CONTENTS

Automat. Comput. Appl. Math.
Volume 21 (2012), Number 3

AUTOMATION

Bearing Diagnosis Method of Power Spectrum of Envelopes of EDM Decomposed Vibration Signal Filtred Based on Kurtosis

Bogdan Betea, Petru Dobra, Mirela Trusca, Liviu Tomesc
Automatic Control Department
Technical University of Cluj–Napoca
Cluj–Napoca, Romania
bogdan.betea@aut.utcluj.ro, petru.dobra@aut.utcluj.ro, mirela.trusca@aut.utcluj.ro, liviu.tomesc@aut.utcluj.ro

Abstract— **This paper introduce a new method for analysis and diagnosis the localized bearing defects, using some of the most used signal processing tools like Kurtosis, EDM, Hilbert transform and FFT. These techniques of bearing defects analysis and diagnosis consist in five main processing blocks: shock impulses detection filtering based on Kurtosis, envelope detection based on Hilbert transform, EDM decomposition, envelope detection of IMFs (Hilbert Huang transform) and power spectrums computation for each IMF envelope.**

The results obtained applying the proposed bearing diagnoses method are compared with some of the most important known spectrum analysis based bearing diagnoses methods, in order to prove the efficiency of the proposed method.

Keywords-diagnosis; defect bearing; formatting; EDM; power spectrum; Kurtosis

I. INTRODUCTION

This paper introduce a new method for analysis and diagnosis the localized bearing defects, using some of the most used signal processing tools like Kurtosis, EDM, Hilbert transform and FFT.

An important evolution on bearing diagnosis researches were the identification of the frequencies of the pulses generated by bearing defects in the vibration signal. McFadden and Smith [1] proposed one of the first and most significant research related single point defect of bearing, proposing a model of defect bearing also based on defect frequencies generation.

Envelope detection is a very important signal processing tool used in bearing diagnosis field [2]. The classical method of computing the envelope of a signal is based on the Hilbert transform. A lot of papers proposed different bearing defects diagnosis methods based on envelope detection based on Hilbert transform, usually in combination with some others signal processing tools like continuous Wavelet transform (CWT) [3, 4], discrete Wavelet transform (DWT) [5, 6, 7], Winner filter [8] or Duffing oscillator [9].

The envelope detection based on Hilbert transform usage was extended, an important contribution being the combination with empirical mode decomposition (EMD) [HS98]. This combination is termed Hilbert-Huang transform, and is considered a very powerful signal processing tool, being used in bearing diagnosis field [11, 12, 13]. This processing tool is also used by the bearing diagnosis method proposed on this paper to decompose the preprocessed vibration signal captured from defect bearing.

Kurtosis is another important statistics and signal processing tool used in bearing diagnosis field, and also the proposed diagnosis method uses it. A large number of papers proposed different bearing diagnosis methods which use in different ways the Kurtosis tool.

A tool name spectral Kurtosis based on Kurtosis is used by some authors [14, 15] on defect bearing diagnosis. Vass et al. [VC05] proposed a Kurtosis ratio, based on Kurtosis tool, a ratio which they used for speckle noise avoidance in laser vibrometry.

Another way of using the Kurtosis tool in bearing diagnosis field is the detection of shock pulses generated by bearing defects and than based on this detection the vibration signal can be filtered to eliminate irrelevant parts for diagnosis process. This interesting tool for shock pulses detection and vibration signal filtering based on Kurtosis is proposed by Badri et al. [17], and this filtering procedure is used as a preprocessing step of the bearing diagnosis method proposed by this paper.

The results obtained applying the proposed bearing diagnosis method on this paper is compare with some others spectrum based bearing diagnosis methods like classical power spectrum of envelope [14], simple spectrum of envelope or the Wang-Jianu diagnosis method [18].

The paper hereafter is organized as follows. In section 2, a theoretical presentation of the signal processing tools related to the proposed diagnosis method is done. There are presented the envelope detection using Hilbert transform, Hilbert-Huang transform and the Kurtosis and Kurtosis based filtering tools. Section 3 presents shortly the defects frequencies computation based on the bearing structural parameters. The detailed formulation of the proposed diagnosis method is given in Section 4. In Section 5 the comparison results are reported and discussed. Finally the last section of this paper is represented by the conclusions.

II. THEORETICAL SECTION

A. *Envelope detection using Hilbert transform*

Michael Feldman presents on his paper [2] a review of the usage of the Hilbert transform on analysis and diagnosis of mechanical systems based on vibration signals.

