Selected Problems of Recognition and Evaluation of Natural Language Commands

Maciej Majewski[1], Wojciech Kacalak[1], Keith Douglas Stuart[2] and David Cuesta Frau[3]

[1] Technical University of Koszalin, Department of Mechanical Engineering
Raclawicka 15-17, 75-620 Koszalin, Poland
{maciej.majewski, wojciech.kacalak}@tu.koszalin.pl
[2] Polytechnic University of Valencia, Department of Applied Linguistics
Camino de Vera, s/n, 46022 Valencia, Spain
kstuart@idm.upv.es
[3] Technological Institute of Informatics, Polytechnic University of Valencia
Plaza Ferrandiz i Carbonell, 2, 03801 Alcoy, Alicante, Spain
dcuesta@disca.upv.es

Abstract. New applications of artificial neural networks are capable of recognition and verification of effects and the safety of commands given by the operator of the technological device. In this paper, a review of selected issues is carried out in relation to estimation of results and safety of the operator's commands as well as the supervision of the process. A view is offered of the complexity of effect analysis and safety assessment of commands given by the operator using neural networks. The first part of the paper introduces a new concept of modern supervising systems of the process using a natural language human-machine interface and discusses general topics and issues. The second part is devoted to a discussion of more specific topics of automatic command verification that has led to interesting new approaches and techniques.

1 Intelligent Two-Way Communication by Voice

The advantages of intelligent two-way voice communication between the technological devices and the operator in Fig. 1 include the following [1,3]:

- More resistance from the operator's errors and more efficient supervising of the process with the chosen level of supervision automation.
- Elimination of scarcities of the typical co-operation between the operator and the technological device.
- Achieving a higher level of organization realization of the technological process equipped with the intelligent two-way voice communication system, which is relevant for its efficiency and production humanization.
- No need of an operator being present at the work stand by the technological device (any distance from the technological device) [7].

Advances in Artificial Intelligence
Research in Computing Science 20, 2006, pp. 77-82

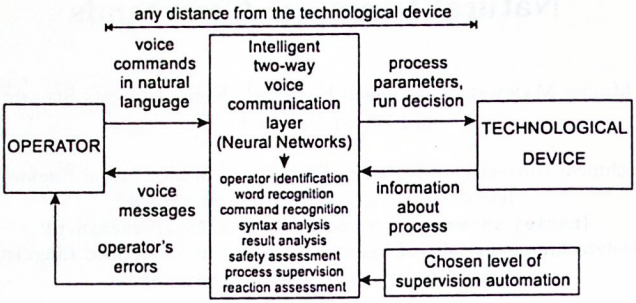

Fig. 1. General scheme of intelligent two-way voice communication between the technological device and the operator

The intelligent two-way voice communication layer in Fig. 2 is equipped with the following intelligent mechanisms: operator identification, recognition of words and commands, command syntax and result analysis, command safety assessment, process supervision, and also reaction assessment [2].

