REALITY, REPRESENTATIONS AND CYBERGRAPHY

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Could we create "artificial art" systems with an ability to generate visual artifacts of the same quality as humans ? Many works of art have forms , with simple formal structure, shapes and appearance, where not only process of creation, but also motivation and inspiration is evident. Artists using computers in the Sixties and Seventies were able to imitate (and even some artists did these experiments) works of contemporary art. It is an interesting historical coincidence that in that, when machines were able to draw synthesize simple patterns, similar to the some trends at the contemporary art (minimal art, neoconstructivism, kinetic and op art). Few artists at that time used computers, even when they would be helpful in their work. Potential ability of today machines is not only in synthesizing of artifacts, compatible with formal styles from the first half of this century, but also in imitating works of realistic descriptive or symbolic paintings, relief or sculptures from antique, middle age or 19th century - works which were attributed with an unified style, canonical forms and conventional themes (religious mythology, historical events, landscapes, still lives and portraits).

The "mission" of information processing machines in art is not to imitate what was done by humans, nevertheless the analyzing and simulating existing styles is the challenging topic for researchers. This paper analyses concepts and possibilities of creating artificial art systems, which include not only the automatic generation of particular (static and dynamic) objects, resulting from visual interpretation of abstract symbols and signs, generated by an intelligent program, but also able to build their cyberworld model (C) simulating learning, motivation, inspiration and evaluation of finished results. The following chapters will analyze conceptual model of relations between real (objective) world (R), their reflection in the subject's brain (mental model M) and artifacts (A), created by humans or generated by machines. This model uses (for simplicity) Descartes' divide paradigm between the thinking subject and the world of objects. In fact, all objects and phenomena, and representations become reality itself. In the following text the notation X->Y will denote transformation of representation X into representation Y.

REALITY AND IMAGINATION

Processes in real world which "deal not only with physical object ontology of things but also with persons, mental states, social constructions and perhaps, gods" [1 p.84] are denoted by

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mapping R->R . Mental model of R is cultural phenomenon" [3 p.67], built during the life. Transformation R->M means sensoric perception of real world, M->R ->M->R means interactive sensory - motoric processes and M->M denotes mental and cognitive processes (perceiving, memorizing-forgetting, thinking, understanding, dreaming, imagination, intuition).

The necessary condition for recording any real object or phenomena in our consciousness is that it must be projected in time and space into at least one of our senses. [16 p.48]. Machine perception, in some cases, is even more sensitive than human (ultrasound, infrared or telesensing), but the representation of any object depends on all information about it. " Schauen, wissen, ahnen, glauben und wie die Fuhlhorner alle heissen, mit denen der Mensch ins Universum tastet, mussen denn doch eigentlich zusamenwirken", wrote J.W. Goethe [13 p.7].

Perception, which is closely connected with learning (application of learned facts in similar situations, induction, deduction, analysis, synthesis, logical reasoning), is not passive. "Learning by child depends on the sensory and motor capabilities of the whole body and on his interactions with family and other people, as well as his sensing the physical environment. One of the research themes in robotics is "active" vision. Learning also involves the social phenomena of language and its feedback cycles "[1 p.2]. We learn also to understand and create abstract symbols, metaphors and sign. "One learns to read conventional symbols of a culture's pictures just as one learns to read conventional words of a language "[2 p. 67].

VISUAL RECORDS OF REALITY AND IMAGINATION

Visual representation of reality or our imagination are 2D or 3D static or dynamic objects or phenomenae (for example infrared photography can records objects, which are no more at the same place like they were at the time of taking snapshot). Those, created by humans are artifacts (formulae, schemes, drawings, sculptures, buildings, film or video). "Abstract artists and scientists strive to create representations of the real physical world with what are sometimes referred to as nonnaturalistic representations. In contrast , a naturalistic representation, or visualization, is based on the visual imagery we abstract from objects and phenomena we have actually experienced" [9 p.14].

Records of reality (R->A transformation) could be created without human's intervention (shadows of objects, spatial prints of objects like fossils or petrified human bodies from Pompeii). Inverse transformation: A->R means changing or creating real objects from its visual representation. Examples are natural (snow in shadow melts slower than snow disposed to the sun rays) or artificial masking processes (printing or stereo lithography, where complicated 3D or 3D shapes are created by the sequence of masking procedures).

Invention of photography (which was traditionally considered as a medium reflecting reality) was an important event, when humans gained a new visual tool, not dependent on painter's skills. The people could see what was unseen before. Film and video is able to record spatio-temporal world not only isomorphly in time and space but also with time compression or even in negative time direction. "It is known that painters, in general do not depict what they see and how they see but they are determined by the specific goals and conventions" [16 p.20,21]. Realistic painting is indirect rendering of reality denoted by the sequence R->M->A.

Ability to draw ("...even the simplest drawing depends on a complex interaction between brain systems" [6]) is considered as an important criteria for admission to (many) fine art and design schools (at our school even the photographers have to draw model during the admission test). Here arises the question, whether the ability to visualize own imagination or reproduce reality by the computer algorithm (formal mathematical and procedural representation) modeling shapes or using the interactive program is not equal skill for visual artists as a drawing ? In any case, designers and artists prefer visual communication over the verbal dialogue or abstract symbols.

Sequence M1->A->M2 denotes visual communication between two subjects. Subject 1 creates image A of his mental model M1, subject 2 reads this message, transforming A to the new mental model M2. Is M1 same as M2 ? A->A denotes artifact modification for example erosion of sculptures due to acid rains or image processing. Physical processes change not only the form of artifact, but also its meaning. Collaging and retouching in digital photography and video which do not require skills in complicated dark room technology, are the powerful weapon in hands of media "brain" manipulators.