The Hilbert transform of a signal $x(t)$, noted $h(t) = H\{x(t)\}$ is defined as follow:

Design Proposal and Control Method for Proton Exchange Membrane Fuel Cell Stacks

Alin Cristian FĂRCAŞ
Automation dept.
Technical University of Cluj-Napoca
Cluj-Napoca, Romania
e-mail: alin.farcas@aut.utcluj.ro

Petru DOBRA
Automation dept.
Technical University of Cluj-Napoca
Cluj-Napoca, Romania
e-mail: petru.dobra@aut.utcluj.ro

Abstract—**This paper presents a control oriented design and control method for Proton Exchange Membrane Fuel Cell systems. The fuel cells system is approached as a dual energy source, electrical power and heat, and is intended to address the consumer's energy demand by providing a combination of the two previously mentioned energy forms. In order to meet this objective, the fuel cell system design permits the activation of a variable number of cells with the purpose of adjusting voltage and current while providing the total power output in the ratio requested. A 20 cells system with total active surface of 200 cm^2 is modeled and a control scheme is put in place to command the output. Four different operation regimes have been simulated where the collected data shows a maximum error of 1.3% between the reference and actual value of the power output.**

Keywords: proton exchange membrane fuel cells, fuel cell stack control, fuel cell model, power control, heat control.

I. INTRODUCTION

The depletion of the fossil fuels (oil, coal, natural gas, etc.) is now a certain and predictable event that, in the last two decades, has stimulated the search for alternative fuels as energy carriers, capable to meet the current and future needs of human society. Hydrogen is considered to be one viable alternative because it can store a relevant amount of energy and later on, this energy can be released through the reaction with oxygen resulting water. Due to having the lightest molecule in the universe, one major holdback of hydrogen as fuel is the fact the hydrogen cannot be found on Earth in deposits, as one would find natural gas for example. Hydrogen must be produced whether by water electrolysis or by hydrocarbons reformation. The latter is not really viable because relies again on the fossil hydrocarbons deposits which will disappear. However, water electrolysis powered from renewable energy sources (solar, wind, etc.) seems to be a long term solution. If adopted, such energy cycle based on hydrogen production, storage and consumption will have a dramatic impact on the world economy and a positive effect on the environment.

Proton Exchange Membrane Fuel Cell (PEMFC) is considered to be one of the key components in the hydrogen based economy. This is the device where the reaction between the hydrogen and the oxygen takes place providing electrical energy and heat to the consumer. Being an electrochemical device, PEMFC presents a nonlinear behavior and requires control algorithms that can address successfully its nonlinearities. The current paper presents a control oriented PEMFC design and the corresponding control method that enables an efficient operation of this device in stationary applications.

II. PEM FUEL CELL

The PEMFC is composed of the following components as shown in Fig.1:

1. Anode Plate
2. Anodic Gas Diffusion Layer
3. Anodic Catalyst Layer
4. Proton Exchange Membrane
5. Cathodic Catalyst Layer
6. Cathodic Gas Diffusion Layer
7. Cathode Plate

The hydrogen enters the PEMFC at the anode side, penetrates through the anodic gas diffusion layer and makes contact with the anodic catalyst layer. In the presence of the catalyst (usually, platinum in quantities of 0.3 mg/cm^2 [1]), hydrogen loses its electron and enters the proton exchange membrane.

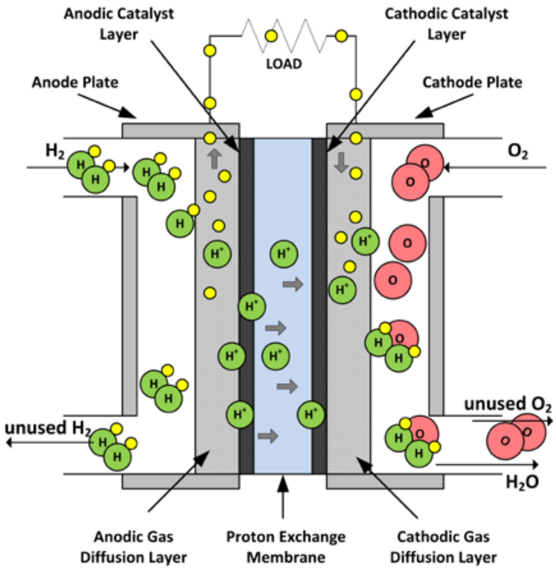

Figure 1. Proton Exchange Membrane Fuel Cell simplified drawing

Predictive Control of Neuromuscular Blockade

Ramona Hodrea, Radu Morar, Ioan Nascu
Automation Department
Technical University of Cluj-Napoca
Cluj-Napoca, Romania
ramona.hodrea@aut.utcluj.ro

Horatiu Vasian
Department of Anaesthesia and Intensive Care
University of Medicine and Pharmacy "Iuliu Hatieganu
Cluj-Napoca, Romania

