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Progress in Artificial Intelligence Techniques: from Brain to Emotion

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Artificial Intelligence (AI) techniques, e.g. expert system (ES), fuzzy logic (FL), artificial neural network (ANN), genetic algorithm (GA), particle swarm optimization (PSO) and biologically inspired (BI) have recently been applied widely in power electronics and motor drives. The aim of the AI is to model natural or human intelligence in a computer to think smartly like a human [1], [2].

The next form of AI is the embedded AI controller system which has ability in learning, self-organizing, and self-adapting. Had been able to solve common and complex control problem, the AI technique in computational intelligence applied in wide application of industrial process control, robotics, automated planning and scheduling, games, hypermedia, image processing, patterns recognition (handwriting, speech, and facial), logistics, data mining, medicine and healthcare, space and diagnostic technology [1].

Each AI method has its own uniqueness and characteristics. The ES and FL techniques tend to mimic the behavioural nature of the human brain and base on the rules; the NN is more generic in nature and tends to pattern directly to the biological NN. The GAs and the evolutionary computation techniques are based on principles of genetics. Basically, GA solves optimization problems through a searching process to find the fittest as a survivor for the best solutions. Among all the sub branches of AI, the NN and FL appear to be most uses for high-performance motor drives. However there are many other feed forward and recurrent NN topologies which require systematic exploration for their applications [3]. In advance, the powerful intelligent control and estimation techniques are dynamically developed through hybrid AI systems such as neuro–fuzzy, neuro–genetic, and neuro–fuzzy–genetic systems. The PSO as a population-based stochastic optimization technique has been developed since 1995 and inspired by social behavior of bird flocking or fish schooling [4]. PSO as evolutionary computation techniques shares many similarities with GA, but PSO offer easy implementation with few adjustable gains. PSO is considered as a fast-developing research topic and applied successfully in optimization function, artificial neural network training, and fuzzy system control [5]. The biological dispositions of animals and mimics bio mechanisms have inspired the BI system. Since 1990s, the NN technology has become one of most attractive topics for the scientific community, and growth rapidly in different and various applications [1], [2], [5].

Recently, researchers have developed a computational model of emotional learning in mammalian brain. Based on the cognitively motive open loop model, brain emotional learning based intelligent controller (BELBIC) was introduced for the first time in 2004 [6]. Basically, the brain emotional learning (BEL) is divided into two parts: amygdala and orbitofrontal cortex. The amygdala is a part of the brain that must be responsible for processing emotions primarly and correspond with the orbitofrontal cortex, thalamus, and sensory input cortex in the network model. The orbitofrontal cortex receives inputs from the cortical areas and the amygdala and responsibles for the reaction to change the contingency of emotions. Error of the expected reward or punishment and the loss of learning in the amygdala will be managed by orbitofrontal cortex [1], [2], [5].

During the past few years, the BELBIC has been successfully employed for making decisions and controlling in a simple linear systems and non-linear systems such as speed control of a permanent magnet synchronous motor (PMSM), automatic voltage regulator (AVR) system, flight control, position tracking and swing damping control of single input multi output overhead traveling crane, washing machine, automotive suspension control system, micro-heat

exchanger, ventilating and air conditioning control [1], [2], [5]. In further development, BELBIC was implemented on field programmable gate array (FPGA) for controlling a mobile crane in a model free and embedded manner. In 2008, BELBIC method for electrical drive control was started and a superior control characteristic was born with fast response, simple implementation, and robustness to disturbances [7].

In [1], the controller was used for first time to control an IM drive and investigated its independent of the parameters variations, especially rotor resistance. Also the controller was implemented for some other electric drives successfully [8]. Based on the above mentioned evidence of the emotional control approaches in computer and control engineering, it can be concluded that the application of emotion in systems could by its simple and unique control design, overcome the problems of non-linear system, manufacturing imperfections, acceptably.

The results indicate the ability of BELBIC to control unknown non-linear dynamic systems. The implementation of the emotional controller shows good control performance in terms or robustness and adaptability in high auto learning feature. Flexibility is one of BELBIC's characteristics and it has the capacity to choose the most-favoured response. Therefore, the BELBIC can be easily adopted for niche mechatronics and industrial applications.

Amongst selected papers in this edition, seventh of them are approved to present AI techniques in various applications. These papers are expected to encourage the research of AI implementation to create a better technology for the future.

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