ABSTRACTS

Chapter 1. Robust dynamic neural network models implementation in the framework of DIASTER. The chapter deals with the implementation of plugins of the MITforRD platform intended for the robust neural modeling. The MITforRD platform is one of components of the DIASTER system elaborated and developed during the realization of the grant entitled Intelligent diagnostic and supportive control system for industrial processes. The chapter consists of two parts. The first part includes two sections describing dynamic neural networks, which have been used to realize plugins: locally recurrent networks and networks of the GMDH type. The second part deals with the general information about the implementation of plugins in the CodeGear ™ environment and shows graphical user interfaces. The utilization of plugins is illustrated on the example of the modeling of an industrial process. – J. Korbicz, K. Patan, M. Witczak, P. Prętki, Ł. Dziekan.

Chapter 2. Modeling of dynamic systems in the PExSim package of DIASTER. In the chapter fundamental properties of the package PExSim as a tool for modeling of complex dynamic processes are presented. In introduction the main principles of package construction and modeling way, based on the plugins technology, are shortly discussed. A variety of operators, structures and tools for constructing and operating with different presentations of process dynamics, are presented. Possibilities of using different input signals via generators, connection with physical environment or file data import, together with tools of processing simulated data and exporting them to a real plant, are next discussed. A variety of dynamic components for representation in the form of linear or non-linear dynamic blocks (set of equations), dynamic discrete-time models in the form of linear, fuzzy or neural nets, and programmed shell models of components, are presented. Shell libraries are constructed as models for dynamic processes (like pneumatic, electric, hydraulic, and others), which can be connected in complex systems. Exemplary applications are presented, and a discussion of the *fast prototyping* approach to design and examination of a main drive for the HSIMM prototype is given. – K.B. Janiszowski.

Chapter 3. Predictive control and set–point optimization in the DIASTER system. This chapter describes predictive control algorithms and set-point optimization co-operating in the multi-layer control system structure. All elements of this structure are implemented DIASTER system as independent function blocks. Different kinds of MPC algorithms available for a control engineer are briefly discussed. All blocks are designed and implemented in a numerically efficient and reliable way. In the steady-state target optimization, instead of a complicated nonlinear optimization problem, an easy to solve linear one is used. MPC algorithms based on nonlinear neural and fuzzy models are implemented using the successive linearization approach. –P. Tatjewski, M. Ławryńczuk, P. Marusak.

Chapter 4. Relay self-tuning in the DIASTER system. Self-tuning, adaptation and supervisory control of PID loops are low-order functions of the DIASTER diagnostic and control system. The self-tuning uses the relay oscillation method due to possible interactions between control loops. The Åström and Hägglund settings for a PID controller have been extended so as to provide smooth set-point step responses and slightly oscillatory disturbance responses for a rather broad class of control plants. The settings depend here on plant dynamics determined by the ratio of the delay to the oscillation period. The structure of the PID loop has been also modified so that it resembles the structure used in servos. As appeared, relay control does not have to be symmetric. – A. Stec, Z. Świder, L. Trybus.

Chapter 5. A fault-tolerant control scheme with input constraints for Takagi-Sugeno fuzzy systems. In this chapter, an active FTC strategy is presented. First, it is developed in the context of linear systems and then it is extended to Takagi-Sugeno fuzzy systems. The key contribution of the proposed approach is an integrated FTC design procedure of the fault identification and fault-tolerant control schemes with input constraints. Fault identification is based on the use of an observer. While, the FTC controller is implemented as a state feedback controller. This controller is designed such that it can stabilize the faulty plant using Lyapunov theory and LMIs. **–** Ł. Dziekan, M. Witczak.

Chapter 6. Robust fault isolation in the DIASTER system. At the beginning, the causes which can lead to generation of false diagnosis are presented. They are as follows: changes in the set of available measurements and diagnostics tests, changes of the diagnosed process structure, uncertainty of symptoms, symptoms delays, etc. A robust method of fault isolation is described. It has the ability to formulate proper diagnosis in spite of the existence of the above specified causes which disturb the process of diagnostic reasoning. This method was implemented in an intelligent system DIASTER of diagnosis and control-support build for industrial processes. – J.M. Kościelny, M. Syfert.