Abstract—**This paper presents the application of Extended Prediction Self-Adaptive Control (EPSAC) strategy to muscle relaxant administration in patients undergoing surgery. The muscle relaxant considered in this study is atracurium and the level of neuromuscular blockade was assessed using TOF-Watch device. The drug distribution and effect have been previously modeled using input-output data recorded during surgical interventions at Regional Institute of Gastroenterology and Hepatology "Prof. Dr. Octavian Fodor" Cluj-Napoca. The performance regarding reference tracking was studied by applying the controller to a set of 8 simulated patients.**

Keywords - neuromuscular blockade, predictive control, anesthesia

I. INTRODUCTION

Muscle relaxants are administrated during general anesthesia or intensive care unit (ICU) to improve conditions for tracheal intubation, to provide immobility during surgery and to facilitate mechanical ventilation. One of the main concerns of the anaesthetist is to maintain an adequate level of muscle relaxation. Although there is no evidence that residual neuromuscular block leads to increased mortality, significant pulmonary morbidity has been demonstrated after using longer-acting agents such as pancuronium [1]. Interfering with pulmonary mechanics, residual neuromuscular block impairs the ventilator response to hypoxia [2]. Administered at low doses, muscle relaxants significantly impair pharyngeal function and lead to an increased risk of tracheal aspiration and airway obstruction [3].

A closed loop controller avoids these side effects and maintains a preselected degree of muscle relaxation with excellent precision while minimizing drug administration. Automatic feedback control of skeletal muscle relaxation has been addressed by several research groups, mainly because syringe pumps can be easily controlled by computer systems and more importantly a direct and reliable measure of effect is available. A variety of control strategies can be found in the literature for muscle relaxants, ranging from on-off controllers [4] to model based and adaptive controllers [5].

An Extended Prediction Self-Adaptive Control (EPSAC) strategy applied to atracurium administration is presented in this paper. The paper is structured as following: clinical data used to identify the model parameters is presented in section II; the structure of the patient model used for prediction and control is given in section III, along with the parameter values estimated for a set of 8 patient; the inter-patient variability is studied in section IV; an overview of the EPSAC approach is given in section V and the controller results are presented and discussed in section VI. The conclusion section summarizes the main outcome of this study.

II. CLINICAL DATA

Data recorded at the Regional Institute of Gastroenterology and Hepatology "Prof. Dr. Octavian Fodor" Cluj-Napoca during a surgical intervention were used to identify the parameters of the model. The biometric values of the patients selected for this study are given in Table I.

TABLE I. BIOMETRIC VALUES

Patient	Age (years)	Length (cm)	Weight (Kg)	Gender
1	68	165	53	M
2	54	165	73	F
3	76	165	86	M
4	75	170	65	M
5	29	175	70	M
6	75	160	60	F
7	73	162	88	F
8	56	157	71	F
Mean ± Std	52.5 ± 23.5	167.5± 7.5	70.5 ± 16.5	

All these patients received atracurium during administered manually by the anesthetist. The degree of neuromuscular block was assessed by applying stimulus to the ulnar nerve and then measuring the associated muscular response using TOF-Watch Sx device. The method is based on a train-of-four (TOF) stimulation and the respective measurement of response. To perform a train-of-four (TOF) pattern of nerve stimulation, 4 supra-maximal electrical stimuli are applied over the course of a 1.5 to 2.0 seconds period (frequency of 2 Hz). Each stimulus causes a muscle contraction, and the fade of response to this stimulus is measured. Dividing the level of the fourth response (r_4) by the level of the first response (r_1) provides the TOF ratio:

$$TOF = 100 \cdot \frac{r_4}{r_1} \qquad (1)$$

The number of responses (TOF-Count) generated by those 4 stimuli is clinically used during partial non-depolarizing block, but it is clearly insufficient for control purposes because of the large quantization intervals. Usually the first twitch of TOF (T_1) and TOF ratio measurements are

Management of Wastewater Treatment Plants Using SCADA Systems and VPN

Bogdan Humoreanu
Faculty of Automation and Computer Science
Technical University of Cluj-Napoca
Cluj-Napoca, Romania
bogdan.humoreanu@aut.utcluj.ro

Ioan Nascu
Faculty of Automation and Computer Science
Technical University of Cluj-Napoca
Cluj-Napoca, Romania

***Abstract*— Today, monitoring and control solutions for industrial processes grow in complexity and offers more advanced features. Automatic management involves managing the development of an automatic and continuous technological process. Hardware and software that are part of the management system shall ensure control of process parameters automatically, with or without operator intervention. A very important aspect is communication between automation devices and remote process. The mode of transmission of data on a physical medium must ensure information security, especially when using public networks.**

Keywords: -SCADA; data acquisition; hardware architecture; wastewater treatment; process monitoring.

