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The Decision-Making System for a Multi-Channel Robotic Device Control

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Abstract

Nowadays, there is a trend of significant robotic devices functionality increase. Accordingly, the robotic devices can perform more operations and have more new ways to control them. Therefore, in some cases there is a situation when the robotic device receives control commands, i.e. instructions for performing different operations from different alternative control channels. It is a problem of a command selection for execution when different control channels have contradictory information. If there are multiple control channels, which have fundamentally different principle of operation, and multiple commands, which might require the same resources for execution, we need a system that will take into account the specifics of channels and commands, store information about incoming commands and decide which command to execute. In this paper, we will present decision-making system with an internal control conflict resolution mechanism for robotics and the implementation example.

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Keywords: decision-making, control channel, command, robotics

1 Introduction

Modern mobile robotic systems are complex heterogeneous software and hardware systems that should provide a certain level of convenience and reliability of management appropriate to the field of their application. Depending on the situation, certain mechanisms of a human-machine interaction may be preferable. In case of a parallel operation of several data channels (human-machine interaction mechanisms) at the output of which the solutions differ from each other, a technique to make the only correct decision for each control event of a mobile robotic system (MRS) is required. This method should be adaptive to a current situation, the peculiarities of a particular operator ensuring the MRS safety in any situation.

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2 Related Works

There are some possible probabilistic approaches for the decision-making: Naive Bayesian classifier described by Leung [1], hidden Markov model researched by Rabiner and Juang [2], graph probability model described by Zeng and Liu [3]. However, to specify the internal parameters of these models we have only the statistics of the data channels accuracy. Therefore, significant improvements are required in the field of methodology of application of these models in practice for the solution of the task of the MRS control using several data channels, for example, shown by Shachter and Peot [4].

For the decision making, a machine learning described by Mitchell [5] or neural networks researched by Demuth et al. [6] can be used. However, the data amount that should be given on the input of the machine learning or the neural network is much greater than we can get during the control testing using several data channels.

None of the considered models take into account the fact of the execution of the commands that require the same resources to perform as this particular command. Therefore, we developed our own system described by Dyumin et al. [7] that allows us to take into consideration other commands when deciding on the execution of an incoming command.

3 Theory

3.1 Parameters

Command is an elementary instruction coming from an operator. The commands come from different data channels and may or may not require the same time resources at runtime. The commands that require the same time resources at runtime are called competing. The set of mutually competing commands is called the command-space group and the set of all groups forms the command space.

When deciding on the command performance the operator's emotions are taken into account. At the moment of the command execution, the operator has a certain set of emotions some of which show an interest in the command performance, the other part – a boredom and indifference to the command execution as shown by Chepin et al. [8]. Therefore, for decision-making the parameter minimum proportion of non-negative emotions is introduced. It is set during the training process and is obtained using the brain-computer interface as considered by Voznenko et al. [9].

In order to determine for how long shall we execute the command and how to resolve the conflicts of incoming competing commands from several data channels, the parameters execution time and command priority are inserted. The command priority is set taking into account the specifics of the commands execution and the accuracy of the data channels.

3.2 Variables

There are variables required for the decision-making.

1. Time ($time$) is a time counter that is used to account the execution time of the commands.
2. Background end time ($backgroundEndTime$) is the time of the command end at the channel input that is used to account which commands from which channels came.
3. Foreground end time ($foregroundEndTime$) is the time of the command end at the output from the decision-making system that is used to determine the commands for execution.