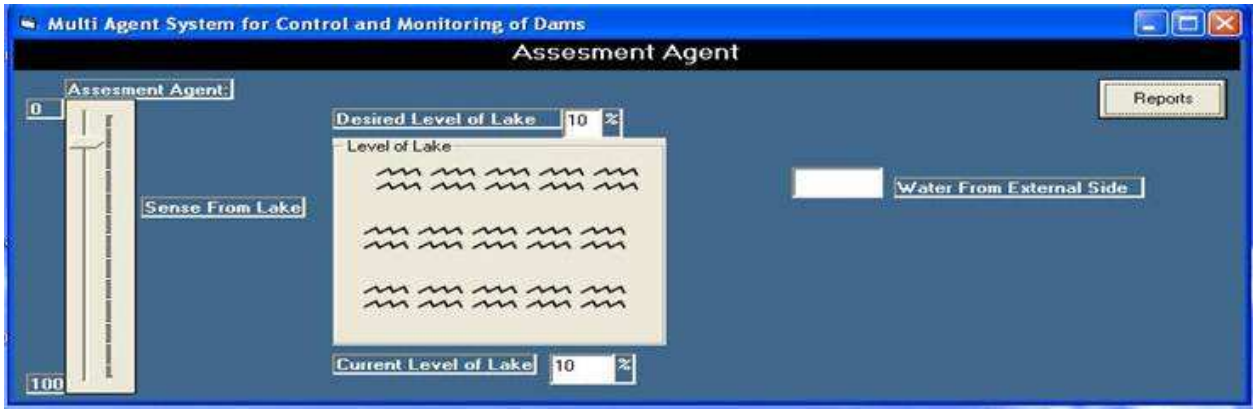
This agent operates when user requests the water for power station. It then requests to the assessment agent for cooperation. It also maintains records about power generation.

6. Demo for proposed model by software

The whole working process for MAS can be represented by means of software demonstration, the working functionality of Assessment Agent, Power station agent and report agent is given in detail in snapshot form.

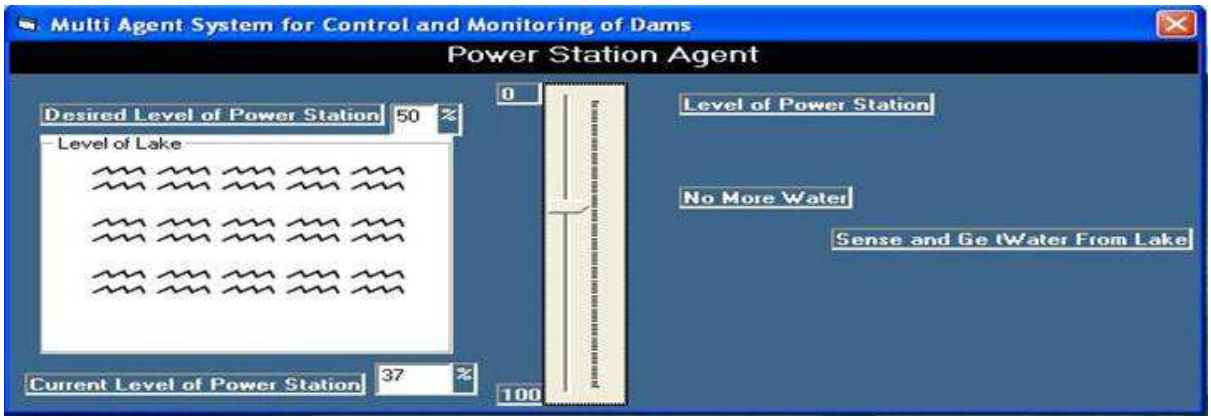
6.1. Assessment Agent Form

This form shows the current water level of lake and desired level of lake. If the water from external side arrives then water level increases which is shown on the sensor and value of sensor increased.



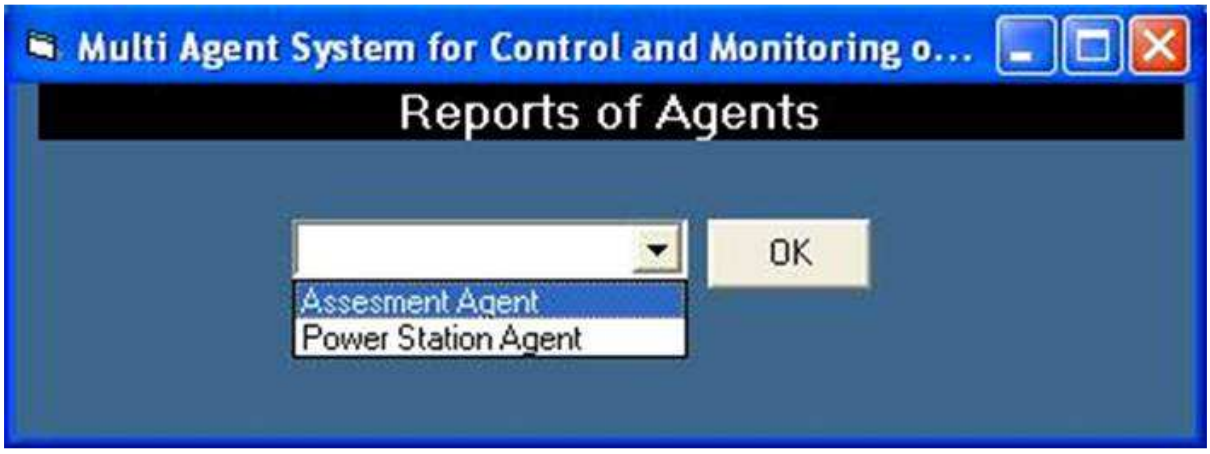
6.2. Power station Agent Form:

This form shows the current and desired levels of the water and sensor shows the water level is less than desired level then it automatically request to assessment agent to provide water.



6.3. Reports Form:

This form is used to generate the results of each agent through reports.



6.3.1. Final Results via reports:

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Assesment Agent

Date	Time	Water in Percentage
1-Mar-09	16:55.34	2
1-Mar-09	16:55.50	10
1-Mar-09	16:56.36	3
1-Mar-09	17:09.38	2
1-Mar-09	17:09.45	7
1-Mar-09	17:09.59	5
1-Mar-09	17:33.31	5

Report-1: Assesment Agent

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Power Station Agent

Date	Time	Water in Percentage
1-Mar-09	16:55.41	2
1-Mar-09	16:56.06	6
1-Mar-09	16:56.28	4
1-Mar-09	16:56.42	3
1-Mar-09	17:33.53	5

Report-2: Power Station Agent

Conclusion:

The multi-agent system comprises on number of agents, which perform its own function and communicate with each other. Dams are built for irrigated agriculture, domestic use, generate hydropower and controlling floods. The problems which encountered in development, working, controlling and monitoring of large Dams are cost, manpower and assessment of level of water. The author proposed model to overcome these drawbacks.

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