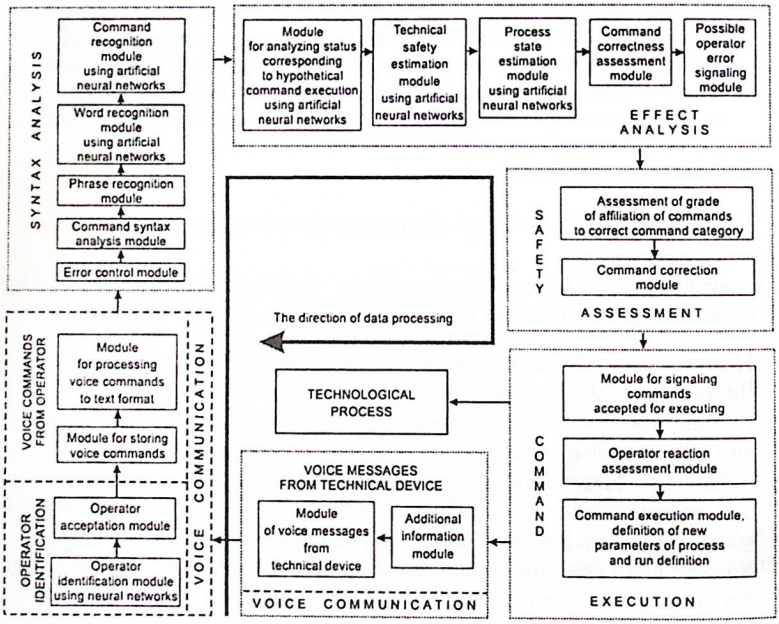

Fig. 2. Scheme of the intelligent layer of two-way voice communication

2 Command Safety Estimation

The effect analysis module, shown in Fig. 3a, makes analysis of the recognised command. The technical safety of the technological device is checked by analysing the state of execution of the commands required to have been done as well as the commands to execute in subsequent decisions. The process parameters to be modified by executing the command are checked and the allowable changes of the parameter values are determined. The analysis of the parameter values is based on the technological process features. The values of the parameter changes are the input signals of the neural network of the process state assessment system. The neurons of the neural network represent solutions to the diagnostics problem. The neural network also makes an estimation of the level of safety of the recognised command. The system for checking the state of the automatic device for grinding small ceramic elements is shown in Fig. 3c, before executing the subsequent commands presented in Fig. 3d. The technological safety assessment system, shown in Fig. 3b, is based on a neural network which is trained with the model of work of the technological device. New values of the process parameters are the input signals of the neural network [6]. As the work result of the system, voice messages from the technological device to the operator about the possibility of executing the command are produced [4,5].