Chapter 7. DIASTER – an intelligent system of diagnostic and control support of industrial processes. A system DIASTER, implementing advanced methods of modeling, diagnostics and supervisory control of industrial processes, is presented. The scope of the tasks realized in the system as well as the system software platform are characterized, and in particular: the software structure, central archival and configuration databases, the way of data exchange in the system and the modules of modeling and calculations. – P. Wnuk, M. Syfert, J. M. Kościelny.

Chapter 8. Knowledge discovery in databases for diagnosis and control in the DIASTER system. The chapter deals with theoretical background and selected information concerning the implementation of modules of a subsystem of knowledge discovery in databases of DIASTER system. The methods were selected taking into consideration their prospective usefulness for acquiring knowledge about dynamic processes. Developed modules of the system comprise the phases of signal selection and observation time-interval selection. Two kinds of knowledge discovery methods are implemented. The first one is the support vector machines. It allows to create models, which can be used for predicting values of process signals. The second group of methods makes possible building knowledge bases as databases of examples, which conversely can be applied in the case-based reasoning method. Furthermore, ways of applying the acquired knowledge are described. Examples of the application of the elaborated methods are shown. The chapter ends with conclusions including the plans concerning the further work. **–** W. Moczulski, P. Tomasik, D.Wachla, R. Szulim.

Chapter 9. Diagnostics with application of belief networks in DIASTER System. The chapter presents diagnostic model based on a Bayesian network which is called a *belief network based model* (BNBM). Easy identification and interpretation of its elements by the users was a key criterion taken into account while introducing the BNBM model. The model allows for knowledge representation with different sources, *e.g.* knowledge acquired from diagnostic experiments, formalized knowledge in the form of diagnostic relations and general domain knowledge, like physical laws, *et cetera*. The main advantage of the BNBM model lies in the possibility of taking into account the partial diagnostic knowledge expressed in a specific context by experts (in the form of approximate or subjective opinions). The general three stage model structure is shown and issues connected with identification, application and model tuning are discussed. The implementation of BNBM model was developed in the form of a MidFoRD module of the DIASTER system. **–** W. Cholewa, P. Chrzanowski,T. Rogala.

Chapter 10. A fuzzy logic diagnostic algorithm organizing the air-condition control system in a conference hall. The chapter presents the problem of automatic control of a heating and air-condition system in conference halls with an changeable structure and shape. Modern conference halls are often designed in such a way that there are possibilities of making many different arrangements within the limits of one expanse. A great hall can be divided into three smaller rooms, for instance. It is obvious that each possible configuration should require different algorithms of heating and air condition control. In order to solve this problem, a system of fuzzy diagnosis was designed based on control parameter estimation. – M. Lower.

Chapter 11. Application of dynamic neural networks with embedded ARMAX systems for fault diagnosis. The chapter deals with the neural modeling of dynamical processes in fault diagnosis. The proposed methodology is based on locally recurrent neural networks and the principles of chaos theory. A brief description of dynamic neural units and locally recurrent neural networks composed of such elements, a hybrid training method, and some methods for relevant inputs and architecture selection are presented. Finally, an intelligent servo-actuator, proposed as a benchmark fault detection test in the framework of European RTN DAMADICS, is employed to illustrate the application of the proposed method. **–** P. Przystałka.

Chapter 12. Modeling of the control and diagnostic system using fuzzy interpreted Petri nets. The chapter presents how to use fuzzy interpreted Petri nets in the control system of two substance mixer. Basic definitions of this net are given. Control operations are assigned to places with unit capacity. Places that can store more fuzzy tokens are used for modeling quantitative changes of components. As indicated, control systems based on such nets can be easily expanded by adding diagnostic functions. In the example presented, the uniformity of components proportioning was monitored. It is demonstrated that the activation of a diagnostic transition can depend on marking of the places belonging to the control system network. Control operations assigned to places of the net can be modified by actions bound to places responsible for diagnostics. It is revealed in this way that diagnostics can dynamically influence the work of control systems based on the fuzzy interpreted Petri nets. – L. Gniewek.

