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CASE STUDY

Path following behavior for an autonomous mobile robot using neuro-fuzzy controller

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Abstract This paper presents a navigation method for an autonomous mobile robot. In order to equip the robot by capability of autonomy and intelligence in its environment, the control system must perform many complex information processing tasks in real time and it is well suited to use the soft-computing techniques. The objective of this paper is to elaborate an intelligent control system for the path following behavior by mobile robot using a neuro-fuzzy controller. The hybrid approach refers to the way of applying learning techniques offered by neural networks for fuzzy systems parameter identification. The proposed controller is used for pursuing a moving target. Simulation results show the effectiveness of the designed controller.

Keywords Mobile robot · Path following · Neuro-fuzzy controller · Hybrid learning · Moving target pursuing

1 Introduction

The evolvement of soft-computing paradigms have provided a powerful tool to deal with mobile robot navigation process, which exhibits incomplete and uncertain knowledge due to the inaccuracy and imprecision inherent from the sensory system. Among all the soft-computing methods fuzzy logic based decision-making and neural networks have been found to be the most attractive techniques that can be used for this purpose (Tzafestas and Blekas 1997; Fulles 1995).

Fuzzy system is tolerant to noise and error in the information coming from the sensory system, and most importantly; it is a factual reflection of the behavior of human expertise. A fuzzy controller is commonly defined as a system that emulates a human expert. The knowledge of the operator would be presenting in the form of a set of fuzzy linguistic rules (Passino and Yurkovich 1998). These rules produce an approximate decision in the same manner as an expert would do. Ever since the fuzzy systems were applied in industrial applications, developers know that the construction of a well performing fuzzy system is not always easy.

The problem of finding appropriate membership functions and fuzzy rules is often a tiring process of trial and error. However, the design of fuzzy logic rules is often reliant on heuristic experience and it lacks systematic methodology, therefore these rules might not be correct and consistent, do not possess a complete domain knowledge, and/or could have a proportion of redundant rules. Furthermore, these fuzzy logic rules cannot be adjusted or tuned on real-time operation, and the off-line adjustment of their parameters is a time consuming process. Another problem could be raised when better precision is needed which is the huge expansion in the fuzzy rule-based system (Jantzen 1998). In general, there are two approaches to the application of fuzzy logic in mobile robot navigation namely, behavior-based approach (Brooks 1986) and classical fuzzy rule-based approach (Saffiotti 1997).

Techniques based on the use of artificial neural networks (ANN) have a great interest in control and robotic domains

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