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BASED ANALYSIS OF INTERACTION BETWEEN HUMAN SUBJECT AND ARTIFICIAL SYSTEM - IMPACTS OF DRIVER ATTENTION FAILURES ON TRANSPORT RELIABILITY AND SAFETY

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Anotace: Táto štúdia pojednáva o možnostiach využitia interakciu medzi ľudským subjektom a strojom, je vhodné si uvedomiť, že technické vybavenie predstavuje jeden z najdôležitejších faktorov ovplyvňujúcich prevádzkovú spoľahlivosť a bezpečnosť. Minimalizovanie strát je dominantná motivácia pre činnosť v tejto oblasti.

Kľúčové slová: bezpečnosť, spoľahlivosť, HMI

Summary: The interaction between human subject and artificial, namely technical equipment represents one of the most important factors influencing the operation reliability and safety of almost all existing systems with which the human society has to deal. The need to minimize these losses is the dominant motivation for activity in this area. Let us restrict here to the car-driver and vehicle interaction.

Key words: security, reliability, HMI

INTRODUCTION

The interaction between human subject and artificial, namely technical equipment represents one of the most important factors influencing the operation reliability and safety of almost all existing systems with which the human society has to deal. This concerns the transportation systems especially. Statistical analyses made in last few years show, that the losses, caused by unsatisfactory level of the reliability of interaction between the transportation vehicle (car, truck, train, ship, plane) and its driver are extremely large. The same concerns also the reliability of interaction between the dispatcher (controller) and transportation system. This represent a tremendous losses repeating everyday in almost all countries and has motivated many people for trying to find some method and tool which can be used for its diminishing. Transportation of people and goods represents still more significant component of the human culture. Its influence is extremely high today and will increase greatly in the future. Another source of system failures lies in the possibility that the human operator (or user) of a particular artificial system may react too late, and that his/her decision and reaction may be incorrect.

- Human behavior is not fully deterministic; it varies from subject to subject. All these factors combine, with the result that the reliability of human subject – artificial system

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interaction is limited, above all from the human side. Main problems related to reliability of interaction between human subject and artificial system (namely of the transportation character) are discussed.

None of the many artificial systems, that human society has daily deals with on a daily basis can operate entirely independently – all of them still have to be controlled, or at least supervised, by man. This concern especially the transportation systems - vehicles (cars, trucks, trains), planes, ships and transport control.

1. HUMAN VIGILANCE AND ATTENTION CLASSIFICATION AND PREDICTION

When dealing with man-system interaction reliability, decrease of vigilance seems to be much more significant than closing of the eyes, but a break in input of visual information longer than a certain limit (e.g., about 1 second for car drivers) can also be dangerous. First, however, we have to state what we mean by vigilance and what we mean by attention:

- Vigilance - The state of the organism in which all its mental functions can be realized and when all receptor signals are accepted and well processed.
- Attention - The form of vigilance, when the dominant part of mental functions is concentrated on external objects (focused attention is considered as concentration on a certain object).

2. MOTIVATION

The need to minimize these losses is the dominant motivation for activity in this area. Let us restrict here to the car-driver and vehicle interaction. The progress in this respect could be reached by combination of the following 5 main approaches, which needs an very interdisciplinary approach:

- Improvement of the training the drivers with respect to their higher resistance to disturbing factors causing decrease of their attention,
- Improvement of the interior of the car cockpit with respect to minimizing the influence of disturbing factors causing the decrease of drivers attention and enrichment of the car equipments by new active and passive tools improving the driving safety,
- Development of micro-sleep warning systems and their installation in car cockpit,
- Improvement of the traffic control systems with respect to wide scale detection of risky and aggressive driving and of its punishment,
- Investigation of the influence of various drugs (including alcohol, nicotine etc) on human subject driving activity and development of new pharmatics improving the human attention.

As concerns the drivers training, much can be reached by the use of traditional methods, especially if they are completed by the systematic use of advanced driving simulators. However, the progressive training methods based on the use of simulators equipped by bio-feedback tools, if the training is carried out in satisfactory number of repetitions and being

controlled by skilled neurologist or psychologist can lead to significantly improved resistance against both the fatigue and number of disturbing factors influencing the driver during his/her driving activity. Such enhanced state of the particular person resistance against fatigue can last considerably long, probably up to few years. In this period, the threat that his/her attention level falls down below acceptable level when driving is much less.

3. SYSTEM ARCHITECTURE

The system is composed by the main module, the control and management module. This module uses the concept of task and event, establishing the task which are made by the rest of modules, the execution policies when events happen and the management of such events. The information of task, events, policies, logs and classification results are stored in a system database.

