Intelligent Control

Academic Year: (2021 / 2022) **Review date: 22-06-2021**

Department assigned to the subject: Systems Engineering and Automation Department

Coordinating teacher: MORENO LORENTE, LUIS ENRIQUE

Type: Compulsory ECTS Credits : 6.0

Year : 1 Semester : 1

OBJECTIVES

The aim of this course is to acquaint students with some control techniques that includes in learning abilities, adaptation or are able to transfer some learning or experience of using a control device. Besides advanced optimization methods will be studied as the most intelligent control systems involve a way or another the use of optimization methods. Among them they will be studied: fuzzy control techniques (fuzzy), control techniques based on neural networks, and advanced optimization methods.

DESCRIPTION OF CONTENTS: PROGRAMME

The program is broken down as follows:
1. Fundamentals of fuzzy or blurred logic.
1.1. Basics of fuzzy logic. Imprecision and uncertainty.
1.2. fuzzy sets.
1.3. Membership functions.
1.4. Operations on fuzzy sets.
1.5. fuzzy relations.
1.6 Operations with fuzzy relations.
1.7. Approximate reasoning. linguistic variables.
1.8. fuzzy propositions.
1.9. Operations with fuzzy propositions.
1.10. Fuzzy if-then rules.
1.11. Operators involvement. fuzzy inference.
1.12. Controller design based on fuzzy logic rules.
1.13. Models Takagi-Sugeno Mandani and-Kang.
2. Modeling and identification systems using fuzzy techniques.
2.1. fuzzy function approximation.
2.2. Fuzzy modeling systems.
2.3. Model types.
2.4. Fuzzy model state of a dynamic system.
2.5. Models Takagi-Sugeno Mandani and-Kang.
2.6. Mandani and TSK fuzzy models equivalent of a classic controller.
2.7. Identification of fuzzy models. Methods.
2.8. Identification of the structure.
2.9. Parameter estimation.
3. Design of fuzzy controllers.
3.1. Design of fuzzy controllers without model.
3.2. PID fuzzy controllers.
3.3. Design of fuzzy model based controllers. Adaptive Methods. methods
direct synthesis. Optimization methods online.
3.4. Fuzzy controller design with matlab.
4. Fundamentals of neural networks.
4.1. Concept artificial neuron. Layers of neurons. Concept of neural network.
4.2. multilayer networks. recurrent networks.
4.3. basic neural networks. Network linear flow: Perceptron and Adaline. Recurrent networks:
Hopfield and Hamming. Learning methods.
4.4. feedforward networks. Learning backpropagation.
4.5. Radial basis functions. Probabilistic networks and networks generalized regression.
4.6. matlab neural networks.
5. Identification of neural network systems
5.1. Function approximation with neural networks.
5.2. Types of system models.

5.3. Modeling systems with neural networks. NN-FIR. NN-ARX. NN-ARMAX, OE-NN, NN-SSIF. hybrid models.
5.4. Types of networks used in modeling. Networks with delay in inner layers. backpropagation in dynamic systems. 5.1. 5.5. Identification of dynamic systems.
6. Control systems with neural networks.
6.1. Direct control schemes. reverse direct control. Internal model control. Feedback linearization. feedforward control.
6.2. Indirect control schemes.
7. Fundamentals of optimization and evolutionary algorithms.
7.1 Methods single point optimization.
7.2 Methods based on the derivative: maximum slope, Newton-Raphson, Quasi-Newton, Conjugate gradient.
7.3 non-derivative methods: brute force, random walk, Hooke-Jeeves, Simulated Annealing-.
7.4 multipoint optimization methods.
7.5 Derivative Methods: MultiStart and clustering.
7.6 non-derivative methods: Nelder-Mead, CRS, Genetic Algorithms, Differential Evolution, PSO

LEARNING ACTIVITIES AND METHODOLOGY

The activities carried out in the teaching of the subject are:
-Lectures. Presentation of the main concepts. Discussion and clarification of doubts on concepts. It will work on transparencies that will be given to students to facilitate also learning a basic text or reference texts on the subject required.
-Laboratories. The students (in teams of 2 or 3) are proposed some practical cases study, they must study and then make the simulation data and analysis. It will be used the knowledge of the topics covered in lectures and practical classes in the subject. It will make a previous study, will work in the laboratory and then a written report shall be submitted with the results and proposed solutions.

Addendum COVID-19:
Due to the situation caused by COVID-19, if necessary, both theory classes and practical exercises classes will be carried out online, the practices will be attempted in the laboratories, unless it is impossible, in which case they would also be adapted to do them. on line.

ASSESSMENT SYSTEM

A teaching job (small project) of some of the techniques studied over a problem of identification or control that will be simulated in Matlab is required to pass the subject (for the normal or extraordinary periods).

% end-of-term-examination:	0
% of continuous assessment (assigments, laboratory, practicals…):	100

BASIC BIBLIOGRAPHY

- L. Moreno Transparencias de clase, -, 2016

ADDITIONAL BIBLIOGRAPHY

- Eiben and J. Smith Introduction to evolutionary computing,, Springer,, 2003
- Gerard Dreyfus Neural Networks: methodology and applications, , Springer Verlag,, 2005
- H. Zhang and D. Liu Fuzzy modelling and Fuzzy Control, , Birkhauser,, 2006
- J. Espinosa, J. Vandewalle and V. Wertz Fuzzy Logic, Identification and Predictive Control,, Springer, , 2004
- Oliver Nelles Nonlinear System Identification: from classical approaches to Neural Networks and Fuzzy Models, , Springer Verlag, , 2001
- R. Fletcher Practical methods of optimization, , John Wiley, , 1980