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ADAPTIVE CONTROL SYSTEM OF DISTRIBUTED PARAMETER SYSTEMS

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Аннотация – В теории автоматического управления существует задача управления объектами с распределенными параметрами. Ее важность обусловлена наличием множества реальных объектов, имеющих распределение параметров в своей структуре. Задача осложняется тем, что большинство алгоритмов синтеза регуляторов создано для объектов с сосредоточенными параметрами и учитывает свойства объектов, которые описываются дифференциальными уравнениями в частных производных и иррациональными передаточными функциями. Данную проблему можно решить, используя специальные алгоритмы идентификации, которые будут формировать, необходимые для управления, модели объектов. В данной работе представлен такой вид адаптивных систем управления, который объединяет подходы идентификации систем и метод адаптивного управления на основе модели (MRAC).

In current times there is a problem with concerning distributed parameter systems in control engineering issues. Importance of the problem is caused by controller design goals for industrial plants which have distribution in its parameters. For example, these parameters may vary from temperature of a rod or deflection of a laser's beam [1]. These systems are described by partial-differential equations (PDE) and often have high order partial derivatives. The transfer functions of distributed parameter systems (DPS) are irrational functions in contrast to lumped-parameter systems which are described by rational transfer functions. It brings complexity to controller design issues, because the most part of controller design algorithms relates to rational transfer function descriptions. Irrational transfer functions have infinitely many poles and zeros and it's one of the problems which make analysis much more difficult than in rational transfer functions case. This is why control engineers and researches are using the approximation methods which can help to understand main distributed parameter systems properties and make their analysis simpler. It gives the possibility to develop a controller and get the best performance of control system. This paper presents a kind of adaptive control systems which unite the model reference approach and identification approach.

There is an approach which is based on model reference adaptive control (MRAC) [2]. Short description of this method tells that if there is a model then control system can compare output of a plant with output of the model. The difference between outputs causes tuning of controller's parameters. This tuning improves quality of control and makes conditions for high performance of the process. The image of this adaptive control system is shown on fig. 1.

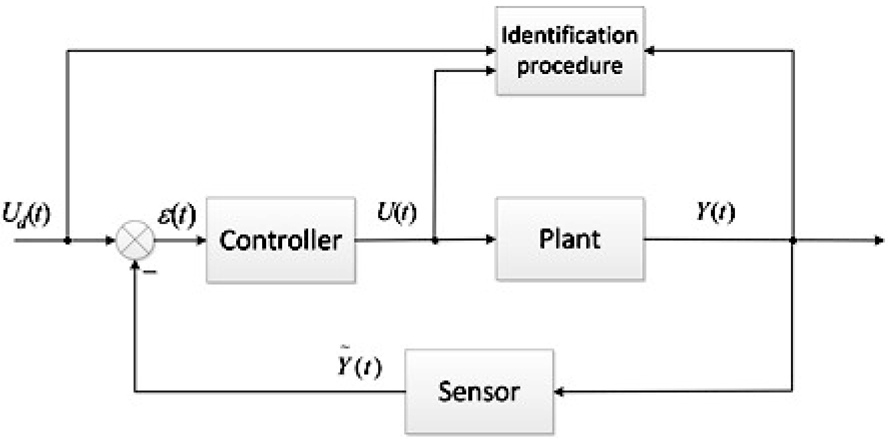

Fig. 1. Control system with identification loop. On this picture:
$U_d(t)$ *– is a desired output;* $\varepsilon(t)$ *– is an error function;* $U(t)$ *– is a control input signal;*
$Y(t)$ *– is a plant's output;* $\tilde{Y}(t)$ *– is a filter's output*

But there is a problem with the model. It is an unusual situation when researches have a mathematical description. Usually there is no model and researches cannot use MRAC approach. Solution for this problem is to use identification loop in structure if control system. It collects experimental data which looks like arrays of inputs and outputs and then use it for obtaining the mathematical model. On fig. 2 there is the image of such kind of systems. Unfortunately, in common case, it is only one part of solution. When researches work with distributed parameter system they have to consider this. For this purpose, in control system's structure summation element with quantity coefficient is placed. This element is used for collecting outputs of distributed parameter system and then calculating an average output. This average output is used for identification purpose. A result of identification purpose is a mathematical description of a plant in terms of rational transfer function. This transfer function helps to use controller design technics which are created for lumped parameter system.

