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Fuzzy Cognitive Control System of Autonomous Vehicle: Brain Neurointerface and Soft Computing Modes

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Abstract

The article show the possibility of neurointerface application based on cognitive helmet with different traditional types of controllers for the vehicle driving. Extraction of knowledge from electroencephalogram based on knowledge base soft computing optimizer demonstrated. The commonly application of computational intelligence and cognitive toolkits improve the reliability of fuzzy control system operations.

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Keywords: Type your keywords here, separated by semicolons ;

1. Introduction: problems of cognitive and intelligent control

So far the theory and design processes of intelligent control systems (ICS) as knowledge-based control systems (in the form of relevant knowledge base (KB)) was carried out by an experts themselves through computational intelligence as soft computing using genetic algorithms or fuzzy neural networks.

The role of the human operator in control loop considered in an explicit form or it described by simplified transfer functions. The including of human operator in control loop was often suppose as a source of emergency or increasing risk information from the human decision-making.

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It has so far proved (Petrov, Ulanov and Ulyanov, 1977) that in large multiple control loop connected management systems to 75% of information often there is an excess quantity which isn't used or hinders decision-making. Therefore, one of the central problems of developing cognitive control system (CCS) was finding a constructive solution of design KB tasks in a given issue oriented applications.

However, cognitive abilities of operator (such as intuition, instinct and emotions) decision in unpredicted situations is both informational resource that enables to improve the effectiveness of the development and application of KB. Experimental studies of the brain and behavior of the human operator confirmed the hypothesis about the relationship of electroencephalogram (EEG) of individual sections of the brain (neurons or groups of neurons) with determination and prediction of human behavior.

Thus, there is an opportunity to apply cognitive processes of the brain the human operator as friendly "brain-computer interface" with a view to enhancing the effectiveness of predictive control to guarantee the achievement of management objectives in the face of uncertainty, contingencies and the increasing risk of information uncertainty (Brandt and Stark, 1997).

The aim of this work is to show the possibilities of experimentally effective application of cognitive interface ("brain-computer-actuating device") on the example of driving small car (mobile robot) reveal the modern management technologies. And show the role and necessity of application of computational intelligence in the work of the "brain-computer interface" to improve the reliability and robustness of the fuzzy control system.

In particular, the paper considers the possibility to control the movement of the object (forward, backward, left, right, bypass obstacles) through cognitive helmet using building block commands recognition and different types of control systems, including those based on soft computing.

For removal of brain, activity used cognitive helmet Emotiv EPOC+ (fig. 1), in conjunction with the supplied software (EPOC Control Panel).

The software includes a block record and recognition of mental commands generated by the operator. EPOC has 14 electrodes, which are passive sensors that allow registering electromagnetic signals and transmit them via Bluetooth to a computer for processing.

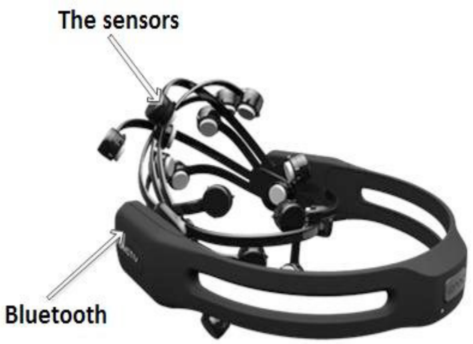

Fig. 1. Cognitive helmet Emotiv EPOC+

The electrodes are mounted on the surface of the skin (not submersible, non-invasive interface) and require wetting special liquid for better contact of the so-called "wet" interface.

Structurally the Emotiv EPOC+ consists of 14 channels AF3, F7, F3, FC5, T7, P7, O1, O2, P8, T8, FC6, F4, F8, AF4 (plus CMS/DRL and P3/P4). Sampling method sampling is serial. Sample rate 128 samples per second (inner 2048 Hz). Resolution is of 14 bits. Bandwidth of 0.2-45 Hz, digital notch filters for 50 Hz and 60 Hz. There is an additional filtering of digital filter.

The software supplied allows you to retrieve, identify and record the EEG signal with helmet, mental commands and assign certain actions to them (for example, to send a signal to a Bluetooth device for autonomous robot movement forward, backward, left and right). Mental training signal is resting and recording conditions, when the