Journal of Physics: Conference Series

PAPER • OPEN ACCESS

Intelligent Model for Electric Power Management: Patterns

To cite this article: Amelec Viloria *et al* 2020 *J. Phys.: Conf. Ser.* **1432** 012032

View the article online for updates and enhancements.

This content was downloaded from IP address 152.200.51.188 on 08/03/2021 at 20:05

Retraction: Intelligent Model for Electric Power Management: Patterns (*Journal of Physics: Conference Series* **1432** 012032)

Amelec Viloria[1], Hugo Hernández Palma[2], Ramiro Gamboa Suarez[3], William Niebles Núñez[4] and José Solórzano Movilla[2]

[1] Universidad de la Costa, Barranquilla, Colombia.

[2] Universidad del Atlántico, Puerto Colombia, Atlántico, Colombia.

[3] Universidad Sur Colombiana, Neiva, Huila, Colombia.

[4] Universidad del Sucre, Sincelejo, Sucre, Colombia.

Published 15 September 2020

This article, and others within this volume, has been retracted by IOP Publishing following clear evidence of plagiarism and citation manipulation.

This work was originally published in Spanish (1) and has been translated and published without permission or acknowledgement to the original authors. IOP Publishing Limited has discovered other papers within this volume that have been subjected to the same treatment. This is scientific misconduct.

Misconduct investigations are ongoing at the author's institutions. IOP Publishing Limited will update this notice if required once those investigations have concluded.

IOP Publishing Limited request any citations to this article be redirected to the original work (1).

Anyone with any information regarding these papers is requested to contact conferenceseries@ioppublishing.org.

(1) Martínez, Mauricio, Santana, Edgardo, & Beliz, Nicholas (2017). Análisis de los paradigmas de inteligencia artificial, para un modelo inteligente de gestión de la energía eléctrica, 2017, vol. 3, Núm. 1: Revista de Iniciación Científica https://revistas.utp.ac.pa/index.php/ric/article/view/1701/html

Content from this work may be used under the terms of the Creative Commons Attribution 3.0 licence. Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.
Published under licence by IOP Publishing Ltd

Retracted

Intelligent Model for Electric Power Management: Patterns

Amelec Viloria[1], Hugo Hernández Palma[2], Ramiro Gamboa Suarez[3], William Niebles Núñez[4], José Solórzano Movilla[5]

[1]Universidad de la Costa, Barranquilla, Colombia.
[2,5] Universidad del Atlántico, Puerto Colombia, Atlántico, Colombia.
[3]Universidad Sur Colombiana, Neiva, Huila, Colombia.
[4]Universidad del Sucre, Sincelejo, Sucre, Colombia.

[1]**Email**: aviloria7@cuc.edu.co

Abstract. When talking about electric power, the first thing to think about is whether enough electrical energy is generated to use without paying attention to it, similar to thinking that water will never runs out, but when faced with extreme droughts, people think that water can be depleted and they must save. In this sense, electrical energy must be saved and used completely and that is why the term energy efficiency is born. This new trend seeks to save electric power to avoid electricity supply shortages, as when countries face phenomena such as El Niño that generate droughts in some areas and rains in others. So, saving energy is a trend because it is important to be prepared for these phenomena, and guaranteeing a sustainable country. This document shows the importance of energy savings, as well as the need to design intelligent models that help to support the reduction of the problem of excessive consumption of electricity.

1. Introduction

In recent years, energy management systems have been developed, and some of them incorporate artificial intelligence approaches such as neural networks, with the aim of developing an intelligent model for the of electric power management to achieve the objectives of saving and making a proper use of energy through monitoring and detention of early alarms to possible failures that occur in the electricity distribution system [1].

Artificial intelligence plays an important role in the development of today's technology because intelligent systems are powerful and help to solve problems that require a degree of intelligence, and the interdisciplinary field cannot let all the weight fall on a specific area. This is a problem of all the population, therefore the analysis of the artificial intelligence approach has been made, in search for a model that can be adapted to the conditions of an electricity distribution network regardless of the number of components they have, but just having data that allow consumption patterns to be found in an electricity network to generate real-world models that can be followed by this intelligent model. This paper presents the relevant approaches that were considered to evaluate the design of the model, showing the importance of the participation of all areas in this problem [2], [3], [4], [5].

2. Previous studies

The need for an electric power intelligent management model arises from the excessive consumption of energy, and the lack of water for the hydroelectric power plants in Panama City, which are the main energy generation sources. In the city, shopping malls present the greatest consumption rates, and during the beginning of operations of the Panama Metro, the new means of transportation [6].

