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Editorial: Brain Emotional Learning Based Intelligent Controller

Artificial Artificial Intelligence (AI) techniques, such as 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 human or natural intelligence in a computer so that a computer can think intelligently like a human being [1], [2].

An intelligent controller is a system with embedded computational that has learning, self-organizing, or self-adapting capability. The computational intelligence has been increasingly utilized to solve any common and complex control problems. Therefore, it is true that AI techniques are now being widely, such as used in industrial process control, robotics, automated planning and scheduling, games, hypermedia, image processing, patterns recognition (handwriting, speech, and facial), logictics, data mining, medicine and healthcare, space and diagnostic technology [1].

The ES and FL techniques are rule based and tend to mimic the behavioral nature of the human brain; the NN is more generic in nature, which tends to pattern the biological NN directly. The GAs as well as the evolutionary computation techniques is based on principles of genetics. Basically, these GA methods solve optimization problems by a search process resulting in best (fittest) solutions (survivor). Among all the subbranches of AI, the NN and FL appear to have most uses for high-performance motor drives, which is evident in the numerous publications in the literature. According to Bose [3], there are many other feedforward and recurrent NN topologies, which require systematic exploration for their applications. Moreover, powerful intelligent control and estimation techniques can be developed using hybrid AI systems such as neuro–fuzzy, neuro–genetic, and neuro–fuzzy–genetic systems. The PSO is a population-based stochastic optimization technique developed by Eberhart and Kennedy in 1995 [4]. The technique inspired by social behavior of bird flocking or fish schooling. PSO shares many similarities with other evolutionary computation techniques such as GA. PSO is easy to implement with few adjustable gains compared to GA. PSO has been successfully applied in many areas such as function optimization, artificial neural network training and fuzzy system control. PSO is also already a new and fast-developing research topic [5]. The BI system is inspired by the biological disposition of animals and mimics biomechanisms. From the beginning of the 1990s, the NN technology attracted the attention of a large part of the scientific community. Since then, the technology has been advancing rapidly, and its applications are expanding in different areas [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 by Lucas in 2004 [6]. The Brain Emotional Learning (BEL) is divided into two parts, very roughly corresponding to the amygdala and the orbitofrontal cortex, respectively. The amygdaloid part receives inputs from the thalamus and from cortical areas, while the orbital part receives inputs from the cortical areas and the amygdala only. The system also receives reinforcing (REW) signal. There is one **A** node for every stimulus **S** (including one for the thalamic stimulus). There is also one **O** node for each of the stimuli (except for the thalamic node). There is one output node in common for all outputs of the model called **MO**. The **MO** node simply sums the outputs from the **A** nodes, and then subtracts the inhibitory outputs from the **O** nodes. The emotional learning occurs mainly in the amygdala. It has been suggested that the relation between a stimulus and its emotional consequences takes place in the amygdala part of the brain. The amygdala is a part of the brain that must be responsible for processing emotions and must correspond with the orbitofrontal cortex, thalamus, and sensory input cortex in the network model [1], [2], [5].

During the past few years, the BELBIC has been used in control devices for several industrial applications. The BELBIC has been successfully employed for making decisions and controlling simple linear systems as in, as well as in non-linear systems such as control of a power system, 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 (SIMO) overhead traveling crane, washing machine with evolutionary algorithms, automotive suspension control system, micro-heat exchanger, ventilating and air conditioning control problems [1], [2], [5]. Even, the BELBIC was designed and implemented on field programmable gate array (FPGA) for controlling a mobile crane in a model free and embedded manner. For the first time, the implementation of the BELBIC method for electrical drive control was presented by Rahman [7] in 2008. The Rahman's results have shown superior control characteristic, particulary very fast response, simple implementation, and robustness with respect to disturbances and parameter variations.

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 (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.

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