Chapter 13. Additive models in the fault detection scheme for sugar evaporator. In this chapter, additive models and statistic techniques of knowledge/data discovery are applied for constructing a model of a sugar evaporator for the purpose of detecting faults in an actuator of an evaporation station. The results of modeling and the fault detection procedures are presented. The research was carried out based on real process data recorded in the Lublin Sugar Factory. The obtained results are satisfactory as the proposed methods detected all simulated faults. Therefore, it is an effectiveness methods for the multivariate industrial process fitting and fault detection in analyzed structures. **–** Z.M. Łabęda.

Chapter 14. Analysis of pipeline dynamics for leak diagnosis purposes. It is shown that occurrence of a leak in a pipeline affects not only its steady-state characteristics, such as pressure and flow distribution, but also its dynamical properties. The transfer function of the pipeline, representing its hydraulic impedance at the valve, defined as the ratio of the complex pressure to the complex flow, changes due to the leak. This affects also the pipeline frequency response. The leak in the pipeline causes partial reflections of the pressure wave fronts, visible in the frequency domain as increase in the damping of the pressure signal. The preliminary analysis shows that patterns introduced into pipeline frequency response by the leaks of different sizes and locations can be used as symptoms, allowing leak detection and classification. – K. Bartecki.

Chapter 15. Modeling and visualization of spirometry measurement – a diagnostic support. The respiratory system functioning is based on the ventilation mechanism whose efficiency is assessed spirometry measurements. The quality of the lung depends on the quality of lung ventilation. In this chapter, modeling of spirometry measurement and visualization of both the measurements and the resulting model are presented. The verification, based on the disease simulation, revealed the diagnostic usefulness of model parameters and visualization. The model spirometry parameters allow to distinguish between healthy and diseased subjects. The visualization of the respiratory system supports the diagnostic process. A graphical presentation of data makes it more clear. The attained outcomes allow us to postulate that the visualization of the spirometry measurements and the model parameter estimates can be successfully applied for diagnostic purposes. – R. Kalicka, W. Słomiński, K. Kuziemski.

Chapter 16. Reduction of dimensionality and size of a sample for synthesis of a statistical fault detection system. The subject of this chapter is the task of reducing the dimensionality and the size of a random sample allocated for exploratory data-mining procedures, developed using the statistical kernel estimators methodology. The concept is based on linear transformation, whereby the elements of its matrix are calculated by a simulated annealing meta-heuristic. Moreover, elimination or reduction in importance of the sample elements which substantially change their positions, is proposed. The presented method was successfully verified for the tasks of identification of atypical elements (outliers), clustering and classification, where appropriate usage allows designing effective statistical fault-detection systems for dynamical processes, with the purpose of detection, diagnosis, and related prediction. The reduction of dimensionality and the size of samples enables an increase in the number of variables used for inference regarding the technical state of a supervised system, and allows for savings in the number of incorrect indications and the calculation time. – P. Kulczycki, S. Łukasik.

Chapter 17. Time series similarity measures for event detection. The chapter presents a concept of measuring temporary similarity of short subsequences in time series employing distance methods. Three original measures, oriented to the detection of patterns in time series (including simultaneous and delayed ones), the detection of shape similarity in time series and the identification of similar subsequences of different lengths, are presented. The results of the efficiency analysis of the proposed measures applied to simulated and real data (converted with four unifying transformations) are shown. – J. T. Duda, T. Pełech-Pilichowski.

Chapter 18. Equivalence of Boolean classifiers. In the chapter the equivalence of Boolean classification algorithms is shown, the measure of similarity between them based on a correlation coefficient is introduced and the relations between the complexity of Boolean functions and the generalization performance of the classifiers are discussed. **–** W. Jędruch, J. Dembski.

Chapter 19. A diagnostic expert system for a distributed structure of control systems. The diagnostic expert system described in the chapter is an original programming solution based on a concurrent reasoning mechanism in the object-oriented environment of Java language. The expert system supports the proper operation of microprocessor devices in a distributed multi-layer network structure. The chapter describes the most essential elements of the system structure used for editing the knowledge base and for reasoning. A new idea of mapping the expert knowledge along with a graphical visualization of relations between the rules is also presented. – W. Wajs, M. Skuba.