I. INTRODUCTION

SCADA is an acronym for Supervisory Control and Data Acquisition. SCADA generally refers to an industrial computer system that monitors and controls a process.

A SCADA program normally runs on a PC and communicates with external instrumentation and control devices. Communications methods can be via direct serial link, radio, modem, fieldbus or Ethernet links. If a mixture of instruments with differing communication interfaces and protocols need to be connected, then converters can be used. SCADA is often used on remote data acquisition systems where the data is viewed and recorded centrally.

The SCADA program has a user configured database which tells the software about the connected instrumentation and which parameters within the instruments are to be accessed. The database may also hold information on how often the parameters of the instruments are accessed and if a parameter is a read only value (e.g. a measured value) or read / write, allowing the operator to change a value e.g. an alarm setpoint).

The parameters of the instrument being accessed are normally split between analogue (numeric) and logic (digital). When running, the SCADA software continuously updates its own database with the latest analogue and digital values collected from the instrumentation. Some SCADA systems allow real time calculations to be created on the received data and the results would be available as a "virtual" value.

The real time values will then be utilized by the SCADA software for: Real Time Display and Operator Interactions (Supervisory Control) and Recording (Data Acquisition). Most SCADA PC software includes a drawing package for the configuration of the operator screens; these provide the animation of objects dependant on the real time data. The SCADA screen designer can produce and graphically display bar-graphs, valve positions, tank levels etc. The operator is also allowed to change the parameters or new values to instruments by use of a mouse / keyboard or a touch screen.

More sophisticated SCADA PC software can provide messaging modules for SMS or E-mail; these change plant conditions to be reportable to external users. Modern SCADA programs can offer higher access to plant information through an internet interface. [1]

II. SCADA ARCHITECTURE FOR WWTP

A. *Hardware architecture*

There are two basic layers in a SCADA system: the "client layer" which caters for the user machine interaction and also the "data server layer" that handles most of the process knowledge management activities. The data servers communicate with devices within the field through process controllers. Process controllers like PLCs, are connected to the data servers either directly or via networks or fieldbuses that are proprietary (e.g. Siemens H1), or non-proprietary (e.g. Profibus). Data servers are connected to each other and to client stations via an Ethernet LAN. The data servers and client stations are NT platforms but for many products the client stations may also be W95 machines.

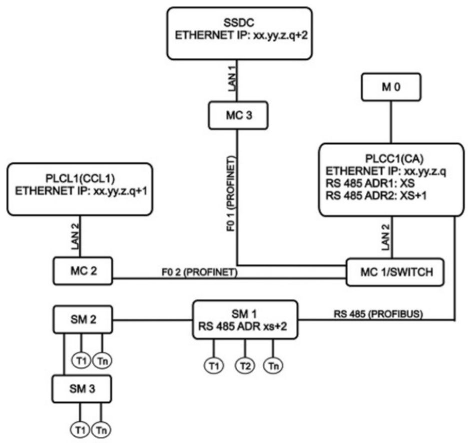

Figure 1. SCADA Hardware architecture for wastewater treatment plant

In-Home Elder Person's Activities Tracking by means of Wireless Sensor Networks

Radu Prodan, Ioan Nașcu
Automation Department
Technical University of Cluj-Napoca
Cluj-Napoca, Romania
prodan.radu@gmail.com
Ioan.Nascu@aut.utcluj.ro

***Abstract*—The paper gives a solution to the position estimation problem for the mobile wireless sensors used for permanent surveillance in homecare of elder persons by measuring the received signal strength during normal data communication between fixed and mobile sensors. The experiments were done with 8 mobile sensors placed in a 10x10 meters square area and 4 fixed sensors placed in the corners. In the first step the mobile sensors were placed randomly. In the next steps the mobile sensors were placed in a V, Z and H shape configuration. For each step and for each of the data point were made 20 measurement trials. Our results show that The Root Mean Square Error between the true location of the sensors and their estimated location was in the best cases in the interval 0.3-0.5 meters and in the worst cases in the interval 0.6-0.9 meters.**

Keywords—elder person, activity tracking, sensors, wireless networks, position estimation

I. INTRODUCTION

The year 1999 was declared by the United Nations as The Year of Older Persons [1]. More than a decade has passed since then and it is essential that we take stock of the advancement done to improve the welfare of the ageing population. According to the European Commission, by 2050 the number of people in the European Union aged 65 and above is expected to grow by 70% and the number of people aged over 80 by 170% [2]. This raises important challenges for the 21 century: meet the higher demand for healthcare; adapt health systems to the needs of an ageing population while keeping them sustainable in societies with smaller workforce [2]. A "wave of awareness" among the World Population, which has reached 7 billion in October 2011, is more than necessary given the new challenges awaiting us all to make the lives of the elderly enjoyable.

