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Quantum Computational Intelligence Smart Toolkit in Intelligent Robotics: Quantum Deep Machine Learning Based on Quantum Fuzzy Inference

Principles of developed in "INESYS" LLC (EFKO Group of Companies) end-to-end quantum intelligent IT and its applications in successful search solutionsas intelligent robotics control of physical experimental Big / Mind Data problems are discussed. In particular case, applications of quantum algorithms main models and quantum soft computing in design of physical and mathematical models from extracted quantum hidden information of experimental classical Big Data are introduced. In the successful sophisticated search of the task's solutions of the robotic robust intelligent and cognitive smart control based on quantum control principles as quantum deep machine learning and quantum soft computing is important to choose type and kind of quantum correlations, as example, between coefficient gains schedule of PID-controllers. Extracted from classical states (as example, from modeling control coefficient gains laws) quantum hidden correlations (that physically rigor and mathematically strong correctness, and corresponding to main qualitative properties in general of ill-defined control object) are considered as an additional physical computational and information resources. These information resources help to changes the time-dependent laws of the coefficient gains schedule of the traditional controllers as PID-controllers in control loop of robots. New information-thermodynamic trade-off interrelations between main control quality measures as stability, controllability and robustness for quantum self-organization algorithm of imperfect KB is introduced. This report discusses the use of quantum genetic algorithm to automatically choice the optimal type and kind of correlations in the quantum fuzzy inference (new quantum search algorithm with embedding of one quantum algorithm in another) and presents the synergetic result of applying the generalized algorithm to intelligent cognitive robotics using the benchmarking system "cart – pole (inverted pendulum)" with one PID-controller for 2 (globally unstable and locally unstable generalized coordinates) DOF control object. Results of controller's behavior comparison confirm the existence of synergetic self-organization effect in the design process of new robust KB on the basis of imperfect (non-robust) KB responsesof fuzzy controllers. IT of knowledge base remote design of the fuzzy cognitive controllers is developed with the use software as "Quantum Soft Computing Optimizer" (QSCOptKBTM) – Computational Intelligence Toolkit based on quantum soft computing. The possibility of setting and transferring the knowledge base using remote connection to the control object is considered. Robot's intelligent control Benchmarks based on quantum soft computing as robot for service use, redundant robotic manipulator with 7 DOF, robotic unicycle, wall climbing robot, collective mobile robots with remote control of KB broadcast for technological operations of carrying out acts ("master-slave" swarm robots), cognitive control of autonomous robot in labyrinth, cognitive robot for children with ASD and dementia, and robotic prosthetic arm based on "brain-computer-intelligent robot" neurointerface are demonstrated.

Biography

Dr. Sergey V. Ulyanov has graduated from Moscow Technical University on the specialty "Electro-Mechanical Engineering and Automation Control Systems". In 1974, he got PhD from the Central Institute of Building Construction (Moscow) on the specialty "Dynamic of Building Construction on Earthquake Excitations". In 1992, he got State Dr. of Physics and Mathematics Sciences from the Institute of Physical-Technical Problems (Moscow) on the specialty "Quantum and Relativistic Dynamic Intelligent Control Systems".

His scientific interests are in AI control systems with time-dependent random (variable) structures for complex mechanical systems, intelligent toolkit for robotics, fuzzy wise control, SW/HW of fuzzy controllers, intelligent mechatronics, bio-medical engineering, quantum and relativistic control systems, soft computing, quantum algorithms and quantum soft computing, AI and intelligent cognitive robotics.

He published more than 55 books and 300 papers in periodical journals and proceedings of conferences in different scientific domains. Professor of Milan University (Italy) and University of Electro-Communication (Tokyo, Japan), Editor-in-Chief of International Journal "Artificial Intelligence Advances"