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AUTOMATICA

M. Hadjiski, N. Deliiski, P. Vitchev, D. Angelski, N. Tumbarkova. Computation of Average Moisture Content in Batches of Wood Materials during Thermal Treatment6

Key Words: Wood materials; average moisture content; autoclave steaming; 2D mathematical models; Table Curve 2D; veneer production.

Abstract. A method and an algorithm for computing the average moisture content of the whole quantity of wood materials in given batch subjected to thermal treatment has been suggested. This value of the average wood moisture content is needed for calculation and automatic realization of optimal energy saving regimes for such treatment of the materials. The method is based on the use of two own mathematical models: one of the 2D temperature distributions in non-frozen prismatic wood materials during their thermal treatment and another – of the heat balance of steaming autoclaves. For numerical solving of the models and practical application of the suggested method, a software program was prepared in the calculation environment of Visual FORTRAN Professional developed by Microsoft and operating under Windows. Using this program computation of the non-stationary change in the processing medium temperature in an autoclave during steaming in it of non-frozen beech prisms with different moisture content aimed at their plasticizing before cutting them into veneer have been carried out. The variables used during the simulations were equal, as follows: an initial wood temperature of 0 °C, moisture content u from 0.4 to 0.8 kg·kg⁻¹ with an interval of 0.05 kg·kg⁻¹, and cross-section dimensions of prisms 0.4 × 0.4 m; steaming autoclave with inner diameter of 2.4 m, length of its cylindrical part of 9.0 m, and loading level with prisms of 50%; limited heat power of 500 kW of the generator, which feeds the autoclave with saturated water steam. The calculated by the models increase of the steaming medium temperature in the beginning stage of basic regime at $u = 0.6$ kg·kg⁻¹ is compared with the real increase of that temperature at different values of u , which is periodically measured with a sensor in the automatic control system. After proper processing of the obtained differences between measured and calculated temperatures with the software package Table Curve 2D, an equation for calculating the average moisture content of the wood materials in the whole batch loaded in an autoclave is derived. The good accuracy of the suggested method is proved for the cases of autoclave steaming of non-frozen beech prisms intended for production of veneer.

N. Petkov. How Process Control Systems Development Supports Digital Transformation13

Key Words: Digital transformation; digitalization; process industries; process automation; simulation.

Abstract. The remarkable evolution of technologies in the last decade enables producers of automaton products, software, and systems to go further in their solutions. At the same time process industries are challenged by the continuously changing competitive environment, keeping new health and safety regulations, and developing environmental-friendly products. New business models are created, and producers need to fit to be successful in their markets. Digital transformation (DT) is the way how process industries could go further. Process automation systems takes significant part in that transformation using the latest developed technologies. Different studies and research in the automation control theory, especially in the last decades, provides us the available knowledge base for further technology improvement. Normally there is a timeline gap between the theory and the practice due to the complex mathematical models and algorithms which were difficult and expensive to be executed in a real production process. With the development of the new automation hardware, software technologies and edge devices, driven by Industry 4.0, the implementation of theory is more applicable, and the return of investment is more visible. Nowadays, the development of science and production processes go more and more hand in hand from the stage of conceptual design the products production. The leading role has the rapid

development of artificial intelligence, supported by the availability of new computer technologies, computational algorithms, and programming languages. The aim of this paper is to show a difference in digital transformation of discrete and process industries. The focus is the DT of process automation using parallel examples from the automation control theory and currently available software and hardware solutions.

MODELING AND CONTROL OF ENERGY SYSTEMS

V. Boishina. Applying Machine Learning to Energy Objects Control19

Key Words: SISO; power plant; machine learning; PID control; error assessments.

Abstract. The research is focused on possibility of applying the Machine Learning (ML) approach, which is using previous data knowledge for the energy system and monitored process values for control behaviour. The main focus of the research is to make assessments for the quality of the control process by comparing the classical PID Control algorithm and Machine Learning Control (ML) one. The investigation is based on possibility to apply supervisor Machine Learning Control to Single Input Single Output (SISO) Power Plant. In the current research the previous information about the system data (manipulated, control, output variables and system states) are used for forming the training sets which is used for performing the Machine Learning Control. Some simulation results illustrating the behaviour of the power system, which is controlled via ML and PID have been presented. The research gives some assessments about the quality of the control by assumption for presence of low and big system disturbances and uncertainties, which may occur in energy system. In current paper applying the supervisor ML algorithm is only under consideration. The steady describes the basic architecture of developed software system implementing the SISO Plant Control. The research gives assessments for four cases – PID and ML control with low disturbances, PID and ML control with big disturbances. Also some assessments about system behavior have been made with possibility to overfeed the training set applying big uncorrelated data. The software system is released with java and weka ML library. Realization of system program modules and architecture of the system has been presented.