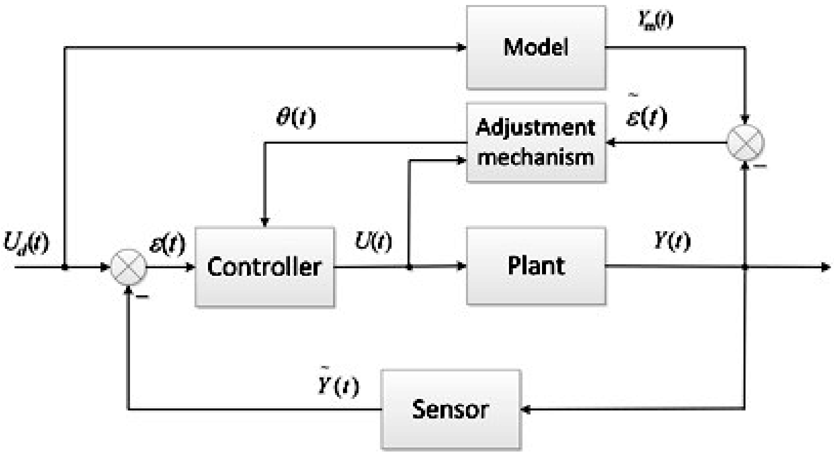

Fig. 2. Model reference adaptive control system. On this picture additional elements are illustrated: $Y_m(t)$ – is an output of the model; $\tilde{\varepsilon}(t)$ – is an additional error function; $\theta(t)$ – is a vector of controller's parameters

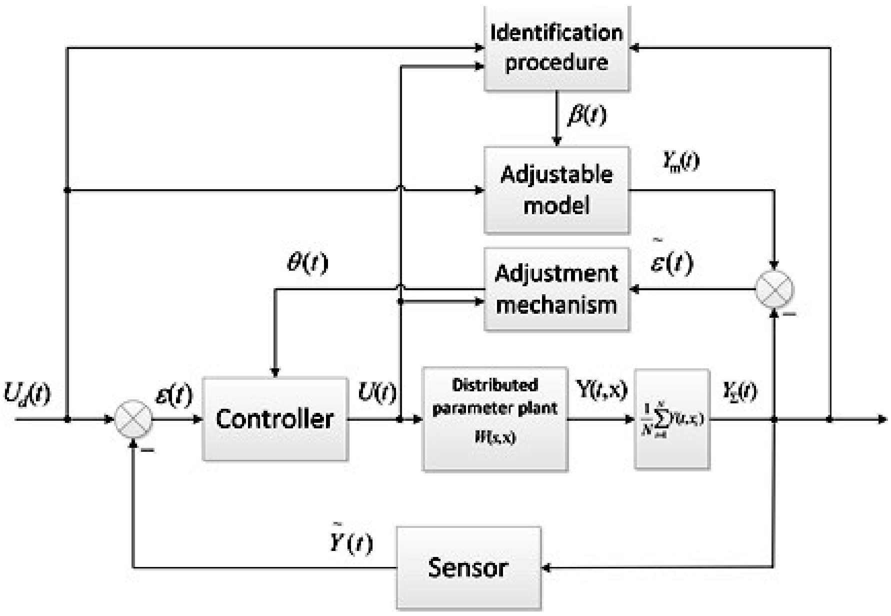

Fig. 3. Model reference adaptive control system with identification loop. On this picture additional elements are illustrated: $Y_\Sigma(t)$ – is an approximated output of the plant; $Y(t, x)$ – is a vector of plant's output signals; $\beta(t)$ – is a vector of adjustable model's parameters

Conclusions

In this paper short description of adaptive control system with MRAC approach and identification loop is presented. This kind of system brings a new way of control for distributed parameter system and gives the possibility to improve control quality.

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THE OPT-ACOUSTIC DEVICE FOR VARIABILITY MONITORING AND DIAGNOCTICS OF EQUIPMENT CONDITION

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Аннотация – Цель данной работы: создание программно-аппаратного комплекса для ранней диагностики и точной локализации неисправности в сложной геометрии нефтегазоперекачивающего оборудования, а именно акустическая камера (АК).

Introduction

Acoustic camera – is the camera with sensors (microphones). The sound reaches each of the microphones for different times due to different distances from the source to each of the microphones.