BASIC CONCEPTS AND APLICATIONS OF THE EXPERT SYSTEMS IN ELECTRICAL TRACTION

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În lucrare sunt prezentate conceptele de bază referitoare la sistemele expert destinate diagnozei acționărilor electrice pentru troleibuz fiind de asemenea descrise structura şi funcțiile logice ale vehiculului. Sistemul expert are ca scop principal diagnoza şi mentenanța echipamentului electric al vehiculului.

The paper presents basic concepts about expert systems designed for diagnosis of electrical drives in the case of trolleybus. General structure and logical functions of the drive system are described. The Expert System is implemented for online diagnosis and maintenance of the electrical vehicle.

Keywords: expert system, diagnosis, trolleybus.

Introduction

It is well known that by means of a computer we can solve problems on the base of specified algorithms, which perform repetitive mathematical operations to final results. When the complexity of the engineering systems is high, only algorithms aren't enough, human experience combined with exact science take place, and the final device is the Expert System.

The paper describe the philosophy of the Expert System designed for diagnosis, test and control of the trolleybus equipment as a whole, beginning with the traction equipment, auxiliaries, and finishing with all the other electrical devices that assure human comfort on board (e.g. air conditioning system).

1. Decisions chain

The decisions chain for an Expert System represent the base of his interaction with the controlled device. Its components are presented in the Fig. 1, as follows:

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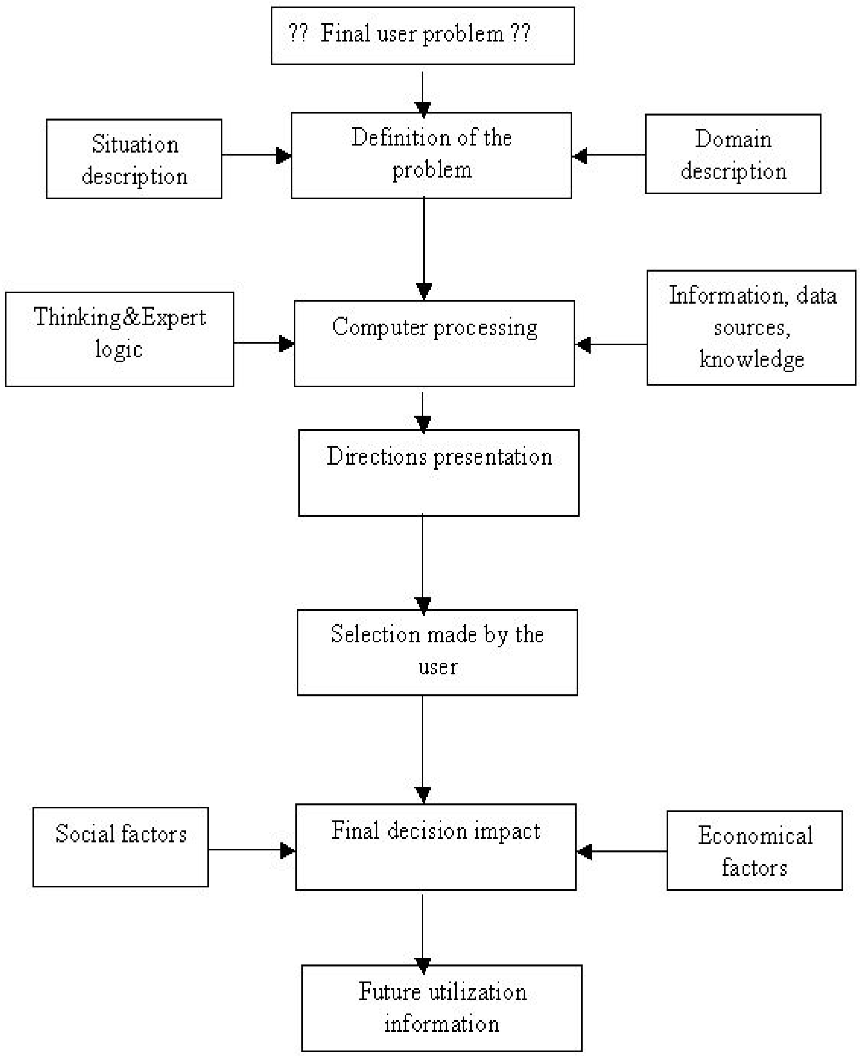


Fig. 1. Basic components of the decision chain of the expert system

- *End user problem*: within this step the end user will determine the question that will be asked to the program.
- *Problem definition*: here must place the development in a clearly manner of the problem together with the establishment of the main wanted goals to rich. This information-processing step represents the

including in a symbolic manner of the information that describes specifically conditions of the fault situation.