Romania's population has decreased by 1.8 million inhabitants during 1990-2008, from 23.2 to 21.4 million inhabitants [3]. Until 2050 Romania's population is set to decrease by a supplementary 4-5 million inhabitants, to achieve 16-17 million residents (according to studies conducted by EU, World Bank, International Monetary Fund and the UN) [3]. Life expectancy in Romania increased from 70 years in 1990 to 74 years in 2008 and continues to rise [3].

Because there are not available for Romania any data regarding Elder Care Costs Evaluation, we have chosen the Genworth Cost of Care Survey made in 2007 in the USA [4]. According to this evaluation, Assisted Living has the lowest costs/day and Nursing Homes – private, single occupancy rooms have the highest costs/day. The survey included feedback from 25000 providers in order to home care providers in all 50 states of USA, and also in the District of Columbia [4].

TABLE I. THE 2007 GENWORTH COST OF CARE SURVEY

Rate Amount	**Care Type**			
	In-Home Care Agencies	***Nursing Homes (semi-private, double occupancy rooms)***	***Nursing Homes (private, single occupancy rooms)***	***Assisted Living Communities (one bedroom unit)***
Hourly Rate	$14	N/A	N/A	N/A
Daily Rate	$112	$180	$205	$90
Annual Rate	$40.880	$65.700	$74.825	$32.850

The elder care in Romania is carried out in most of the cases without help from the new technologies, by the family members. The fast spreading of wired and wireless networks [6, 7] is a great opportunity for our research team to bring to public awareness some viable solutions that can support the families in their effort.

The "smart home" solutions imply the presence of wired and wireless sensors around the homes.

The growing size of the sensor networks increases the challenges over the human management and monitoring. In wireless sensor networks there is a great need for self-configuration in an automated manner, as they tend to grow in the future time.

TABLE II. THE 2012 GENWORTH COST OF CARE SURVEY

Rate Amount	**Care Type**			
	In-Home Care Agencies	***Nursing Homes (semi-private, double occupancy rooms)***	***Nursing Homes (private, single occupancy rooms)***	***Assisted Living Communities (one bedroom unit)***
Hourly Rate	$19	N/A	N/A	N/A
Daily Rate	$152	$200	$222	$110
Annual Rate	$55.480	$73.000	$81.030	$40.150

An Ontology-based Multi-Agent Framework for a Dependable Cyber-Physical System

Teodora Sanislav, Liviu Miclea
Faculty of Automation and Computer Science, Department of Automation
Technical University of Cluj-Napoca
Cluj-Napoca, Romania
Emails: teodora.sanislav@aut.utcluj.ro, liviu.miclea@aut.utcluj.ro

***Abstract*—The paper proposes a multi-agent framework for deploying a cyber-physical system that uses the ontological knowledge of the dependability concept in order to control, to monitor and to diagnose an industrial system. The proposed solution uses the semantic web ontology language, OWL and the JADE platform to develop the dependability ontology, and respectively the detailed models of agents' behaviour to specify the functionality of the agent-based dependable cyber-physical system using the task-method decomposition technique. The usefulness of the proposed solution is illustrated by constructing a multi-agent system that supports the (re)configuration in case of faults and failures in a water treatment plant.**

Keywords-Cyber-physical systems, architecture, modeling, ontology, multi-agent systems, dependability, water treatment

I. INTRODUCTION

Cyber-Physical Systems (CPSs), a new generation of systems, represent more than networking and information technology, information and knowledge being integrated into physical objects [1]. By integrating perception, communication, learning, behaviour generation, reasoning into such systems a new generation of intelligent and autonomous systems may be developed [1]. CPSs are characterized by the following fundamental properties: (1) Functionality; (2) Performance; (3) Dependability (usability, management and adaptability) and security; (4) Cost. In order to meet the CPS definition and its properties, a possible approach for implementing a dependable CPS is a multi-agent system that uses ontological knowledge of the dependability concept. Such approach is presented in this paper: an ontology based multi-agent framework for a CPS with dependability features. This framework is targeted to the multi-agent JADE platform [2] to provide a set of software libraries to specify he functionality of the CPS and uses the web ontology language, OWL [3] to define the ontology that describes the dependability concept.

The rest of the paper is organized as follows: Section II presents a scientific literature, brief review that highlights the use of ontologies in multi-agent systems and the use of ontologies to determine the systems dependability, Section III defines the software architecture of the dependable CPS (the data and events layer, the knowledge layer and the agents' society) while Section IV discusses the implementation of the water treatment CPS based on the proposed solution. Finally, in Section V the conclusions are drawn.