A task is the accomplishment of a sequence of action by device as a camera or an acoustic radar. An event is the answer to an incident during the accomplishment of a task. When a module generates an event, it is received by the control and management module, which decides, according to his policies, the actions to make:

- to initiate a task in another module and to check the result,
- to initiate a task in another module,
- to send an event to another module,
- to ignore the event.

The system is compounded by another set of basic modules that accomplish different tasks:

- image module – it makes the capture of images through a camera device following the accomplishment of a task,
- acoustic module – it takes acoustic images following established tasks or activated by an event ones and detects the moving objects sending an event,
- authentication module – it controls the activation and the deactivation of the system using smart cards to identify the people that accede to the room,
- classification module – it allows classifying the results for the system training and the capture of information.

If we analyze the system architecture in layers or levels we found that it is divided in:

- centralized system database, where the whole information of the system is stored – tasks, events, logs, video and acoustic images, etc.,
- communication channel – channel used by the modules to intercommunicate,
- system module – each one of the elements that control the rest of devices used by the system,
- web server – that provides user interface service to the modules.

The main functionalities of the system are:

- monitoring of a closed enclosure – through the use of image and sound devices the system can monitor a room with permanent characteristics,

- capture of video-acoustic images allowing the correlation between both media,
- automatic intruder pre-detection thorough the processing of the video-acoustic images,
- user authentication thanks to use of smart cards and the visual and acoustic characteristics of the user,
- classification of the data obtained by the system,
- generation of statistical information for its later analysis.

4. CONTROL AND MANAGEMENT MODULE

The control and management module is the central and more significant element of the system. It is the responsible to control that the other modules accomplish every tasks, the management of the information and the events generated by the other modules and the definition of the policies to execute when the events arrive.

We have two types of tasks:

- programmed tasks which are planned to be executed in a fixed moment, at a concrete date and time,
- not programmed tasks – those which are executed by the arrived of an event to the system.

The policies define the operation that the system must do after each event is produced. They are stored in the database, defining the thresholds that an event must surpass in order to be considered.

5. COMMUNICATION REQUIREMENTS

Another constraint comes with the fact that biometric data should be transferred to the biometric token. In that sense, two situations should be considered:

- the transmission of the template,
- the communication of the current biometric sample.

The first one, in a match-on-token system, is not really constraint, because that communication will only take place once or twice in the token life, i.e. the template will only be transferred in the personalization phase and never will go out of the token during its usage.

Sending the current biometric sample from the terminal to the token is a completely different issue. Depending on the technique and method used, it could be as simple as just transferring the feature vector – once it has been extracted from the image or signal captured – to the token. In these cases this will mean to send as many bytes as the template. The way data is transferred to the token will limit the viable length of the vector, which will also depend on the application restrictions. Usually applications need that the biometric verification could be done in less that 1 s, for not giving users the feeling of a slow identification. Considering a serial communication – which is a real restriction to reduce connection pins, there is a direct relation between the speed of the communication and the size of the vector to be transferred. As an example, considering the matching time as null – which is not at all realistic, and the lack of communication overheads – parity, ciphering,

handshake, packet handling, etc., a communication at 9600 b/s will restrict the size of the vector to 1200 bytes, while to be able to send 7kB, communication speed should increase to 56kb/s.

The serial communication has been chosen, instead of parallel one, in order to reduce cable connection. This decision has the inconvenience of reducing also communication speed, but considering current protocols and interfaces – USB, fire-wire, etc., this is not longer a hard restriction.

CONCLUSIONS

Our work up to now indicates that, though the dependences between the components of EEG pseudo-spectra and reaction time are very individual and differ for each subject, they do not change within the lifetime of an individual subject (except in the event of some serious illnesses or injuries). This seems to be very significant, because it allows us to put forward the idea that in due course an individually applicable tool for classifying and predicting of the attention level of an operator dealing with a specific (namely transportation) system can be developed. This will warn him/her (and also a supervisor) of the imminent possibility of falling into dangerous stages of interaction with the artificial system, and will improve the potential to prevent accidents.

Current research and market trends indicate that future applications of biometrics technologies. Such applications are already in demand in several markets. For example, health-care, financial services and other industries that handle large numbers of sensitive documents have begun to incorporate multiple biometrics into their security strategies. The use of products for multiple and layered biometrics is further supported by declining prices.

