Design and Evaluation of a MIMO ANFIS using MATLAB and V-REP

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Abstract— **Employing software computing tools, such as fuzzy logic, neural networks and genetic algorithms, encouraged researchers to design intelligent systems that mimic human behavior. The Adaptive Fuzzy Nervous System (ANFIS) is one of the most useful hybrid technologies for designing intelligent control algorithms. Designing a Multiple-Input, Multiple-Output (MIMO) ANFIS algorithm, is not an easy task for those with limited programming experience. This paper presents a simple way to design MATLAB-based MIMO ANFIS controllers for two mechatronics plants; a two-wheeled mobile robot and a 6DOF KUKA robotic arm. The 3D simulation software (V-REP) has been interfaced directly with the MATLAB Simulink to test the proposed controller. The generated 3D simulation environment given in this paper will help researchers to easily design and test of MIMO ANFIS algorithms. The obtained results demonstrate the performance of the mobile robot and ability of the implemented ANFIS controller to deal with input commands, obstacle avoidances in the working environment.**

Index Terms— **MIMO ANFIS, V-REP, Obstacle avoidance Control, MATLAB, Simulink, 3D simulation, Real-time Control, ANFIS.**

I. INTRODUCTION

Softcomputing tools incorporating fuzzy logic, artificial neural networks and genetic algorithms are widely used to design intelligent control algorithms to mimic human behavior [1,2]. Fuzzy logic is widely used in control and decision making applications. Artificial neural networks are used in simulations of several problems and can perform just as well as fuzzy logic in many cases, while genetic algorithms are used as optimization tools [3]. Fuzzy logic has the advantage of dealing with vague knowledge and approximate reasoning but lacks an effective learning capability. While, neural networks have the positive features of learning and adaptation. Merging these tools provides an opportunity to maximize their strengths and avoid their shortcomings [4,5].

The Adaptive Fuzzy Nervous System (ANFIS) is actually fuzzy inference system optimized by neural networks. ANFIS is one of the most useful hybrid technologies for designing intelligent control algorithms. The MATLAB *ANFIS* tunes Sugeno-type fuzzy inference system using training data. It can be used to design a Multiple-Input Single-Output (MISO) controller. In fact, designing a Multiple-Input, Multiple-Output (MIMO) ANFIS algorithm, is a big challenge especially in real-time applications [5,6].

The Sugeno-type ANFIS provides more efficient and compact by customizing the membership functions compared to the Mamdani-type fuzzy Inference system. The membership functions and rules are generated automatically by the adaptive techniques and could be used to produce the best result from training data [7]. There is several published papers discuss design of MIMO ANFIS controllers. A MIMO ANFIS controller was designed for obstacle avoidance control of a two-wheel differential drive mobile robot [8]. An ANFIS controller has been designed for each motor (Left and Right). The speed control command of each motor has been trained using MATLAB ANFIS tool box. In such system, there will be two ANFIS algorithms and each one should be uploaded on a microcontroller. Therefor two microcontrollers needed to implement such system.