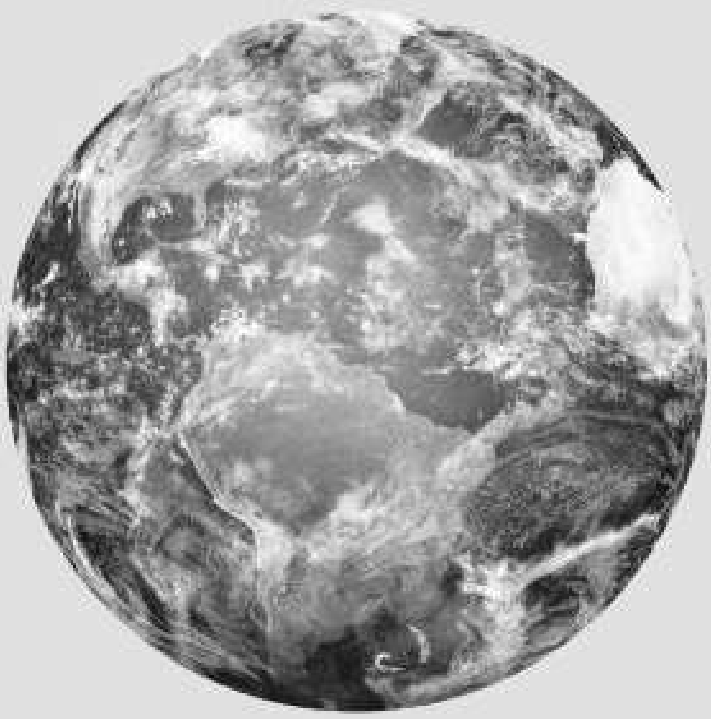
ERSD 2018

KỶ YẾU

HỘI NGHỊ TOÀN QUỐC
KHOA HỌC TRÁI ĐẤT VÀ TÀI NGUYÊN VỚI PHÁT TRIỂN BỀN VỮNG

Hà Nội, 07 - 12 - 2018

CƠ ĐIỆN



Nhà xuất bản giao thông vận tải

Decision support system for small hydropower systems

Nguyen Duc Khoat [1,*] , Ha Van Thuy [1]
[1] *Trường Đại học Mỏ - Địa chất*

ABSTRACT

In this paper, we consider a decision support system for small hydropower systems with the implementation of more advanced rescheduling, control and forcasting in small hydroelectric system. This model is being designed to address both current and future needs of small hydroelectric system toward improving productivity and minimizing cost through information flow between each component in the operation.

Keywords: Real time rescheduling, Control system, Genetic Algorithm

1. Introduction

Since the early 1970s, decision support systems (DSS) technology and applications have evolved significantly. Many technological and organizational developments have made an impact on this evolution. Initially, DSSs possessed limited database, modeling and user interface functionality, but technological innovations enabled the development of more powerful DSS functionality (J. P. Shim, 2002). DSSs are, in fact, computer technology solutions that can be used to support complex decision making and problem solving. Decision making is the study of how decisions are actually taken, and how they can be better, or more successfully taken (B. Roy, 1993).

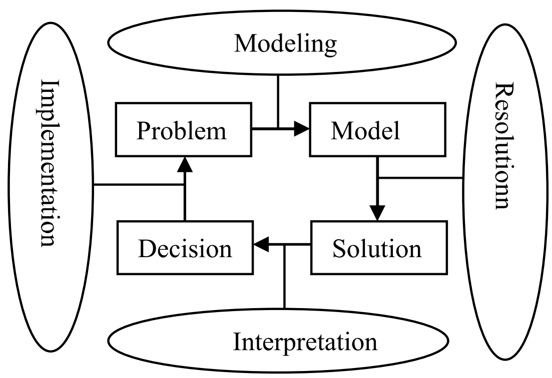


Fig. 1 DSS decision-making

In a DSS decision-making process (Fig. 1), once the problem is recognized, it is defined in terms that facilitate the creation actors and of the concerned entities, the definition of the decision horizon, of the parameters and the constraints, and also the criteria formalization. The resolution stage imposes a choice of an exact or a heuristic algorithmic approach. A set of decision proposals is then established through the interpretation stage and presented to the concerned actors. The final implementation stage consists in applying the operational decisions, supervising their impacts, taking corrective actions, and validating the decisions. Carlsson and Turban in (C. Carlsson, 2002) state that modern support systems research is focused on the theory and application of intelligent systems, and soft computing in management. This includes processes of problem solving, planning, and decision making. The context for this research ranges from strategic management, business process re-engineering, effective collaboration, improved user-computer interfaces, and mobile and electronic commerce to production, marketing, and financial management. The methodologies that are used may be analysis or system-oriented, action research or case-based, or they may be experimentally or empirically focused. An emerging common denominator for many field studies, favored in DSS, is the design and use of intelligent (expert systems, multi-agent

* *Tác giả liên hệ*
Email: nguyenduckhoat@humg.edu.vn

systems, etc.) and/or soft computing systems (evolutionary algorithms, fuzzy logic, etc.). Moreover, in the architectures of DSSs, the complexity reduction tools should not curb the combinatorial capabilities of the system (I. A. Meystel, 2001). For instance, when dealing with a DSS, such as on production scheduling systems (PSS), the modeling approaches and the resolution tools are based on the study and the analysis of concrete cases coming from real problems. Hence, we consider the combined task which includes "satisfaction needs cooperation needs computational complexity reduction," as the major capability of such a DSS

The following qualities of DSS architecture can be measured:

- Complexity Reduction: Traditionally, assignment and scheduling decisions are made separately at different levels of the PTS framework. The combining of such decisions presents additional complexity and new problems. This complexity should be evaluated and, if possible, reduced.