- *Description of the domain*: here will be included the information that describe in a general mode the necessary knowledge to make possible to solve the fault situation.
- *Computer processing*: in this step the information will be transposed into a software program together with the human expert logic by a software programmer specialist, which will make the final implementation of the code on the machine.
- *The expert reasoning and logic:* the structure of the knowledge which represent the problem solving logic of the expert, is separated from the specific coding system of the inputs and the outputs needed for the machine.
- *The knowledge, information and data sources:* the facts and actions that represent the logic of the solving process of the problems by the expert can be various in shape, including tables, algorithms, images, other programs, sensors and transducers and so on.
- *Alternatives selection*: the alternatives selection is made usually by gradual presentation for the end user. The option of the end user is relatively the best solution among the presented list.
- *User selection*: in this moment the end user make a selection between the solutions presented by the software.
- *The projection of the consequences*
- *The social and economical implications*: the connectivity and the interactions of these factors represents inputs for the projection of the consequences.
- *Future utilizations information*: these can be hard copies obtained after the software running or by memory-stored information that can be used for the next utilization.

2. The Expert System for trolleybus

The traction system of the trolleybus is presented through functional blocks [2] in Fig. 2. The blocks are:

- D.C. chopper
- D.C. motor
- Trolleybus digital control unit

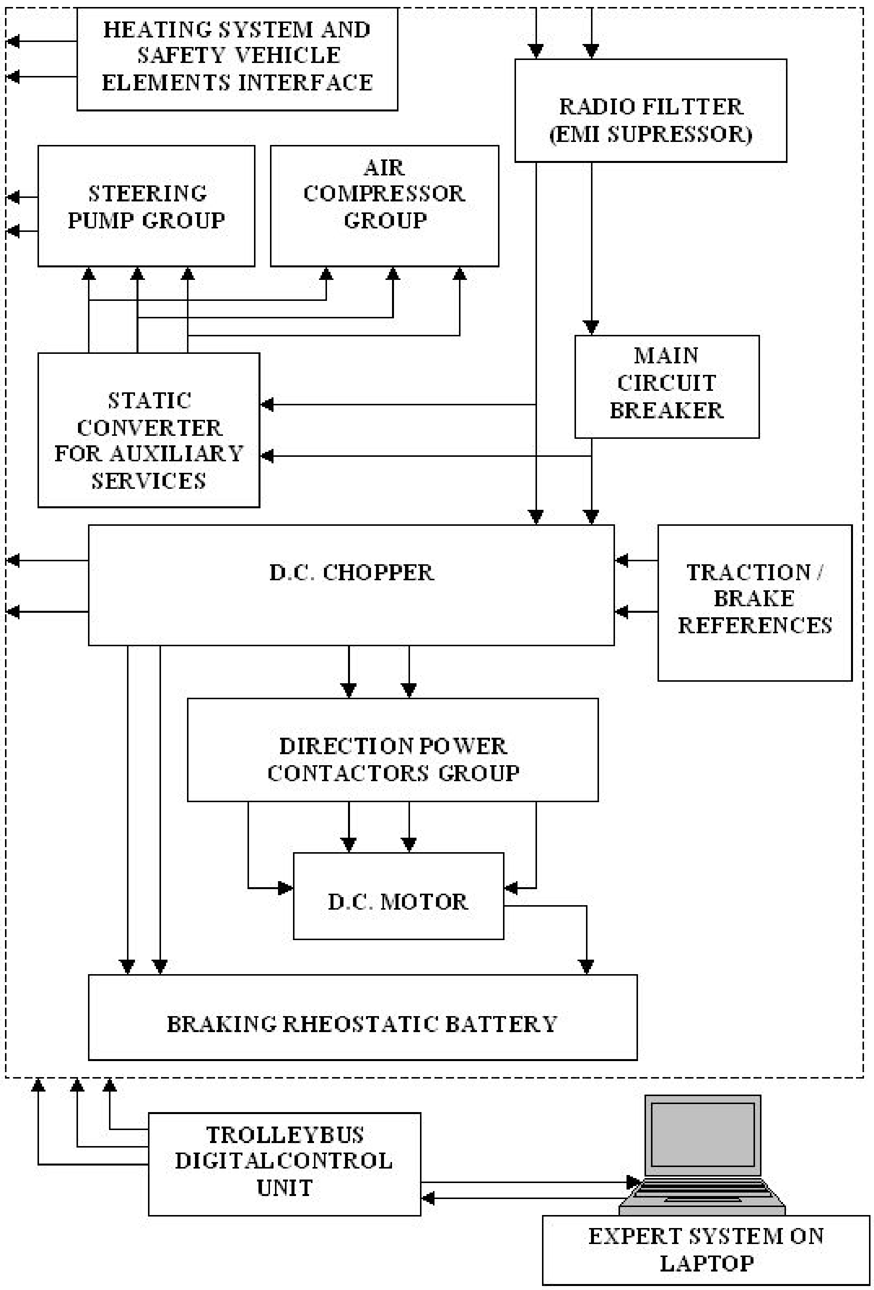