Chapter 20. Hierarchical Pareto-optimization of detection observers. A possibility of using evolutionary methods of multi-objective optimization of engineering systems is considered in this chapter. The method is founded on the idea of hierarchical rank assessment in the Pareto sense (HRP). The proposed method is an extension of our previous evolutionary approach based on genetic genders used for solving multi-objective optimization tasks. In particular, the multi-level ranking HRP leads to a scalar evaluation of each solution (individual) without the necessity for arbitrary weighting. This approach facilitates the issue of forming sub-criteria, allows for a complete multi-objective assessment, and assists the designer in choosing a final solution, as well as establishes an entirely new mechanism of selecting individuals for the parental pools in evolutionary computations. Effectiveness of the proposed approach is illustrated by means of an exemplary solution to a problem of designing linear state observers working as detection filters. – Z. Kowalczuk, T. Białaszewski.

Chapter 21. Safety management problems of a hazardous industrial plant. In this chapter selected issues concerning the safety management in an automated complex hazardous plant are presented. It is shown that the risk of losses can be significantly reduced using appropriate technical solutions in the form of a layer protection system, which includes a basic process control system, human-operator and protection automatics. The significance of appropriate design of alarm systems that contributes to decreasing the human-operator error probability, is emphasized. The functional safety management, which includes the risk control in a life cycle of complex plants, is to be carried out in relation to the requirements associated with avoiding of systematic failures in programmable systems of protection automatics and probabilistic criteria that concern performing the safety-related functions on demand. – K.T. Kosmowski.

Chapter 22. Reliability assessment based on soft and hard failures. Higher reliability requirements of electronic elements make their producers use new methods to assess reliability, based on both hard-failure distribution time and degradation processes. This chapter presents the possibility of using joint information about hard and soft failure distribution. Reliability distribution based on hard failures can use traditional statistical analysis, like exponential or Weibull distributions, and can be derived based on observation times to these kinds of failures. Reliability distribution based on soft failures is described by inverse Gaussian distribution. Time distribution of soft failures is derived from modeling degradation processes with stochastic differential equations. By observing the initial part of degradation process, one can derive the parameters of these equations, and then simulate expected processes. – R. Kopka.

Chapter 23. Increasing efficiency of communal waste processing using high pressure technology. The chapter discusses the problem of communal waste processing. High pressure technology has been used in the proposed system. After experiments, a comparative analysis of the traditional processing and the processing with the constructed machine has been performed. The analysis of service conditions of the machine and the proprieties of dry and wet waste fractions resulted in several interesting conclusions. – T. Komorowski, I.J. Jóźwiak.

Chapter 24. Information technologies in radiology monitoring systems. In the chapter dosimeter gates monitoring system installed on roads, railway and airport of Polish cross borders is presented. The functionalities, structure and basic components of the elaborated monitoring system, as well as current computer technologies used in the development of the system are outlined. Special attention is paid to *Web Services*. An essential requirement put by the system user was the accordance with the regulations concerning personal data protection. The first version of the monitoring system was installed on the new international airport Bydgoszcz. Four dosimeter gates were installed and connected by means of the Border Guard Intranet with the central data-base server in Border Guard Head Quarter in Warsaw. Other border crossings will be connected to the central server when exchanging currently working old dosimeter gates to a new generation of dosimeter gates. – E. Michta, R. Szulim.

Chapter 25. Fuzzy cognitive maps in relational modeling of monitoring systems. Dynamic models of the relational fuzzy cognitive structures are designed. A simulation analysis has been performed. It is shown that created structures properly represent the relations between input and output factors of the monitored system. It results that such a type of structures can be applied in the systems for monitoring technical objects. – A. Jastriebow, G. Słoń.

Chapter 26. Network monitoring and diagnosis of processes. The chapter presents a method of creating an interactive system for monitoring technical parameters of plant objects over network, as well as its construction. Our application is equipped with relational database systems and dedicated diagnostic software. Data transmission is realized with the use of the standard ZigBee. – Z. Kowalczuk, J. Wszołek.