- Multi-model Systems: Multi-model techniques provide intelligent systems designers with approaches to perform simultaneously structural and parameter identification. Until now, we have not known how many models an intelligent DSS should have.

- Multi-cooperation Systems: Multi-cooperation methods (FL, EA, agents) have applications in many real-world contexts because humans are forced to choose among solutions that vary in performance with respect to multiple competing objectives. The degree of cooperation of an intelligent DSS is still unknown.

- Functionality Increase: For example, in the case of PSS, increase in functionality, model generation, and planning specification interaction and performance along each of these directions may need to be compromised to satisfy specifications. Definitely, an ability to evaluate functionality would be an advantage, but the list of specifications is often unknown.

- Intelligence Degree (I. A. Meystel, 2001): A measure of intelligence is presumed to be known. Key ingredients for intelligent systems are knowledge representation structures and methods to adapt these structures.

- Autonomy Degree: The main idea is to produce multidimensional partitions of the DSS and then to assign actions to each of them. A measure of autonomy is presumed for the DSS for each partition (model, method) to decide their own courses of actions.

- Increase in success probability (I. A. Meystel, 2001): The DSS success evaluation depends on the ability to specify it. In nature, intelligence evolution can be demonstrated as the development of the survival tools.

In the paper, we begin Section II by show components of the DSS for small hydropower systém and then some conclusions are finally shown in Section III.

2. Decision support system for small hydropower systems

The structure of the system includes the following (Fig. 2):

2.1. Hydro-turbine governing module

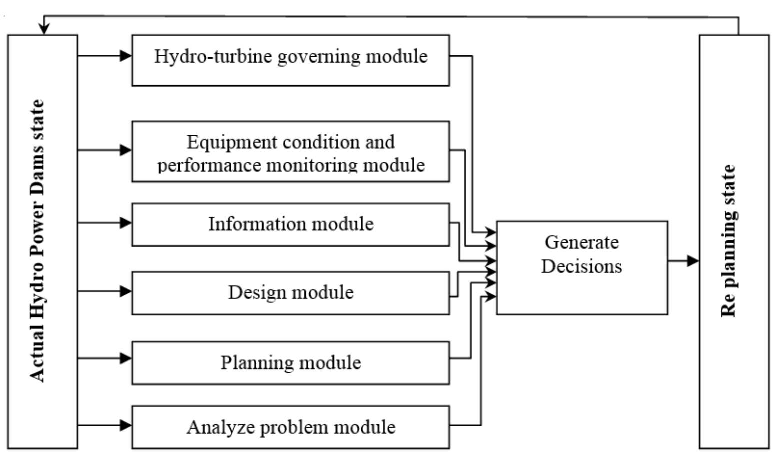


Fig. 2. DSS decision- making process for small hydro power systems

In governor module, digital controller is used in turbine governing system. This is also generally PID controller. Digital control hardware running an application programme accomplishes the required control function with this system. Digital controllers used for turbine governing system are very flexible and can be used for functions not directly related to the turbine governing control function.

Present day practice is to use digital governing control system in hydroelectric units. The major advantages of microprocessor based system over the earlier analogue governors (based on solid state electronic circuitry) are higher reliability, self diagnostic feature, modular design, flexibility of changing control functions via software, stability of set parameters, reduced wiring and easy remote control through optical fiber cables. Microprocessor based governor control system are capable of carrying out the following control functions in addition to speed control during idle run, operating in isolated grid; interconnected operation and islanding operation.

2.2. Equipment condition and performance monitoring

The current vision in the present work offer monitoring and reporting of three sets of parameters: those related to equipment condition, those related to its performance (load carried, speed…) and those derived by digital manipulation of the first two. The first are of help with failure prevention and diagnostics, the second allow accurate production and performance reporting, while the last are normally designed to facilitate performance analysis.

2.3. Information Module

This module contains a set of programs for the creation of databases on the dams and also for continuous updating of the geological, survey, and technological data (Claudio J.C. Blanco, 2008).

The geological section of the database is intended for the storage of primary geological information and integration of the data. The primary geological information includes core-sample data on bed intersections and intersections of weather forecast, obtained from geological rifts and trenches. The survey section of the database includes information from performance monitoring module. The technological section of the databases is intended for the storage of information on the technical potential of the dams, the parameters of all the technological systems used in the dams or considered as options at the design stage.

2.4. Design Module

This module contains the basic programs required for determining the order and boundaries of the hydropower gennerator, the output level, and scheduling. The reserves and rate of removal are calculated, with differentiation over the levels, terraces, technologically uniform parcels, and beds, and appropriate parameters of the production system are determined.