Content from this work may be used under the terms of the Creative Commons Attribution 3.0 licence. Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.
Published under licence by IOP Publishing Ltd

The first element to study about the development of intelligent models, is the behavior of the system, so the monitoring through a visualization system known as SCADA (Supervisory Control and Data Acquisition) is an important aspect to consider [7]. The term SCADA was first heard in the 80's along with the technological advances of the time, related to the monitoring of the system operation to show how the electrical system works in order to make needed decisions. This system is composed of the following three important subsystems:

- Acquisition and control system, which contains sensors and actuators to capture data.
- Interconnection system, which allows remote communication with the devices.
- SCADA software, which is the interface that communicates the user with the environment and allows visualization.

This visualization system provides a database, used by artificial intelligence for data processing. A model cannot be built without data, so it is necessary to have data to know how artificial intelligence can help manage the electrical system.

Artificial intelligence is the science that seeks to design hardware and software that behave intelligently, or perform activities or tasks that require a degree of intelligence [8] [9].

In 1957, the term *artificial intelligence* was used for the first time by John McCarthy during the Darmouth conference [2]; however, an attempt had already been made to design a model that simulated human behavior.

In 1943, with the studies carried out by Warren McCulloch and Walter Pitts, they proposed a model of neural network based on the biological neuron, being this the first model that simulates the behavior of a biological system. In 1947, the famous mathematician Alan Turing first proposed the possibility of building an intelligent machine, and also proposed the Turing test which seeks to discover whether a machine has reached a degree of intelligence capable of deceiving a person [7].

3. Paradigms of artificial intelligence

Artificial intelligence has developed different models, techniques, methods or tasks to make systems behave intelligently, this is known as paradigm. This section presents the relevant techniques and artificial intelligence applications that were analyzed for the development of intelligent models for electric power management, just mentioning those that helped approach the final model.

3.1 Techniques

The artificial intelligence techniques are applied to searches in trees, which can be informed or not informed. The informed searches are known as heuristic searches that reduce the time in which a solution can be found, thus allowing the optimization of the processes that require finding a fast way to solve a problem [10] [11].

The use of these techniques was considered for the energy management model; however, the system just offers numerical data, and these variables cannot be controlled. The amount of voltage sent to the system is constant, and only the consumption varies according to the demand of electrical devices, lights and air conditioners. Thus, the techniques were not considered for an initial model [12].

3.2 Tasks

The tasks performed by artificial intelligence are: diagnosis, planning and control, which are discussed below.

3.2.1 Diagnosis

This task seeks to keep a system working as long as possible. Through the knowledge, the system verifies if the system presents a proper behavior or if there is any failure to notify or if it is possible to make a decision and act on the System [13].

The main systems that perform these tasks are named knowledge-based systems, which take the knowledge of an expert and structure it so that they can be accessed to diagnose faults in the system. It is similar to the work done by doctors who use a questionnaire to know the symptoms of a patient.

Retracted

Systems based on knowledge may have a questionnaire as input or data that indicate if the behavior is adequate in the system being diagnosed. These systems consist of three components:

- Inference Engine
- Knowledge base
- User interface

Where the knowledge base contains the rules that can be applied to obtain an adequate diagnosis, or with a fairly high level of acceptance. These rules are written using predicate logic [14] [15].

The concept of diagnosis was considered for the final model since the electrical system must be kept in constant monitoring to verify if the behavior is adequate; however, the term knowledge-based system was not fully considered by the use of logic predicates, since just numerical data were considered.

3.2.2 Planning

This task seeks to develop control algorithms that allow to synthesize sequences that lead to achieve goals. Planning requires rules to be applied or actions to be taken so that the system behaves appropriately from an initial state to a final target state [16].

The question that leads to take or not this paradigm is whether or not this intelligent model for the management of electricity can perform actions autonomously. It is where we find the limitation that there are no actuators; however, the system will have an operator and this can take the role of an intelligent agent, where the intelligent model shows alarms or notifications of failures and notifies the operator to perform the required actions.

In this case, planning was considered because it meets one of the final goals of the intelligent model, which needs to apply actions on the system, verify its current status, and notify any kind of failure. In this sense, the diagnosis and planning were considered because both tasks led to know that should diagnose through the use of rules that set limits to generate alerts.

3.2.3 Control

To control a system consists in making it behave in a wished way. It is one of the tasks that the artificial intelligence frequently uses in closed systems, where it is possible to control the flow of variables and data.

