

FPGA for Robotic Applications: from Android/Humanoid Robots to Artificial Men

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Welcome to the end issue of Volume 9 and to the first year of the new-look TELKOMNIKA in fully English. In this year, the TELKOMNIKA continues to provide a rapid and competitive forum for the latest, significant research advances. A first special edition on AI applications has just been issued which is continued and equipped with special edition on robotics in this issue. This is only achievable thanks to the hard work of the contributors and we would like to express our sincere gratitude and appreciation to the authors, the editors and, of course, the reviewers who play such a crucial role for contributing to the high standards of the journal.

Researches on home robots have been increasing enormously. There has always existed a continuous research effort on problems of anthropomorphic robots which is now called humanoid robots. Currently, robotics has evolved to the point that different branches have reached a remarkable level of maturity, that neural network and fuzzy logic are the main artificial intelligence as intelligent control on the robotics. Despite all this progress, while aiming at accomplishing work-tasks originally charged only to humans, robotic science has perhaps quite naturally turned into the attempt to create artificial men. It is true that artificial men or android humanoid robots open certainly very broad prospects. This "robot" may be viewed as a personal helper, and it will be called a home-robot, or personal robot. This is main reason why the two special sections are issued in the TELKOMNIKA sequentially.

Personal robots as devices properly defined in terms of their ability to replace a human being in a number of everyday file jobs. Humanoid robotics today has a broader scope: it does not include only the humanoid as artificial man, but also some hybrid configurations that technology makes possible today. The integration of artificial parts into human bodies, as well as the control of paralyzed natural limbs by electrical stimulation, is investigated by the research community with increasing success. Home robots have different structures to serve humans in many aspects. Mobility is a necessary ability for the home robots to move around. Manipulation of home robots is also important, but relatively less developed due to the difficulty of making the robot smaller.

Since the size and weight of home robots are limited, control hardware should be embedded to make more rooms for other necessary hardware. The other difficulty comes when commercial processors are used to control robot arms due to the limitation of output port. Hardware technologies such as DSPs or microprocessors allow us to have real-time control. However, since the DSP has limited output ports, control of humanoid robots is not suitable. The most possible solution for the humanoid robots is field programmable gate array (FPGA). It will reduce their size and weight, and therefore their cost. In addition, a major revolution in the design of integrated circuit has been possible efficiently integrates embedded processors intellectual properties (IPs) into a FPGA. With the revolution, the highly sophisticated algorithms with heavy computations can be realized by software in FPGA. Some FPGA-based solutions have been reported in the field of robotics. A fuzzy logic controller for robotics has been implemented using an FPGA in [1]; a neural network controller on FPGA for a humanoid robot arm has been conducted in [2]; an embedded robust adaptive controller using FPGA for mobile robotics has proposed in [3] and [4]; and a fuzzy logic and neural network based controller has been applied in [5]. The researches have proved that the FPGA is a best solution as satisfactory performance of robotic applications.

Now, at the given the current level of technology, it is very realistic to pose the question: Is the development of humanoids still a challenge for human creativity and a demonstration of scientific understanding and advanced technology? Are we ready to move towards personal robotics, when and what is the most possible to be the first step? Is it the most socially acceptable? Answers to the questions cannot be given without taking into account all such implications: there are cultural barriers in the introduction of humanoids in the human society, a proper paradigm of the human-robot relationship has to be identified, a proper balance between humanoids aspect and functionality needs to be designed and an ethics for humanoid research and for humanoids should be defined. It is believed that the first step in a coordinated effort toward home robots should be an assessment project that evaluates the idea and promotes technological initiatives in specific aspects of humanoid robots and man-machine analogy. The ultimate objective is that the creating a robot should consider resembles human behavior regarding motion, intelligent, and communication. The special section has presented paper about behavior learning to improve robot performance in handling uncertainty [6], and other paper [7] present about motion tracking based on image processing.

From the human-like motion point of view, a human robot should be kinematically redundant. However, redundancy increases the mathematical complexity of the robot control problem. Second feature, human-like intelligence is an absolute prerequisite to designing personal and service robots. The use of neural networks and fuzzy logics promise to offer more adaptive and more competent obstacle avoiding schemes in real situations. One of the papers in the special section presents a novel pattern recognition using neural network [8] and other paper [9] proposed multiple moving obstacles avoidance using stereo vision for service robots. Third feature, human-like communication is that a human robot must have easy to use natural, human-like, and communication interfaces. The special section in this issue will present an extension for the SimVis3D framework that allows the simulation of human-robot interaction [10]. A promising approach is synergy the three above feature utilizing FPGA hardware and artificial intelligent.

Consider the major advances of artificial intelligent, robotics and FPGA technology; it seems reasonable to expect that a direct cooperation between the human worker and the robot which "*represent Man and the concept of his Mind*" will be possible in the near future. Comfortable working conditions for the human and the robot are essential since they may have a significant impact on productivity. How far away is "*artificial Men*", a perfect personal robot - a real human, cloned and genetically engineered?

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