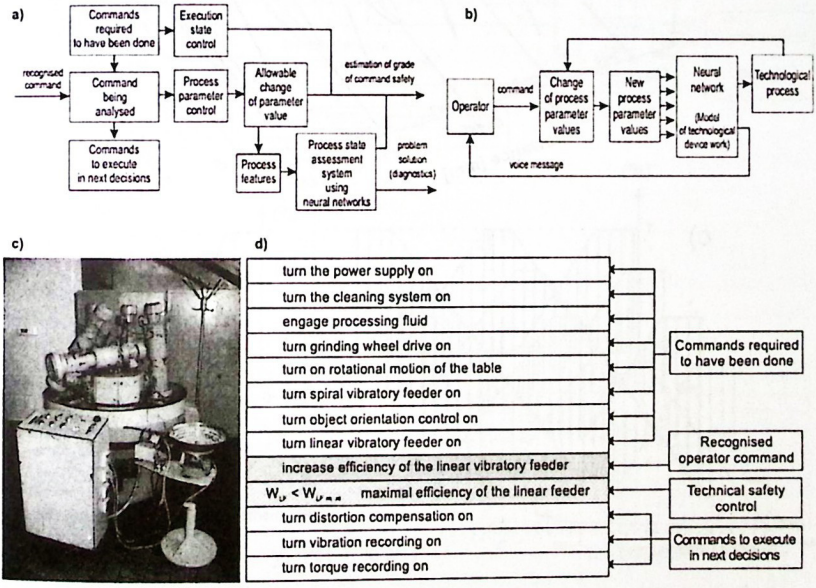

Fig. 3. Scheme of the command effect analysis and safety assessment system

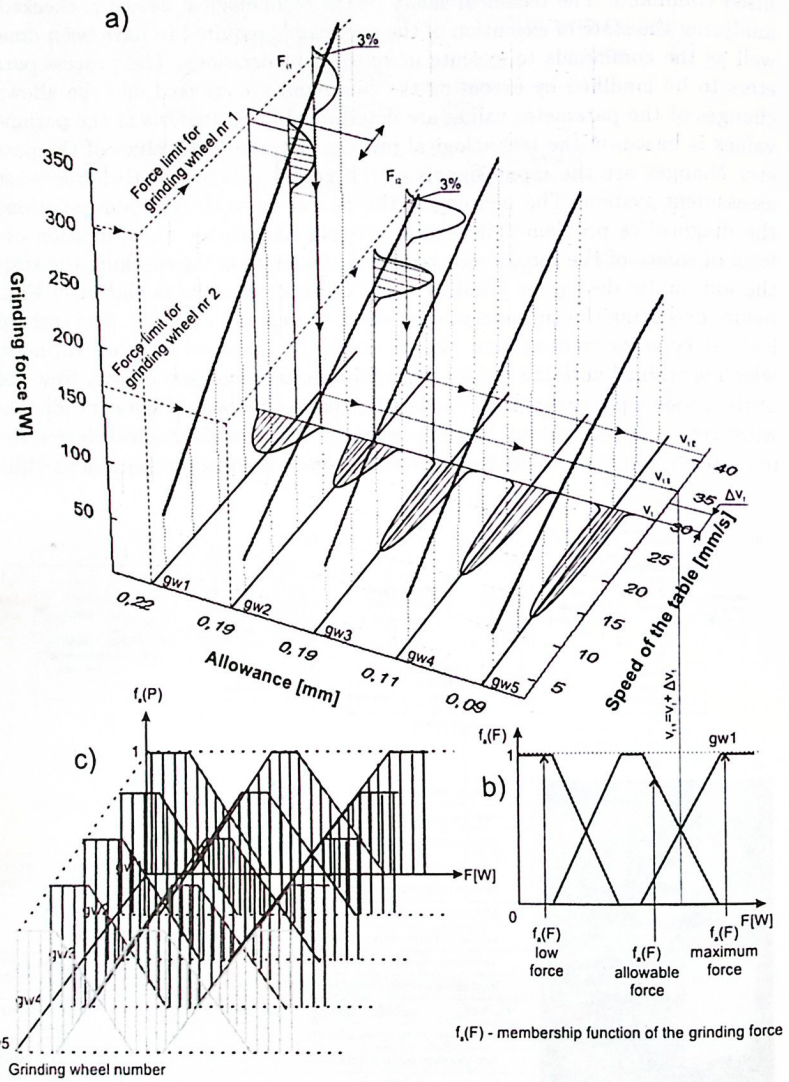

Fig. 4. Algorithm for assessing the technological safety of commands based on the real technological process

An algorithm was created for assessing the technological safety of commands. In Fig. 4, the lines represent force dependence on the grinding process parameters for particular grinding wheels. Based on the specified criteria, the grinding force limit is determined for each grinding wheel. Based on the grinding force limit, the table speed limit is assigned. According to the operator's command, if the increase in speed makes the speed of the table smaller than the smallest speed determined from the force limit for all the grinding wheels, then the command is safe to be executed.

3 Research Results

The simulation set of the technological device diagnostics and the process state assessment, built for creating and training artificial neural networks is shown in Fig. 5a. The neural networks are trained with the model of the technological

