Design and Measurement with Interactive Evolutionary Computation

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Design and Measurement with Interactive Evolutionary Computation

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Abstract:

Following the overview of Interactive Evolutionary Computation (IEC) research, three recent topics are introduced: micro-electrical mechanical systems (MEMS) design with IEC, psychological measurement with IEC, and extended IEC with physiological feedback.

IEC is an optimization system that optimizes a target system based on human subjective evaluation. There are many systems whose performances for system optimization are not measurable but can be evaluated by humans when we hear, see, or touch the system outputs. IEC is a technology that is applicable to such systems. It is widely used now and some of its applications include generating computer graphics (CG), music, or artistic design, designing acoustic or image processing filters, controlling virtual reality or robotics, designing in engineering, and others [1]. First, we review this status-quo of IEC research.

(a) IEC-based MEMS Design

We combine IEC with existing evolutionary synthesis software for the design of micro-machined resonators and evaluate its effectiveness using human evaluation of the final designs and a test for statistical significance of the improvements. The addition of IEC produces superior designs with fewer potential design or manufacturing problems than those produced through the evolutionary synthesis software alone as it takes advantage of the human ability to perceive design flaws that cannot currently be simulated. A user study has been performed to compare the effectiveness of the IEC enhanced software with the non-interactive software. The results show that the IEC-enhanced synthesis software creates a statistically significant greater number of designs rated 'best' by users [2].

(b) Mental Health Measurement with IEC

We show experimentally the applicability of IEC to a new application field, *mental health measurement*. We had 3 schizophrenics and 5 mentally healthy students design *happy* and *sad* impression CG lighting images using IEC and asked other 33 students to evaluate the CG images using Scheffé's method of paired comparison. Statistical tests of the evaluations showed that the range of emotional impressions perceived by the three schizophrenics between *happy--sad* was significantly narrower than that which was perceived by the mentally healthy students ($p < 0.01$). This experimental result implies that IEC has potential to contribute to psychiatry, and it also showed the possibility to expand IEC applicability beyond conventional system optimization and to a new area, mental health measurement [3].

(c) Extended IEC with Physiological Feedback

We propose and then evaluate a new framework for finding the physical characteristics of an artificial environment which give rise to given target physiological characteristics [4]. We assume that a human is a system that takes as inputs the physical parameters of an artificial environment and outputs physiological parameters in response. We define our task as the inverse problem; we must find the best inputs from given target outputs. Our proposed framework solves the inverse problem using evolutionary computation techniques to optimize an artificial environment. We evaluate this framework using a simulation with a vibration environment and verify that it works.

Keywords: interactive evolutionary computation,

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Biosketch

Hideyuki Takagi received the degrees of Bachelor and Master from Kyushu Institute of Design in 1979 and 1981, and the degree of Doctor of Engineering from Toyohashi University of Technology in 1991.

He had worked for the Central Research Laboratories of Matsushita Electric Industrial Co., Ltd. in April, 1981 - March, 1995. He was a Visiting Industrial Fellow of the University of California at Berkeley in Oct., 1991 - Sept., 1993, hosted by Prof. Lotfi A. Zadeh. He worked for Kyushu Institute of Design since April, 1995 as an Associate Professor and is an Associate Professor of Kyushu University since two universities merged on Oct. 1, 2003.

Prof. Takagi is interested in computational intelligence such as neural networks, fuzzy systems, evolutionary computations, and other so-called Soft Computing technologies, especially cooperation of these technologies. Currently, his interest focuses on Interactive Evolutionary Computation which aims the cooperation of human and evolutionary computation.

He received the Shinohara Memorial Young Engineer Award of Institute of the Electronics, Information and Communication Engineers in 1989: Best Paper Awards from KES1997 and IIZUKA1998: Program Committee Best Paper Award from ICOIN-15 in 2001: Distinguished Service Award from Slovak Artificial Intelligence Society in 2002: Outstanding Contribution Award from IEEE Systems, Man, and Cybernetics Society (SMC) in 2003: Paper Award from Japan Society for Fuzzy Theory and Intelligent Informatics (SOFT) in 2004.

He is serving for IEEE SMC Society as an elected Board of Governor member in 2001-2003, 2004-2006: SMC Technical Committee Coordinator since the end of 2004: an Associate Editor of IEEE Trans. on SMC, Part B since 2001. He served as the Chair of SMC Technical Committee on Soft Computing in 1998 - 2004.