Chapter 27. Open architecture of documents supporting decision-making in knowledge-based organizations. Decision-making problem in knowledge-based organizations is connected with the necessity of collaborative work in terms of incomplete knowledge and information, or in conflicting situations. The open architecture of documents that provides an automated circulation of them between knowledge workers and improves their access to the desired information. Their interaction with a distributed processing system that offers efficient circulation of documents allows us to solve non-algorithmic decision-making problems. Effective exchange of information managed by the system helps to prevent from losing data and hastening the process, assists the procedures, and allows for remote collaboration. – M. Godlewska.

Chapter 28. Process of evolving e-petition documents using genetic algorithm. Transferring the iterative collaboration on petition documents into Internet is not an easy task. The Internet societies expect efficiency and swiftness in reaching the point in which it can be well employed. The mechanism of legislative initiatives can be an example. Modeling the process of e-petitioning document development using genetic algorithms is proposed. Findings from the experiments allows for stating the accuracy and scalability of the approach. – A. Ryszewski.

Chapter 29. Fingerprint classification using computational intelligence algorithms in medical diagnostics. The chapter describes an application of image processing and computational intelligence algorithms in classification of fingerprints. The described classifier is a part of an automatic system for rapid screen diagnosis of trisomy 21 (Down syndrome) in infants. The system supports anthropologist by automatic processing dermatoglyphic prints and detecting features indicating the presence of genetic disorders. Images of dermatoglyphic prints are pre-processed before the classification stage to extract features analyzed by the SVM ealgorithm. Experiments are conducted on the database of the Collegium Medicum Jagiellonian University in Cracow. – W. Wajs, H. Wojtowicz J. Wojtowicz.

Chapter 30. Applications of image super resolution in process diagnostic. In this chapter an image super resolution application is shown. Super resolution allows one to obtain a single high resolution image from a sequence of several low resolution images. There is a slight difference between super resolution and interpolation. Super-resolution images demonstrate improvements in the perceived detail content as compared to that of low-resolution images, the interpolated one has only more pixels, but does not have more details. Super-resolution is applied at a diagnostic signals generation stage. Defects of paving stones, originated during a production process have been taken into account. The use of images with increased resolving power enabled detection of some defects and their recognition. As a consequence, more reliable diagnostic signals were obtained, which can be considered as a basis for accurate diagnosis. – W. Jamrozik

Chapter 31. Double fault isolation. The chapter shortly characterizes the current state of investigations and points out to the necessity of isolating double faults in industrial processes. A simple algorithm of double fault isolation, assuming binary evaluation of residuals, is given and two examples of using the linear description of a diagnosed object are presented. The results achieved for linear models are compared to ones of a non-linear model. – Ł. Gozdek.

Chapter 32. Multivariate analysis of parameters within a steam and gas power plant. The chapter explores the use of multivariate methods approach to model and monitor of some parameters of a gas and steam power block within CHP plant in Zielona Gora. Models are built based on partial least squares regression techniques and then applied to real data sets. Examples show that the model predictions correspond with process measurements. The deviations and instrumental failures in the process are correctly detected. – J. Gramacki, A. Gramacki.

Chapter 33. Fault detection of a mobile robot using of dynamic neural networks. In this chapter the problem of mobile robot fault detection with a locally-recurrent globally-feedforward neural network is considered. The neural network is applied to the mobile robot modeling task. This model can be used for fault detection procedure to generate residuals. The chapter presents some basic concepts related to the mobile robot diagnosis. Special emphasis is put on a method which makes use of analytical redundancy. Neural network models with local feed back are introduced. The chapter presents the proposed FDI scheme, which is next applied to the problem of a mobile robot diagnosis. At the end of the chapter, simulations results of the robot at the nominal and faulty states are presented and summarized. – M. Zając, K. Patan.