T. Radeva. Stages and Measures in Preparing an Energy Efficiency Report of an Educational Center25

Key Words: Energy efficiency; survey; costs.

Abstract. The object of the study is treated as an integrated system, consisting of a building, systems for ensuring the microclimate, inhabitants and modes of habitation, climatic effects of the environment. The source information required for the analysis was gathered from existing documentation and surveying. In solving the task, the following methods and procedures were used and applied: interviews with owners; inspections; modeling and simulation of energy transfer processes; calculations. The source information required for the analysis was collected from: existing documentation; recordings. Solving the task is implemented in the following sequence of actions: analysis of the existing situation; formation of the necessary database for modeling and simulation of energy transfer processes; creating models of real energy consumption; establishment of the main energy characteristics under normal mode of exploitation; simulating the energy transfer processes and revealing the potential possibilities for energy saving; generation of energy-saving measures and technical solutions for their implementation; technical-economic evaluation of prospective measures and their combinations; assessment of saved carbon dioxide emissions as a result of the implementation of measures to increase energy efficiency. The presented material reflects only the obtained results without going into detail the implementation of the individual stages.

INTELLIGENT SYSTEMS

A. V. Atanasov, D. Pilev, F. Tomova. Improving the Accuracy of Facial Emotion Recognition through Deep Neural Networks for Facial Emotions and Weather Conditions Recognition30

Key Words: Deep Neural Networks; Facial Emotions Recognition; Weather Condition Recognition; Python.

Abstract. Emotions are one of the main ways to communicate between people and to express their attitude towards objects, products, services, etc. Emotions are divided into two classes – verbal and non-verbal. Human speech and intonation belong to the first class, and to the second class are facial and body emotions, also known as body language. The subject of this paper is facial emotions and their relationship to the scene in which they occur. A number of studies have established that there is a strong relationship between a person's emotions and their surroundings. The latter includes meteorological conditions (weather) and other objects, such as other people, landscape, etc. Facial emotions range (FER) from seven basic emotions (joy, anger, surprise, fear, sadness, neutral and disgust and neutral) categorized by P. Ekman through his Facial Action Coding System

to 26 emotions represented by Russell through his 3D Valence Arousal Dominance model. Most of the existing deep neural networks for Facial Emotions Recognition recognize mentioned seven emotions. In our previous research, we presented a pre-trained FER model with 69.85% accuracy. Weather conditions are closely related to geographic regions and vary in some cases from sunny to cloudy, or in other cases include some subset of sunny, foggy, snowy, rainy, hot, etc. In this research, we analyze deep learning neural networks, for weather conditions recognition and selected appropriate model. We combined our FER DNN with the selected weather recognition DNN and build a bimodal system, which improves facial emotion recognition to 80-83% especially in the cases when FER model provides contradictory results.

ECOLOGICAL SYSTEMS

G. Mihalev, S. Yordanov, H. Stoycheva. Beehive Condition Monitoring System Intended for Application in Beekeeping 37

Key Words: *Beehive monitoring system; precision beekeeping.*

Abstract. *Honey bees are one of the most important insects for human existence. They have a main role in the production of various agricultural crops, as well as in the development of nature itself. Currently, bee colonies are facing many problems related to climate change, diseases, chemical pollution and most of all human activity regarding the development, production and sustainability of the bee colony. The aim of the present development is to provide a solution or at least to partially suppress certain problems of bee families during their development in their active period, with a minimum expenditure of resources. These problems can be summarized as problems related to the health of the hive, problems related to reproduction and problems related to the production of certain bee products (honey, pollen and wax). A system for monitoring of some bee colonies parameters in real time is proposed, based on cloud services and a microprocessor system with a set of sensors. The obtained information can help the beekeeper take timely action with minimal stress to the bees in the colony. The developed system is based on an ESP32 microcontroller and measures basic parameters, such as internal and external temperature, humidity and weight of the beehive. The data is stored in a cloud structure with a good graphical presentation environment for the purpose of subsequent analysis. Attention is paid to energy saving and communication in difficult to reach places and regions. The architecture of the system and its implementation are described in details. The developed system can be used to monitor the production of honey, prevent the process of swarming, as well as to maintain a high health status of the bee colonies. Results of actual data obtained for the observed values during the active period of development of a beehive are presented. Through the technical and economic analysis, information is given about the achieved socio-economic results.*

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