The following two control problems can be distinguished [17]:

- The problem of regulation, where the desired behavior is to maintain the output in a constant way independent of the disturbances that act on the system.
- Tracking problems, when the desired behavior is to make the system output follow a given reference.

In the intelligent model of electric power management, directly applying this paradigm would mean to control the input variables to reduce the consumption of electrical energy. However, as mentioned in the techniques, the system variables cannot be controlled due to the constant voltage, therefore input data different from the standard cannot be sent because it could generate problems.

3.3 *Rule-based system*

The fundamental part of these systems are the rule bases, which contain rules that are applied to the system by means of an inference engine so that it has an adequate behavior [18] [19].

In this way, the systems can work with a real-world model and follow that behavior.

- The parts that make up a rule-based system are:
- Facts base, which contains what is happening or has happened in the system.
- Rule base, which contains the rules applicable to the system.
- Inference engine, to apply the necessary rules to reach an ideal state.

This system can perform artificial intelligence tasks, allowing the systems to be monitored in an adequate way, and thanks to its rules base, that can contain numerical type conditions for acceptance limits before generating an alarm, makes it possible to take any data that is being received through a sensor and act through the limits that are defined in the system.

3.4 Automatic learning

Among automatic learning models, the neural networks [1] [20] allow to identify patterns in the system, and learn its behavior to generate an adequate output.

Neural network systems [21] are also present in data mining due to their treatment, so they were not considered for the intelligent model to be developed. However, it is important to mention them since, for necessary control tasks, these networks can predict the system behavior and change the variables adjusting them to an acceptable value that allows them to avoid system failures.

4. Results

Once these models, tasks and techniques were evaluated, an intelligent model was designed according to the rule-based system, since this system allows to know the environment, that is, how the system is acting. Since only data were available, and not sensors, the initial data of the system are those found in the database of the visualization system mentioned in point 2. In this way, rules were developed to limit the system to behave within a range or interval appropriate to electricity consumption that does not exceed the audit data made in the building where the model would be implemented [22]. The intelligent model will have the following necessary components:

- Static base
- Facts Base
- Rule base
- New facts base
- Inference engine
- Temporary alarm record

While rule-based systems comprise three components, this model has two separate components added to it, which are the new fact base and the temporary alarm record. Below is a description of each component [7], [8], [23]:

4.1 Static base

The static base will contain the data of electrical consumption that have been audited, that is to say, this base of facts will indicate the model to follow by the system considering that the audit was carried out with the minimum consumption by electronic devices that are in the place where the system will be implemented.

The model will apply rules that indicate that the behavior or consumption of the system is out of the permitted range, always verifying against the static data model, and any new base of facts that is recorded.

4.2 Basis of Facts

This database must present the system data in such a way that the system can represent the real-world behavior of the environment being monitored.

For the intelligent model, the facts base would be the base of the SCADA system, which shows the state of the system. The idea this database as a facts base emerges from considering it as a source of environmental information such as a sensor or another device would do.

4.3 Rule base

The rules that will verify the electrical consumption among other variables such as the voltage, which may drop at any time, will be kept. It will allow a failure to be reported in the system referring to the voltages. If a voltage drops results in a fault, the rules being applied can verify the behavior prior to the fault, consulting with the new facts base and the actual behavior of the system.

Retracted

An example of these rules would be to consider that a variable 'A' located in the static base is equal or less than a variable 'B' located in the database of the display system. If so, and that variable must have a value above the other variable, it must be recorded and notified that this value is out of the optimum, applying rules of Condition → Action type.

4.4 New Facts Base
When talking about a new base of facts, it must be considered that the data of the static base are the minimum in consumption, and that other models of consumption can be presented depending on the variables that act on the system, including the increase in use of mobile devices or new acquisitions of electrical or electronic systems.

When this happens, the model is able to identify this new behavior of the real world in such a way that it can be considered new knowledge in the system. This will allow to act in a better way when facing new problems that may arise during the operation of the electrical network.

4.5 Inference engine
This component is important since the rules that apply to the system must be executed in it. In the knowledge-based systems model, the inference engine executes the rules until reaching a goal state.

In this intelligent model of electric power management, the initial function of the inference motor is similar to the one mentioned above in systems based on rules. It differs in that the system cannot act directly in the electrical network so the rules will be executed and recorded to indicate a malfunction, sending the information to the operator where it must attend to the needs of the network, verifying if there is a fault in any electronic device or any specific area of the place where the system will be implemented.

