IDEA GROUP PUBLISHING
701 E. Chocolate Avenue, Hershey PA 17033-1240, USA
Tel: 717/533-8845; Fax 717/533-8661; URL-http://www.idea-group.com
ITB8716

Chapter III

Helicopter Motion Control Using a General Regression Neural Network

T.G.B. Amaral
Superior Technical School of Setúbal – IPS, Portugal

M.M. Crisóstomo
University of Coimbra, Portugal

V. Fernão Pires
Superior Technical School of Setúbal – IPS, Portugal

ABSTRACT

This chapter describes the application of a general regression neural network (GRNN) to control the flight of a helicopter. This GRNN is an adaptive network that provides estimates of continuous variables and is a one-pass learning algorithm with a highly parallel structure. Even with sparse data in a multidimensional measurement space, the algorithm provides smooth transitions from one observed value to another. An important reason for using the GRNN as a controller is the fast learning capability and its non-iterative process. The disadvantage of this neural network is the amount of computation required to produce an estimate, which can become large if many training instances are gathered. To overcome this problem, it is described as a clustering algorithm to produce representative exemplars from a group of training instances that are close to one another reducing the computation amount to obtain an estimate. The reduction of training data used by the GRNN can make it possible to separate the obtained representative

exemplars, for example, in two data sets for the coarse and fine control. Experiments are performed to determine the degradation of the performance of the clustering algorithm with less training data. In the control flight system, data training is also reduced to obtain faster controllers, maintaining the desired performance.

INTRODUCTION

The application of a general regression neural network to control a non-linear system such as the flight of a helicopter at or near hover is described. This general regression neural network in an adaptive network that provides estimates of continuous variables and is a one-pass learning algorithm with a highly parallel structure. Even with sparse data in a multidimensional measurement space, the algorithm provides smooth transitions from one observed value to another. The automatic flight control system, through the longitudinal and lateral cyclic, the collective and pedals are used to enable a helicopter to maintain its position fixed in space for a long period of time. In order to reduce the computation amount of the gathered data for training, and to obtain an estimate, a clustering algorithm was implemented. Simulation results are presented and the performance of the controller is analysed.

HELICOPTER MOTION CONTROL

Recently, unmanned helicopters, particularly large-scale ones, have been expected not only for the industrial fields such as agricultural spraying and aerial photography, but also for such fields as observation, rescuing and fire fighting. For monotonous and dangerous tasks, an autonomous flight control of the helicopter is advantageous.

In general, the unmanned helicopter is an example of an intelligent autonomous agent. Autonomous flight control involves some difficulties due to the following:

- it is non-linear;
- flight modes are cross-coupled;
- its dynamics are unstable;
- it is a multivariate (i.e., there are many input-output variables) system;
- it is sensitive to external disturbances and environmental conditions such as wind, temperature, etc;
- it can be used in many different flight modes (e.g., hover or forward flight), each of which requires different control laws;
- it is often used in dangerous environments (e.g., at low altitudes near obstacles).

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