Fig.2 Block diagram of the driving system of the trolleybus

- Traction / brake reference controllers
- Direction power contactors group
- Breaking rheostat
- Main circuit breaker
- Radio Filter (EMI suppressor)
- Auxiliary static converter
- Steering pump and air compressor group
- Heating system and human safety device against dangerous voltage on the body of the vehicle

The control and command of the driving equipment that execute the functional regimes of the trolleybus are made by a digital controller [3] based on a microprocessor platform that monitor the parameters from the system, especially voltage and current on/through the motor, performs regulations and limitations of the parameters and gives necessary commands to the devices of the driving unit.

The digital controller contains from the designer stage the hardware and software components of an Expert System adequate for self-testing, preventing, memorizing permanent or transient faulty situations [2], as well as, suited for communication through a friendly interface with service personnel.

The diagnosis block diagram for the trolleybus is presented below in Fig. 3.

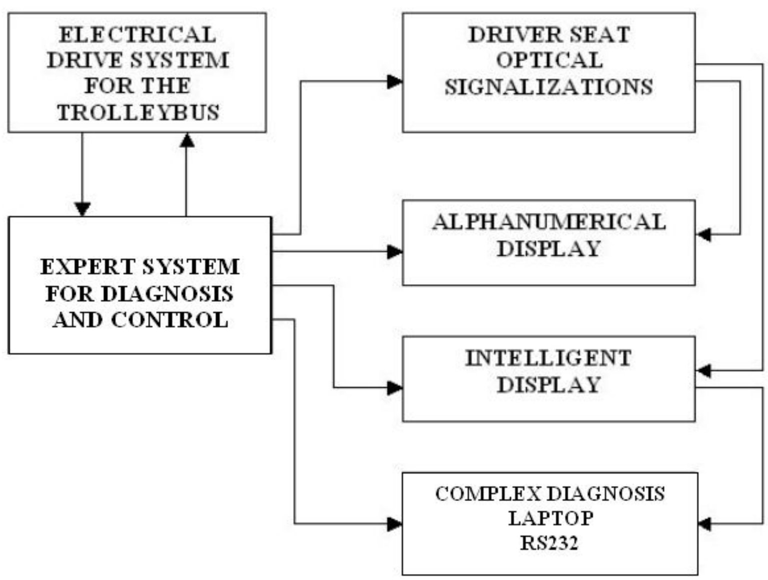


Fig.3 Block diagram of necessary diagnosis elements at trolleybus

The trolleybus Expert System is specialized for the electrical drives used in urban traction and is made from two software modules each having special characteristics. The main difference between them is that one named *self-testing software module* is loaded into the program memory of the command unit controller of the trolleybus, and the other one named *complex diagnosis software module*, is loaded into a portable computer being at the disposal of the end user that can made ulterior data tests. Fig. 4 presents a block diagram of the command unit controller and his connectivity with the Expert System.