The human agent (operator) will apply the necessary actions depending on its severity. This will allow the system to return to a flow of consumption in a specific range, thus the inference engine of the intelligent model of energy management will achieve state-goals.

4.6 Temporary Alarm Record
The function of temporary records of possible alarms is to gather information through the rules applied in the inference engine.

In this sense, when a pattern is constant, and has been maintained in the same way in a given time, and this does not affect the operation of the electrical system, nor compromises energy consumption in an excessive way, it is considered a new knowledge and is added to the new base of facts.

However, if a pattern is out of range, it must be notified emphasizing that the proper functioning of the system is being put at risk. The record will be updated according to the severity of the pattern. If this pattern is not recorded after a while, it is completely deleted from the record without allowing to access it again.

Initially, the intelligent energy management model considered developing an alarm base. However, it was designed as a temporary record to avoid data overflow.

This model can change that concept if necessary, always thinking that the need depends on the amount of memory space required for consumption, and the need to keep all alarms, or just those that are directly relevant [24].

5. Discussion
The proposed model is based on the paradigms of artificial intelligence, seeking to develop a system capable of behaving with a degree of intelligence, for meeting the definition of artificial intelligence. It is a model that involves part of control systems, taking some concepts such as monitoring versus a real time model, as this characteristic is allowed by rule-based systems. It is also important to mention that neural networks can help in this type of control, so it is suggested to evaluate for further research.

When incorporating new components to the classic model of rules-based systems, the objective is to make the system have different knowledge to infer the alarms of the electrical network. This way, this way, the system must learn by means of observation of the variables that are captured by the SCADA visualization system.

Redacted

How is the model adaptable? For being a system based on rules, just numerical data are processed. In this way, when connecting a new device, the operator must direct the reading of that component so that the system can infer and give a solution.

If there is a temperature sensor for a place where servers are housed and the temperature of the place should not increase over 20 degrees Celsius, the data of the temperature sensor must be used to observe the behavior of the area. In this case, 20 would be the limit for the new rule that is integrated to the system without affecting the operation of the other components.

Currently, systems such as EFIS are being developed to allow the processing of large volumes of data and integration with sensors. The proposed model seeks to break the need or dependence on other components, making it work with data that can be obtained from a database of a visualization system, as well as a database containing data from electronic devices such as sensors or others.

In this sense, the new trend of the Internet of things is considered, with the objective of connecting devices that can communicate with each other.

In this way, the proposed model allows connectivity, making it possible to connect devices and integrate them through a single main point. Thus, the concept of energy efficiency and energy savings is not just part of electrical engineering but also of other disciplines such as computer science which contribute to the development of these types of models.

6. Conclusions

The intelligent electric energy management model adapts to the needs of the environment, allowing it to be functional with small data as well as with big data.

Artificial intelligence is related to other disciplines without limits and not only to a specific area, that is, only in control or diagnosis, but also integrating concepts of each to generate new knowledge.

The monitoring of systems is the first step to control and improve the processes, optimizing them and reducing errors and failures that prevent the proper functioning of the system being monitored.

References

[1] Caballero, V., Vernet, D., Zaballos, A., & Corral, G. (2018). Web of Energy: Hacia la integración inteligente para las redes de sensores en Smart Grids. XIII Jornadas de Ingeniería telemática (JITEL 2017). Libro de actas, 30-39.

[2] López, D., & Mideros, D. (2018). Diseño de un sistema inteligente y compacto de iluminación. Enfoque UTE, 9(1), 226-235.

[3] Velez, N. R. B. (2018). Gestión eficiente de redes eléctricas inteligentes en la mini-central fotovoltaica de la universidad técnica de Manabí (Doctoral dissertation).

[4] Garcia-Rendon, J. J., Gómez, A. G., Tobón, L. V., & Ceballos, H. V. (2018). Redes inteligentes y mecanismo de respuesta de la demanda: el caso del sector eléctrico colombiano Smart grids and demand response mechanism: the case of the Colombian electricity market? (No. 016975). UNIVERSIDAD EAFIT.

[5] Abdul Masud, M., Zhexue Huang, J., Wei, C., Wang, J., Khan, I., Zhong, M.: Inice: A New Approach for Identifying the Number of Clusters and Initial Cluster Centres. Inf. Sci. (2018). https://doi.org/10.1016/j.ins.2018.07.034

[6] Martins, L.; Carvalho, R.; Victorino, C.; Holanda, M.: Early Prediction of College Attrition Using Data Mining. 16th IEEE International Conference on Machine Learning and Applications (ICMLA), pp. 1075-1078 (2017)

[7] Gómez, V. A., Hernández, C., & Rivas, E. (2018). Visión General, Características y Funcionalidades de la Red Eléctrica Inteligente (Smart Grid). *Información tecnológica*, *29*(2), 89-102.