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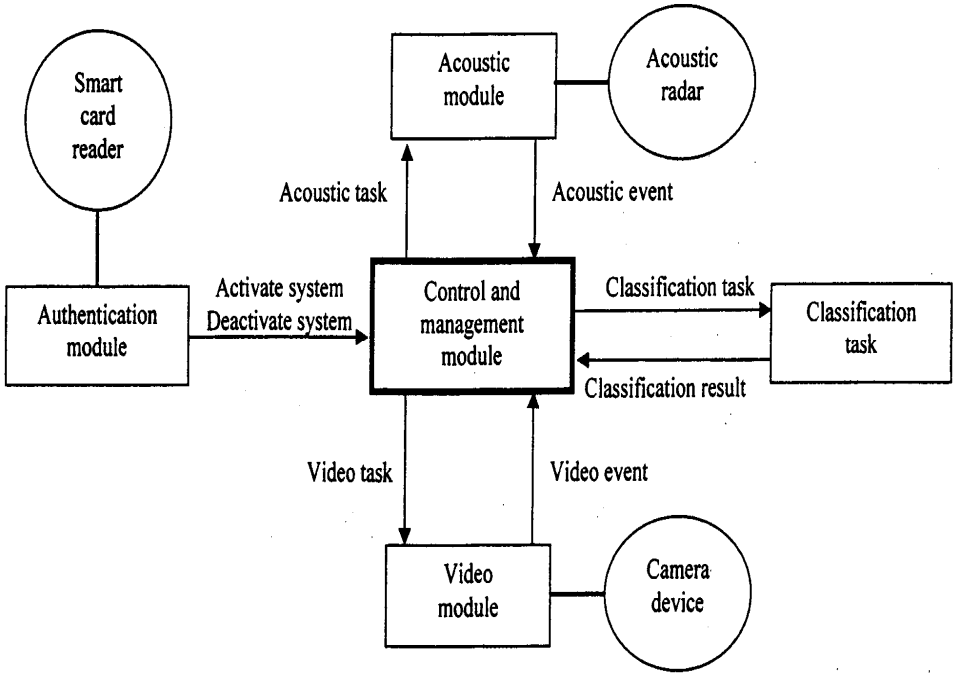

Fig. 1 - System architecture

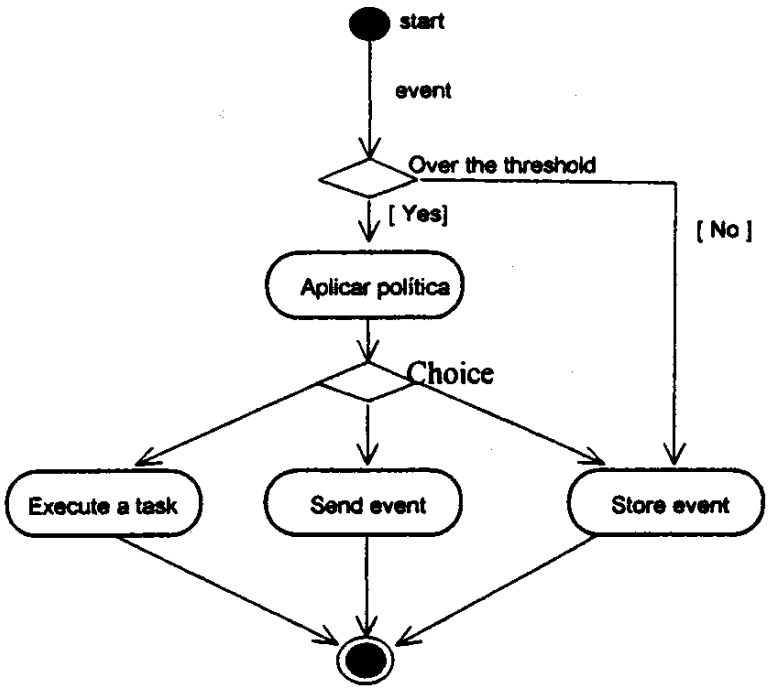

Fig. 2 - Task management diagram

Table 1 - Example deployed application

Function	Application type	Example
Security	Data and data networks	**Password reset (over the telephone) using virtual help desk**
		Off-site access to secure data networks
	Physical/site access	**Internal wire transfers**
		Immigration and naturalization service
		Door access control system and located box for children
		Evening and weekend access to the city buildings
Fraud prevention	Telephone network security (tool fraud)	Tool-free long-distance lines for buildings and staff
		Integration of speaker verification into wireless security package offered to carriers
	Transaction security	**Automated product-ordering over the telephone**
		Transfer of money between accounts of a bank customer
Monitoring	Time and attendance monitoring	Time and attendance of part-time employees
		Time and attendance of workers
	Corrections monitoring	Tracking of juvenile and adult probationers
		Monitoring of home-incarcerated offenders