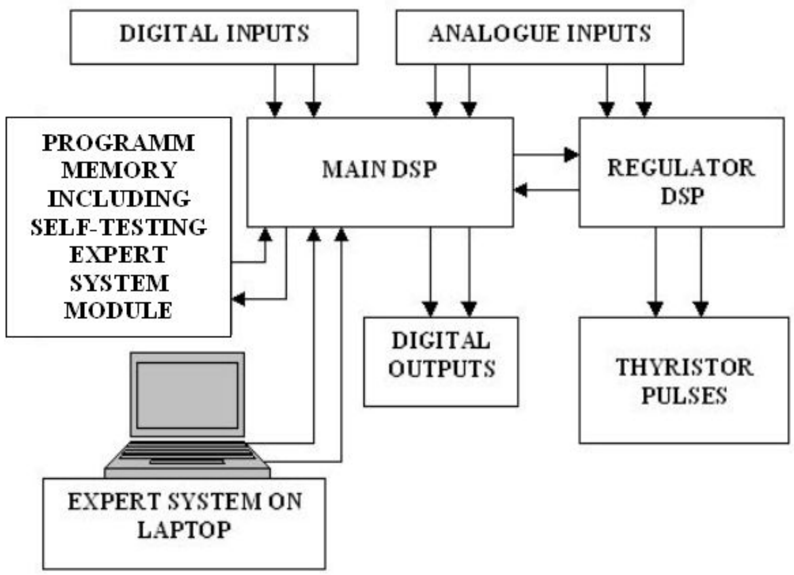


Fig 4 Block diagram of the controller unit of the trolleybus

The self-testing software module performs control tests for the status of the electrical devices from the traction equipment before and after launching the commands needed for different operational regimes. This module of the Expert System performs the first level of information communication with the service personnel through a two digit alpha numerical display [4], which display the error status of the hole traction / braking system and for the other devices controlled by the command unit like steering pump, air compressor system, static converter for supplying auxiliary services and battery compartment of the vehicle.

The complex diagnosis software module is loaded on a laptop and by means of a serial cable link can interact with the command unit of the trolleybus assuring the following:

- Visualization, control, and testing of the digital inputs /outputs of the system
- Visualization, control, and testing of the analogue inputs/outputs of the system
- Different levels fault simulations and control of the systems reactions
- Oscilloscope implemented software function which can display 2 settable parameters at the same time
- Black box function that track and monitor eight (8) settable status parameters of the system at end users choice (from the parameters list) being possible to perform a fine tune of the electrical drive. There can be memorized up to 50 seconds before a major event occurrence, event that determine an automatic stop of the black box. With this recording data the specialized service personnel can clearly take a conclusion about the faulty situation and find how to eliminate it.
- Trace of events function defined through the basic program of the command unit of the trolleybus, and traced by the self-testing software module of the resident expert system, which determine the recording in a nonvolatile memory of specified errors established by the human expert. This function allows the reading of the last 1000 events, which occurred in the system, the recording being made in FIFO logic.

In the Fig. 5 are presented the basic functions of the Expert System.

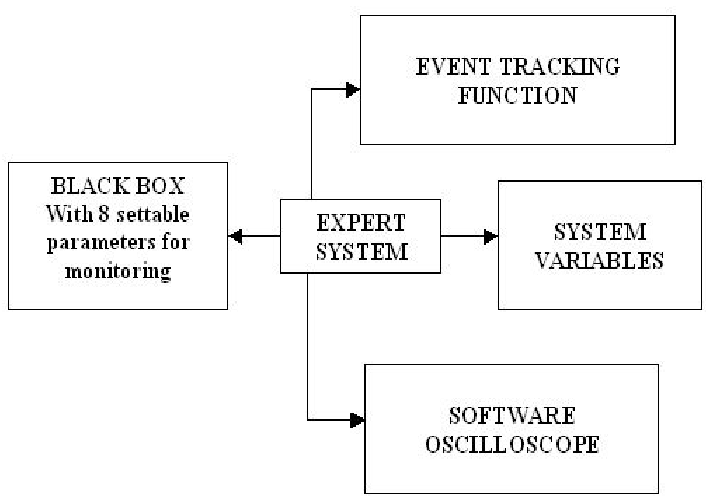
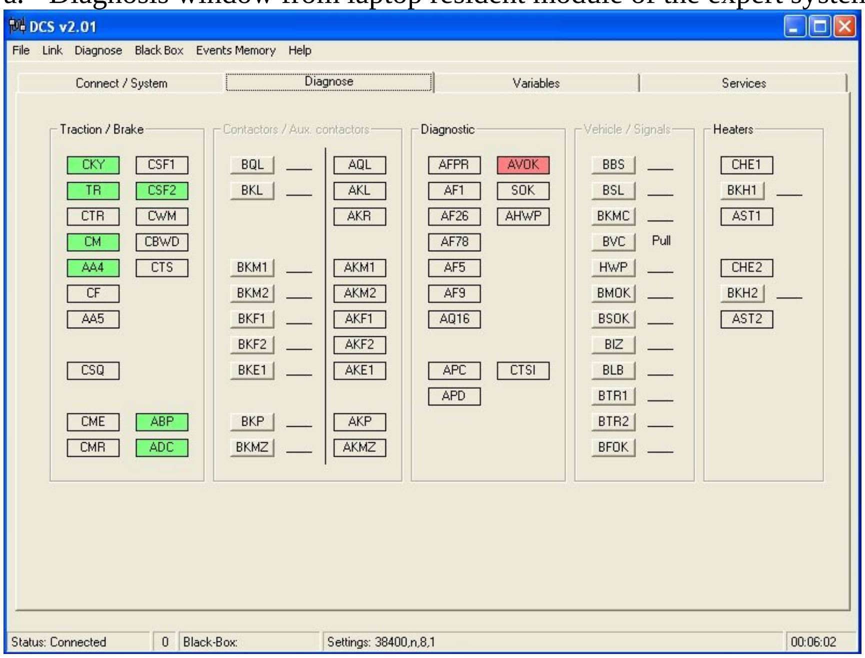


