HUMAN– VEHICLE SYSTEMS MODELING – FOCUS ON OPERATOR HEURISTIC MODELLING AND SAFETY

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INTRODUCTION

This paper presents a model of the driver- machine system. In this model the reaction time was used as the parameter of the operator's efficiency under different working conditions. The impact of such conditions was evaluated using the modelling method and computer simulation. Heuristic modelling using fuzzy sets was applied to model selected actions of the locomotive driver. The so-called linguistic model was defined and expresses in the form of logical implications. An original model based on Takagi-Sugeno-Kanga structures was developed and numerically implemented in the Matlab_Simulink environment. Example computer simulation results are presented..

METHODS

In many cases, the decision to take rational action is crucially influenced by the operator's reaction time, i.e. the time lapsed between noticing a signal and actually using the driving controls. In transport, this reaction time often has a direct impact on the life and safety of the passengers. This is why it is so crucial to ensure that the working conditions in the cockpit are compliant with the ergonomic requirements to make this parameter as short as possible.

We analysed the system presented in Fig. 1. In constructing the model we made the following assumptions [1]:

- different actions of the vehicle operator can be modelled (e.g. the use of steering devices),
- reaction time is an important parameter characterizing the actions of the operator and it has a crucial impact on the behaviour of the whole operator-rail vehicle-environment system,
- the impact made by the operator on the vehicle using the relevant steering devices is characterized with a three-element vector Ui, (1),
- the values of the Ui vector are a function of the human factor, the technical factor and of the material work environment.

Man can affect the locomotive through n activities typical of a given situation analysed by the model (e.g. while overtaking, the driver affects the vehicle by moving the steering wheel, pressing the pedals, etc.). For a given n-th activity, the human impact on the vehicle is characterised by a three-element vector:

$$\mathbf{U_i} = [\mathbf{u_{i1}}, \mathbf{u_{i2}}, \mathbf{u_{i3}}]^T \quad (1)$$

$\mathbf{u_{i1}}$ time of acquiring information

$\mathbf{u_{i2}}$ time of decision making

$\mathbf{u_{i3}}$ time of manoeuvring

The signals, u_{i1}, u_{i2}, u_{i3}, were treated as random variables with a set average value and a normal distribution N(m,σ) which was uniquely defined by providing the average m value and the standard deviation σij (σij2 - variance). These were generated by a random number generator with a predefined distribution. The distribution parameters are a function of three groups of factors:

$$\mathbf{U_i} = \mathbf{F}(\overline{\mathbf{C}}, \overline{\mathbf{M}}, \overline{\mathbf{S}}) \quad (2)$$

where:

$\overline{\mathbf{C}}$ - vector of the so-called human factor

$\overline{\mathbf{M}}$ - vector of the so-called technical factor

$\overline{\mathbf{S}}$ - vector of environment-related factor (material work environment).

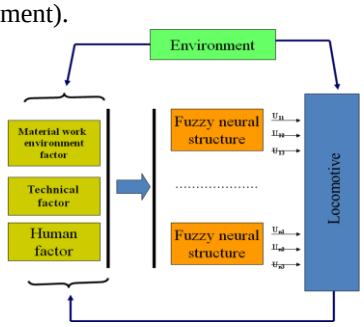

Fig.1 . Scheme model

For modeling the reaction time of driver the heuristic model (Takagi-Sugeno) was applied. Example result is shown on Fig2

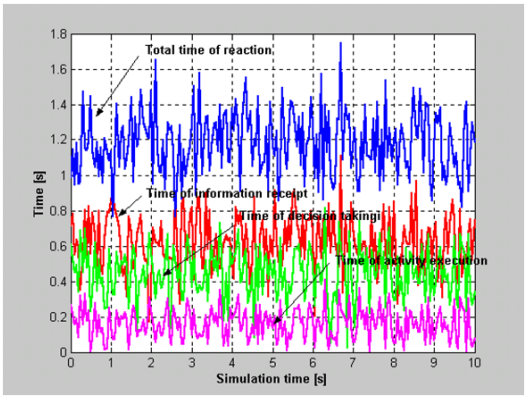

Fig.2 . A case of strong destructor impact – real progression (taking into account the random nautre of events) of reaction times

CONCLUSIONS:

The paper presents a new concept for developing heuristic models of the operator-vehicle-environment system using fuzzy models. These describe the important parameters and properties of the system in terms of non-mechanical phenomena.

REFERENCES:

1 W.Choromański, I.Grabarek "New Conspect In Modelling Man-Vehicle-Environment System", Proc. of the IASTED International Conferences – Applied Simulation and Modelling, 28-30 June 2007, pp. 577-582