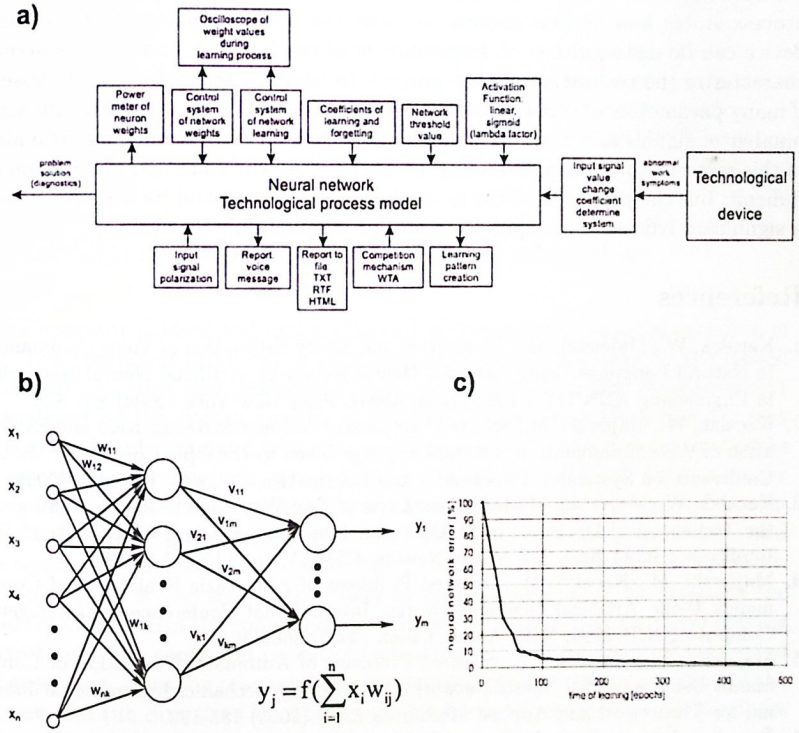

Fig. 5. Neural network simulations of the technological process models, neural network architecture and error rate

process. The applied neural network architecture is presented in Fig. 5b. The networks consist of two layers of neurons with the competitive mechanism.

The ability of the neural network to learn to recognise specific process states depends on the number of learning epochs. The specified time of learning enables the network to minimize the error so that it could work more efficiently. Based on the research, the following conclusion has been reached as shown in Fig. 5c.

Error rate is about 20% at learning time equals 50 epochs and 5% at 100 epochs. The error rate dropped by about 90% after training with 60 series of all patterns.

4 Conclusions and Perspectives

In the automated processes of production, the condition for safe communication between the operator and the technological device is analyzing the state of the technological device and the process before the command is given and using artificial intelligence for assessment of the technological effects and safety of the command. In operations of the automated technological processes, many process states and various commands from the operator to the technological device can be distinguished. A large number of combined technological systems characterize the realization of that process. In complex technological processes, if many parameters are controlled, the operator is not able to analyse a sufficient number of signals and react by manual operations on control buttons. The aim of this research to develop an intelligent layer of two-way voice communication is difficult, but the prognosis of the technology development and its first use shows a significant efficiency in supervision and production humanisation.

References

1. Kacalak, W., Majewski, M.: Recognition and Safety Estimation of Voice Commands in Natural Language Using Artificial Neural Networks. Artificial Neural Networks in Engineering ANNIE 2004 St. Louis. ASME Press New York (2004) 831-836
2. Kacalak, W., Majewski, M.: Selected Problems of Automatic Recognition and Evaluation of Voice Commands in Natural Language Given by the Operator. World Multi-Conference on Systemics, Cybernetics and Informatics, Orlando, Florida (2005)
3. Kacalak, W., Majewski, M.: Intelligent Layer of Two-Way Speech Communication of the Technological Device with the Operator. International Conference on Artificial Intelligence ICAI 2005, Las Vegas, Nevada. CSREA Press (2005) 779-785
4. Majewski, M., Kacalak, W.: Selected Problems of Automatic Evaluation of Commands Using Artificial Neural Networks. International Conference on Intelligent Computing ICIC2005, Hefei Anhui, China (2005) 3605-3614
5. Majewski, M., Kacalak, W., Selected Problems of Automatic Evaluation of Commands Using Artificial Neural Networks. Engineering Mechanics International Journal for Theoretical and Applied Mechanics 12(3) (2005) 185-192
6. Principe, J. C., Euliano, N. R., and Lefebvre, W. C.: Neural and Adaptive Systems: Fundamentals through Simulations. John Wiley and Sons Inc., New York (2000)
7. O'Shaughnessy, D.: Speech Communications: Human and Machine. IEEE Press, New York (2000)