Fig. 5 Basic functions performed by the Expert System

2. Examples of interactions of the Expert System with service personnel

A working situation of the Expert System will be presented in Fig. 6, where was simulated a chopper failure and in Fig. 7 where we have a black box recording. The red signal activated AVOK means chopper failure.

a. Diagnosis window from laptop resident module of the expert system



b. Intelligent display information "Chopper failure, action to take RESET / TRACKING"

c. Intelligent display information main menu with action to take, line 3 "TRACKING " of the vehicle to depot

Fig. 6 Action of the Expert System in case of a chopper failure

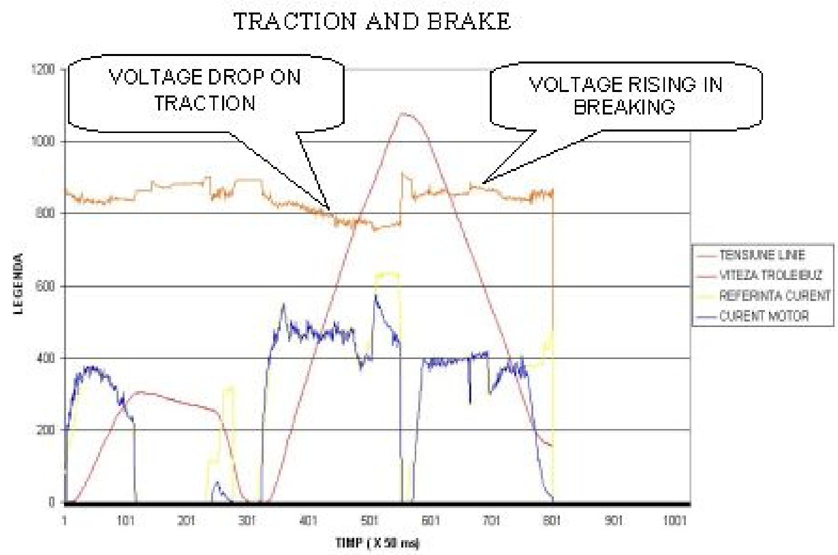


Fig. 7 Black box recording made by the Expert System

Conclusions

The control made by microprocessors for the electrical drives represent a major development for the technology of the electrical traction drives not only by increasing performances but reliability and also productivity through reducing faulty periods. All these was possible by implementation of the expert systems techniques that lead to rising the periods between technical revisions and avoiding the expensive fault situations by using intelligent diagnosis concepts and smart and easy to run maintenance.

The philosophy of the expert system presented in this paper is applied for a series of different types of trolleybuses manufactured and designed in our country and which are in service at the main transportation companies from big cities like Bucharest, Cluj Napoca, and Galati. The result of intense exploitation of the vehicles is significant concerning the running maintenance expenses.

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