In this module, digital controller is used in turbine governing system. This is also generally PID controller. Digital control hardware running an application programme accomplishes the required control function with this system. Digital controllers used for turbine governing system are very flexible and can be used for functions not directly related to the turbine governing control function. The major advantages of microprocessor based system over the earlier analogue governors (based on solid state electronic circuitry) are higher reliability, self diagnostic feature, modular design, flexibility of changing control functions via software, stability of set parameters, reduced wiring and easy remote control through optical fiber cables. Microprocessor based governor control system are capable of carrying out the following control functions in addition to speed control during idle run, operating in isolated grid; interconnected operation and islanding operation.

2.5. Planning Module

This module addresses the following geological, survey, and technological problems: taking account of the movement of resources, preparing accounting documents, analyzing tacheometric survey recordings, calculating production volumes, automatic recoding of the current position of the workings on the survey documentation, calculation of the water reserves in storage, planning the output volumes and the contours of the generator working, and so on.

2.6. Analyze Problem Module

This module basically consists of programs for graphical work: making charts and plans of the workings. Graphical operations may be performed both in a graph plotter and using a printer.

The six components of systems described above lays a firm foundation of the DSS for hydropower systems, but to make it a reality several technologies need further development. Between those are:

- The need for all the monitoring, turbines control, hydraulic pressure supply system to be integrated in a one coherent whole;
- Eliminate or reduce the need for operator interference into overall system operation;
- Effective and efficient processing of voluminous data.

- Traditional flow control governor with mechanical hydraulic actuator is complex demanding maintenance and high first cost. Further performance requirements of stability and sensitivity i.e. deadband, dead time and dashpot time especially for interconnected units may not be met by mechanical governors.

- Electronic and Digital flow control governors can take up plant control functions.

- Cost of speed control and automation with analog flow governors, unit control and protection systems are high. These systems require attended operation and are mostly based on large capacity hydro units.

- This makes most of the units very costly and uneconomical to operate.

- The manpower as available is unskilled and further adequate supervision is not feasible.

- Load factors for stand-alone micro hydros are usually low affecting economic viability.

- Flow Control Turbine Governors are expensive and not recommended for small hydro units in micro hydro range. Electronic load control governing system with water cooled hot water tanks as ballast loads for unit size up to 100 kW are cost effective. This makes a saving of about 40% on capital cost. If the thyristor control (ELC) is used then the alternator needs to be oversized up to 2% on kVA to cope with the higher circulating current induced. Accordingly, in case of small units up to 100 kW size elimination of flow control governors using load actuator with digital speed controller make these units economically viable and properly designed will eliminate continuous attendance requirement.

- Data storage function can be added to the Digital Governors control system with hard disk (i.e. PC).

- The dummy loads in the Shunt Load Governors (ELC) can be useful load system or can be used for supplying domestic energy needs.

- Digital generation controllers were evolved to take care of speed control, unit control and automation, unit protection and even generation scheduling and have been successfully in operation for over ten years.

- Dedicated PC based systems for complete generation control can be easily adopted for data acquisition and storage at a nominal cost and can also be adopted to SCADA system.

- Manual back up and or redundant control system is required.

3. Conclusions

In our paper, we present a decision support system for small hydropower systems that provide hydro power equipment operator with information required to optimize dams performance in terms of power efficiency and effectiveness. Shows for the development of the DSS for small hydropower systems, some work are needed for integrated all components in a one coherent one.

References

J. P. Shim, M. Warkentin, J. F. Courtney, D. J. Power, R. Sharda, and C. Carlsson, *"Past, present, and future of decision support technology,"* J. Dec. Support Syst., vol. 33, no. 2, pp. 111–126, June 2002.

B. Roy and D. Bouyssou, *Aide Multicritère à la Décision: Méthodes et Cas*: ECONOMICA, 1993.

C. Carlsson and E. Turban, *"DSS: directions for the next decade,"* J.Dec. Support Syst., vol. 33, no. 2, pp. 105–110, June 2002.

I. A. Meystel, *"The tools of intelligence: Are we smart enough to handle them?," in Proc. European Workshop Intelligent Forecasting, DiagnosisControl,* Santorini, Greece, June 24–28, 2001, pp. 2–4.

Claudio J.C. Blanco, Yves Secretan, André L. Amarante Mesquita, *"Decision support system for micro-hydro power plants in the Amazon region under a sustainable development perspective"* Energy for Sustainable Development • Volume XII No. 3, pp.13-21, September 2008

ABSTRACT

Decision support system for small hydropower systems

Nguyen Duc Khoat[1], Ha Van Thuy[1]

[1] *Hanoi University of Mining and Geology*

In this paper, we consider a decisionss support system for small hydropower systems with the implementation of more advanced rescheduling, control and forcasting in small hydroelectric system. This model is being designed to address both current and future needs of small hydroelectric system toward improving productivity and minimizing cost through information flow between each component in the operation.

Keywords: Real time rescheduling, Control system, Genetic Algorithm.