[8] Inga, E., Inga, J., Correa, E., & Hincapié, R. (2018). Reconstrucción del patrón de consumo eléctrico a partir de Big Data mediante técnica de MapReduce. Enfoque Ute, 9(1), 177-187.

[9] Makhabel, B.: Learning Data Mining with R. Packt Publishing 1st Ed, pp. 143 (2015)

[10] Witten, I.; Frank, E.; Hall, M.; Pal, C.: Data Mining Practical Machine Learning Tools and Techniques. Elsevier 4th Ed, pp. 167-169 (2016).

[11] Bishop, C. (1995). Extremely well-written, up-to-date. Requires a good mathematical background, but rewards careful reading, putting neural networks firmly into a statistical context. *Neural Networks for Pattern Recognition*

[12] Figueroa, J. F., Ochoa, M. A. R., Rodriguez, M. S., & Palma, M. G. V. (2018). Diseño de un medidor de energía eléctrica bidireccional y monitoreado mediante aplicación móvil/Design of a two-way electric power meter monitoring with a mobile application. RECI Revista Iberoamericana de las Ciencias Computacionales e Informática, 7(14), 1-30.

[13] Sanchez L., Vásquez C., Viloria A., Cmeza-estrada (2018) Conglomerates of Latin American Countries and Public Policies for the Sustainable Development of the Electric Power Generation Sector. In: Tan Y., Shi Y., Tang Q. (eds) Data Mining and Big Data. DMBD 2018. Lecture Notes in Computer Science, vol 10943. Springer, Cham.

[14] Perez, R., Inga, E., Aguila, A., Vásquez, C., Lima, L., Viloria, A., & Henry, M. A. (2018, June). Fault diagnosis on electrical distribution systems based on fuzzy logic. In *International Conference on Sensing and Imaging* (pp. 174-185). Springer, Cham.

[15] Perez, Ramón, Carmen Vásquez, and Amelec Viloria. "An intelligent strategy for faults location in distribution networks with distributed generation." *Journal of Intelligent & Fuzzy Systems* Preprint (2019): 1-11.

[16] Bucci, N., Luna, M., Viloria, A., García, J. H., Parody, A., Varela, N., & López, L. A. B. (2018, June). Factor analysis of the psychosocial risk assessment instrument. In International Conference on Data Mining and Big Data (pp. 149-158). Springer, Cham.

[17] Chakraborty, S., Das, S.: Simultaneous variable weighting and determining the number of clusters—A weighted Gaussian algorithm means. Stat. Probab. Lett. 137, 148–156 (2018). https://doi.org/10.1016/j.spl.2018.01.015.

[18] Escobar, Adriana Marcela Vega, et al. "Home energy management model: preliminary proposal/Modelo de gestion de energia electrica domiciliaria: propuesta preliminar." *Redes de Ingenieria*, vol. 6, no. 1, 2015, p. 95+. *Gale OneFile: Informe Académico*, Accessed 12 Oct. 2019.

[19] Sandoval-Ruiz, C. (2017). Modelo Neuro-Adaptativo en VHDL, basado en circuitos NLFSR, para Control de un Sistema Inteligente de Tecnología Sostenible. *Universidad, Ciencia Y Tecnología*, *21*(85), 140-149.

[20] Sánchez Fleitas, N., Comas Rodríguez, R., Lorenzo, G., & Matilde, M. (2019). Sistema Inteligente de Información Geográfica para las empresas eléctricas cubanas. *Ingeniare. Revista chilena de ingeniería*, *27*(2), 197-209.

[21] Camarena, N., & Angel, M. (2019). Modelo de gestión de la energía, para disminuir los costos productivos del horno N 3, en la Empresa UNACEM SAA.

[22] Ruiz, M., & Inga, E. (2019). Asignación óptima de recursos de comunicaciones para sistemas de gestión de energía. Enfoque UTE, 10(1), 141-152.

[23] Reina Espinosa, C. (2019). Adaptación de modelos de ciudades sostenibles e inteligentes para Santiago de Cali (Doctoral dissertation, Universidad Santiago de Cali).

[24] Rendón, J. J. G., Gómez, A. G., Tobón, L. V., & Ceballos, H. V. (2019). Redes inteligentes y mecanismo de respuesta de la demanda. Revista de Economía del Caribe, (23), 33.

Retracted