II. RELATED WORK

The scientific literature highlights several works that have used ontologies in agent systems. The ontologies are used to describe the behaviours of the agents.

For example, [4] and [5] papers present the AgentOWL library, developed to support RDF/OWL ontology models in JADE multi-agent systems. The software library covers functionalities such as: (a) the agent knowledge model based on OWL; (b) infrastructure for sending ACL messages with OWL as context language; (c) infrastructure for receiving ACL messages with OWL; (d) XMLRPC receiving of the message used for communication with GUI; (e) XMLRPC returning of RDF and plain XML used for displaying of agent results to GUI.

Papers [6] and [7] propose an ontology reconfiguration agent that attempts to produce a reconfiguration of the system as a reaction to the changes in the requirements or in a manufacturing environment based on a knowledge model and an extension of this agent, which enables the integration between the high level planning with the distributed low level control (compliant with IEC 61499 standard).

Paper [8] describes the concepts of the care model that are formalized using ontologies. The ontologies' language is OWL and the Protégé-OWL plug-in is used to create and to manage the ontologies. The ontologies represent the knowledge assets of the K4Care application and the catalyst for the agents' behavioural model, as well as the fundamentals for the agents' code generation.

Paper [9] presents a framework that provides end-to-end solution for the development of the JADE platform applications using the semantic web ontology language OWL. The framework contains models and software tools and supports the automatic deployment of agents' behaviour from these models. Also, the paper [9] demonstrates the proposed solution utility by creating a multi-agent system that detects the disease outbreaks.

Also, a brief analysis of the related works in terms of using ontologies to determine the system dependability or to automatic configure the system for dependability purpose or to diagnose the system (the diagnosis being made based on process faults analysis and on the categories of faults or failures) was done by the authors of the paper [10] and will not be reversed in this paper.

These research works presented above demonstrate the advantages and the popularity of the ontology-based knowledge model of a multi-agent system. A significant part of these research works is specific to the domain which it is addressed and it cannot be used, exactly as it is, for any further developments of other multi-agent systems. In this situation, a new ontology-based multi-agent framework for a

Water Transfer Control System for Automated Buildings

Ioan Valentin Sita
Department of Automation
Technical University of Cluj–Napoca
Cluj–Napoca, Romania
e-mail: valentin.sita@aut.utcluj.ro

Mirela Dobra
Department of Automation
Technical University of Cluj–Napoca
Cluj–Napoca, Romania
e-mail: mirela.trusca@aut.utcluj.ro

***Abstract*—This paper presents a cost effective solution for water transfer, flow metering and level control by using SIEMENS LOGO! programmable logic controllers. The resulting installation is integrated in a KNX dedicated building automation system by using a CM EIB/KNX communication module. A graphical interface for monitoring and controlling the system is implemented in WinCC Flexible as part of the Building Management System.**

Keywords-PLC; KNX; WinCC; building automation.

I. Introduction

Supplying a building with water involves: the caption of raw water; first pumping stage; pipelines to transport raw water from the source to the treatment plant; treatment plant, for the quality correction of the raw water, depending on the quality imposed by the consumer; tanks for storing the volume of water required for: emergency reserve, compensation time consumption, reservation required for firefighting; second pumping stage, to provide the necessary pressure in the distribution network (pressure assurance can also be provided gravitational); distribution network for the distribution of water to consumers. Basic methods and tools for managing water resources are explained in [1]. In this process of capture-filtration-distribution of water, but also in other processes alike it is necessary to be able to control the level and/or flow from a reservoir. To do this you must first know the values of these parameters at any time. This involves monitoring the system and its parameters with a Supervisory Control and Data Acquisition (SCADA) system. An example of SCADA system for monitoring water supply networks is presented in [2]. The same process is copied in every water transfer system: from a city reservoir to a building reservoir or from a main building reservoir to a smaller reservoir from the same building, system used in skyscrapers.

An important fact in implementation is the security of the system and the security in the communication between the supply plant and the building. A secure SCADA for critical infrastructures is treated in [3].

II. System Components

The aim of this paper is to develop a secure and stable application for monitoring and controlling water transfer processes, but with the possibility for integration in a building automation system (BAS). Through the process automation, direct human intervention is eliminated; men assume in this case the role of general management. An automatic level control system ensures that the system operating mode is as close as possible to the reference mode. Adjustment algorithm is used to cancel the deviation which represents the difference between the reference value and the measured value, cancelling the effect of external actions. In a system of automatic adjustment, the control and modification of the output value is achieved in a closed loop, so that the steady state deviation is as close to zero as possible. The design and implementation methods of a network management system for water distribution networks can be found in [4].