Chapter 34. System facilitating communication with hearing-impaired people. The chapter is devoted to the mechanism which facilitates communication with hearing-impaired people. The key element of the program is an application which translates the written Polish texts into the sign language. It uses two complementary databases: the main one consists of the list of lexemes with their characterization, and another containing a set of grammatical and semantic facts. The message is to be conveyed in several phases. The core (ideographic) information will be complemented by the mimic signs and the synthesized speech. The main application joins all the modules and serves as an interface. The authors claim that the program will be helpful in offices, healthcare centers, schools, and so forth. – W. Kozioł, W. Wajs, K. Sikora.

Chapter 35. Predicting an indicator of respiratory deficiency intensification with the use of an artificial immune system. In this chapter an artificial immune system is applied in the process of medical data prediction. The purpose of the system is to predict the parameter pO_2/FiO_2 indicating the respiratory deficiency intensification. Prediction is carried out for the period of first three days of patient's hospitalization. Positive evaluation of the indicant prediction accuracy can be a basis for building software supporting a physician in the decision making process concerning the patient treatment. – W. Wajs, P. Wais, M. Święcicki.

Chapter 36. Machinery diagnosis center – an architecture proposal. The work presents advantages of using monitoring and diagnostic systems. Dissemination of such systems causes problems in the analysis of quickly growing amount of data. They require highly specialized experts and limits for the time spend on a single machine analysis. A solution lies in a diagnostic center, which can acquire the data from local monitoring systems and (to a maximum possible extent) analyze these data in an automatic way. The chapter describes fundamental features of such a center, and proposes an organization of its operation. The chapter further describes the hardware-software architecture of the center, and presents details of its modules. – T Barszcz.

Chapter 37. Diagnostics of machine seals. The basic measure of the technical condition of machine seals is tightness measured in the units of leakage. This chapter describes seals used in machines in terms of their construction and provides exemplary values of maximum admissible leaks. The mechanism of wear, leading to increased leakage via seals, is characterized. A classification of measurement methods and leak tightness tests are given. The applied leak tightness diagnostics are described. Alternative methods of leak tightness assessment are also pointed out. It has also been shown that machine seal is increasingly regarded as a mechatronic element, in which the sealing and measurement functions are integrated. – P. Bielawski.

Chapter 38. Application of data mining methods for detection and analysis of faults in a mining cutter-loader. In this chapter, chosen data-mining techniques are used for the purpose of detecting faults in mining cutter-loaders based on diagnostic relations automatically discovered. In a sense, the technical condition of machinery can be assessed without installing specialized diagnostic systems. The results of such an assessment are explained by a set of simple rules concerning the values of measured data taken from servicing protocols. The classification models built in this way, can be applied for forecasting changes in the state of a device. Another application of this knowledge can be found in identification of most fallible components that require attention during exploitation. The data mining methods can also be used for forecasting the scope of servicing activities. Discovered sequences of maintenance actions create the opportunity to optimize maintenance strategies by servicing the selected parts during one machinery stoppage. – M. Gibiec.

Chapter 39. Systems detecting, analyzing and fault tolerant. Possible interpretation of the measurement uncertainties of the measured values characterizing power units operation and the measured values of working media in the power cycle, is presented in the chapter. The presented analysis concerns also uncertainties of the measurements necessary for calculating inefficient operation symptoms and uncertainties of determining such symptoms. The possible method to limit these uncertainties for set for complex power DCS systems is discussed. – J. Głuch.

Chapter 40. Improvement of effectiveness of diagnosing leakages in pipelines using a new method of measuring diagnostic signals. A method of measurement of new diagnostic signals is proposed in this chapter. A characteristic feature of this method is the use of active sensors performing corrective function. The system has an improved relationship between the range of measured quantity changes and the measuring range of sensor. The proposed solution was tested on a laboratory model pipeline. The acquired diagnostic signals were subjected to estimation and comparison with pressure signals and their differentiated forms used so far. Using the new and former signals within the method of detecting pressure waves, diagnosis of simulated leakages was performed. An improved version of the detection algorithm is also suggested. It is shown that due to the new diagnostic signals and the elaborated algorithm it is possible to improve the diagnostic susceptibility of pipelines and to increase the effectiveness of diagnosing leakages, as compared to the earlier solutions. – P. Ostapkowicz.