For achieving the level and flow control in a water transfer system we propose a system of two tanks, one is considered the buffer tank and the second the main tank – in which the level control is achieved, four pumps (P1, P2, P3, P4), analog proximity sensor (LS0), six floating sensors (three in each tank for low level, maximum level and overflow fitting level (marked as S.MIN, S.MAX and S.MAXMAX), a flow sensor (FM0), a valve (V0) and a programmable logic controller (PLC) placed in the protection panel P0 - that is able to perform autonomously logic operations, without the need of a computer. The proposed system schematic can be seen in Fig. 1.

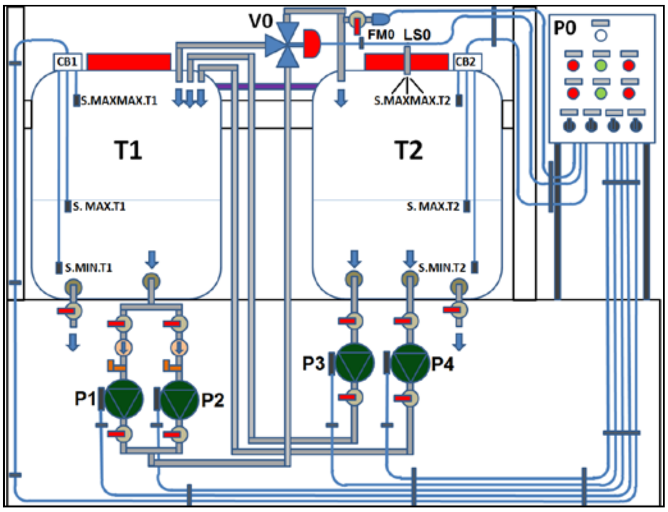

Figure 1. System schematic.

A. *Description of plant components*

The execution elements are the pumps that will pump the liquid through a system of pipes. The pumps P1 and P2 will pump the liquid from the buffer tank to the main tank and pumps P3 and P4 will remove liquid from the main tank and

Interoperable platform for Romanian Healthcare System

O. Stan*, D. Sauciuc*, L. Miclea*, C. Dehelean*
* Department of Automation,
Technical University of Cluj-Napoca,
Cluj Napoca, Romania,
ovidiu.stan@aut.utcluj.ro

***Abstract*: This article approaches the main challenges of the medical field - the availability of healthcare information at least at national level and it represents an intersection of the computer science and the healthcare field. Our platform shows how to use the computer systems from medical units to create a national network and how to transfer data between these units. The present platform is based on openEHR specifications and the Electronic Health Record Communication EN/ISO 13606 in order to achieve interoperability.**

I. INTRODUCTION

Electronic Health Records (EHRs) have a tremendous potential to improve health outcomes, but, given the fact that they contain and work with socio-demographical and medical data, it is imperative to provide a high level of security and accuracy.

EHRs should contain all the significant events of a person's health history, from minor issues to the most critical medical situations and have to be available at least the entire life of the patient [1]. Nothing is allowed to be excluded or deleted.

Generally, the medical information systems that exist nowadays in Romania store the clinical information in their own format and they don't guarantee that after the exchange of the information, the original meaning of the medical records will be kept.

In papers [2] and [3] it is described why the standardization in this field is important and crucial to reduce medical errors caused by wrong data interpretation and representation. Taking into consideration the issues of common terminology and coding systems, integration and interoperability, security and reliability, it is obvious that solid and well agreed standards are needed.

Because the medical information has to be accessible anytime from anywhere and without regard to where the patient lives or travels the medical information systems must allow the transfer of medical records between different medical units, but without modifying their original medical meaning. Therefore, a medical information system should provide a high level of semantic interoperability. This avoids fragmentation of health data, overloads the databases with the same information, provides a high quality of healthcare and reduces the cost of patient care [4].

The term Interoperability is defined by The Institute of Electrical and Electronics as "the ability of two or more systems or components to exchange and use the information that has been exchanged" [5]. This definition encompasses two separate ideas: the first one is the exchange of the information - technical interoperability - so that it is human readable by the receiver and the second one is the ability to understand and to use the information - semantic interoperability. These concepts are interdependent and we need both of them to bring significant benefits. In fact, in order to achieve semantic interoperability we primarily need the technical interoperability.

In medical informatics field, the European Commission brings forward three types of interoperability [6]:

- "interoperability of electronic health record systems": the data exchanged is both computer and human readable information and knowledge
- "cross-border interoperability": interoperability between different countries and their entire territories
- "semantic interoperability": the precise meaning intended by the original author is understandable by any other system or application

II. CORE CONCEPTS

A. *openEHR Specifications*

The openEHR Specifications are developed by an independent nonprofit community. The aims of the foundation are to facilitate the creation and sharing of health records by consumers and clinicians via open-source and standard-based implementations. The registered online community is composed of 1200 members from 75 different countries. It publishes evolving EHR design specifications, strongly underpinned by live clinical demonstrators, using a multi-model approach, including archetypes [7].

The key innovation of the openEHR architecture is the two level modeling structures obtained by separating record keeping concerns from clinical data collection using archetypes.

The first level, Reference Model, is used to represent the generic properties of health record information. It represents the global characteristics of health record components, the way they are aggregated and the context information required to meet ethical, legal and provenance requirements. This model defines the set of classes forming the generic building blocks of the EHR. It reflects the stable characteristics of an electronic health record [7].

The second level, Archetypes and Templates, are meta-data used to define patterns for the specific characteristics of the clinical data representing the requirements of each particular profession, specialty or service. This level creates a semantic link to the terminologies, clinical guidelines and classifications in the EHRs. The Archetypes are developed by medical staff and, basically,

Using the ARX Model to Determine the Frequency Response of a DC-DC Buck Converter

Liviu Tomesc, Petru Dobra, Bogdan Betea
Automation Department
Technical University of Cluj-Napoca
Cluj-Napoca, Romania
liviu.tomesc@aut.utcluj.ro,
petru.dobra@aut.utcluj.ro,
bogdan.betea@aut.utcluj.ro

***Abstract*—System identification theory provides powerful theoretical tools for the control system design and analysis. Using the ARX model estimation and the system response to a pseudo-random binary sequence, the transfer function and the frequency response characteristics are determined for a partially known system**

Keywords-system identification, system transfer functions, frequency response characteristics, bode diagrams, filter circuit

I. INTRODUCTION

When designing power electronics conversion systems engineers will rarely have complete information required to model the entire plant. This is common in systems built by integrating sub-systems (components, filters, protection devices and loads) designed and manufactured by different companies, which normally provide input and output voltages and power rating of the components but little information about the internal design and structure of their products. Consequently, the design of these systems relies on the experience of engineers and is susceptible to errors.

In this paper, a method based on system identification is proposed to detect those errors, to determine the unknown system characteristics or to determine a valid equivalent model for the entire plant so the regulator can be designed. Other benefits and possible use-cases will be underlined along the way.

II. SYSTEM IDENTIFICATION

System identification theory states that a discrete system can be described by using the general-linear polynomial model. This model provides flexibility for both system dynamics and stochastic dynamics. The general-linear polynomial model is formally expressed by (1)

$$y(k) = z^{-n} G(z^{-1}, \theta)u(k) + H(z^{-1}, \theta)e(k) \qquad (1)$$

where: **u(k)** and **y(k)** are the input and output of the system, respectively

e(k) is the disturbance of the system which usually is zero-mean white noise

$G(z^{-1}, \theta)$ is the transfer function of the deterministic part of the system

$H(z^{-1}, \theta)$ is the transfer function of the stochastic part of the system

The deterministic transfer function specifies the relationship between the output and the input signal. The stochastic transfer function specifies how the random disturbance affects the output signal.

z^{-1} is the backward shift operator

z^{-n} defines the number of delay samples between the input and the output.

$G(z^{-1}, \theta)u(k)$ and **$H(z^{-1}, \theta)e(k)$** are rational polynomials as defined by the following equations:

$$G(z^{-1}, \theta) = \frac{B(z, \theta)}{A(z, \theta)F(z, \theta)} \qquad (2)$$

$$H(z^{-1}, \theta) = \frac{C(z, \theta)}{A(z, \theta)D(z, \theta)} \qquad (3)$$

where vector θ is the set of model parameters.

The following expression shows the form of the general-linear model.

$$A(z)y(k) = \frac{B(z)}{F(z)}u(k-n) + \frac{C(z)}{D(z)}e(k) \qquad (4)$$

The structure and signal flow of the general-linear model is shown next (Figure 1)

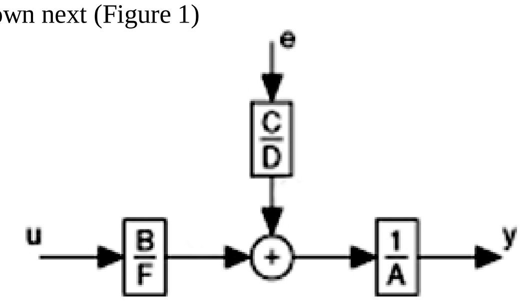

Figure 1. General-linear model.

When C(z), D(z), and F(z) equal 1, the general-linear polynomial model reduces to an autoregressive with exogenous terms (ARX) model. This model is the simplest model that incorporates the stimulus signal but has the disadvantage that the disturbances are part of the system dynamic.

The following expression (5) shows the form of the ARX model[3]