CYBERWORLD

Computer became the most universal tool in history of man. Let us investigate relation between computer modeling (C) and pre-cybernetical representations of the world. Transformation R->C means computer perception - data input in form of coded electrical signals from punched cards, keyboard buttons, movement of fingers in data glove, 2D and 3D scanners, brain waves sensors, blood pressure, body temperature, moisture and sound sensors.

The reverse process C->R means converting virtual computer model into the real material objects or their physical modification. Computers are able to draw with pencil, paint with the paintbrush, engrave, generate sound, grip, carry, assembly and even destroy objects. They can cause pain or stimulate pleasant feelings. Factories "without" people are dreams of many entrepreneurs.

Visualization of cyberworld or manufacturing artifacts from their virtual model (C->A) is the hot theme of research in computer animation and virtual reality systems. Direct brain - computer communication M->C->M is theme of sci-fi writers and an ultimate goal of many scientists. Can we imagine computer program which understands and executes commands given by our thoughts or even creates illusion of seeing by stimulating brain of a blind person ?

Experimental systems for gesture and voice recognition, eye movement tracking, or brain controlled systems (exploiting analysis of encephalographic signals) become attractions not only at the computer science conferences and shows but also at the art symposia and exhibitions (ISEA, Ars Electronica, Imagina).

MACHINE INTELLIGENCE AND AUTOMATION OF CREATIVE PROCESSES

Transformation C->C means simulation by the computer - the conceptually parallel process with mental activity. Limits of computers (one point of view) are expressed by the mathematician Kurt Godel in his incompleteness theory, but "We can argue that Godel's incompleteness theorem does not prove that machines cannot be intelligent" [1 p. 21]. Physicist Roger Penrose (in his recently published book "The Emperor's New Mind") is also pessimistic about "thinking" machines and computer models of the world. On the other side many problems are solved better by computers than can be solved by most of the population. Logical and rational behavior is not case of every individuum, nor is a driving principle of our civilization. Man does not use only his brain, he has desires, pleasures, suffers from pain.

In last few years artistic community is interested in problems of artificial life -simulating primitive life forms, their growth, evolution and interactions with the same or different species. This is also hot theme in Artificial Intelligence (AI) research, which focuses on programming computers as machines with intelligent behavior. Forecasts, expressed during the historical scientific conference on The Fifth Generation of Computers (with the stress on AI), held in 1981 in Japan are not fully realized, however, there were invented many methods, paradigms, languages, special computers in this field. Many promising experimental programs and theoretical results exist, but practical applications of AI are still rare. Real scale problems and mass production will require faster and cheaper machines and deeper knowledge of cognitive processes.

Works, exploiting cutting edge of the "new technology" in art (objects, installations or animation) use just the "top of the iceberg" in the know how, existing in the scientific research. These, mostly experimental works are art per se, but they are maybe the basic building blocks of the user friendly "computer aided creativity" systems of the next generations.

Automation of creative processes is topic of research since a long time, especially in engineering and product design. The progress in computer technology and software engineering in the Eighties caused the boom of interactive graphic systems with user friendly environment . "..using an interactive program is very basic - simply pointing and clicking. By a clever sequence of such simple actions, a user sets into motion huge piles of frozen mental labor that others - system and software designers and programmers have done" wrote F. Nake, one of the pioneers of computer assisted art. [11 p.204]. Can be this clever sequences controlled by a machines ?

Most of the CAD systems emphases on automation of engineering drawing and preparing data for computer manufacturing process, but some are able to check design rules, evaluate some parameters during the design cycle or test "virtual" objects before they are prototyped. Some design automation systems can even more. For example, in the microelectronic design, many processes are fully automated. Silicon Compilers, investigated since early Eighties are systems with ability to design very large microelectronics circuits from brief functional specification, "almost" without an intervention of designer. The final result, it is a set of complicated mask patterns for lithographic manufacturing must not be the "best" solutions (human designers can achieve better results), but the design cycle is much faster and cheaper. Sometimes "manual" redesigning must follow. Of course silicon compiler (some scientists predicted already in mid eighties "metal, wooden or plastic" compilers) need database of pre-designed elements and modules, built in design rules and procedures for object synthesis.

Challenging goal in research would be automatic layout or graphic design compiler for desk top publishing systems, book covers, posters, bulletin boards, logos or business cards design. There is a big boom of such tasks and need for qualified designers in the post-communist countries today. Many times the results (this task is very often performed by non professional designers) are so poor, that a procedure using canonical layout, fonts and color selection algorithm could achieve better quality. The books with images of the existing logotypes are among the most frequently studied, at our school library. Browsing, evaluating and modifying existing designs is the simplest algorithm for some graphic designers.

Designing, according to E. Gombrich, is schema and correction-trial and error process. It is an helical progression from initial specification or idea towards some desired result. Concepts, partial and final results are tested against some criteria of function, appearance and cost. The highly creative process during conceptual design can be structured into several steps, but in general it is generation and evaluation. Some authors stresses more on the second stage. In his article, M. Elton discusses qualification of computer in this task [5].

Quantitative functional and parametric evaluation of technical products can be rigorous (even in case of very complex systems). The evaluation of artifacts in architectural and product design (functional parameters and appearance) is more ambiguous. In the fine arts, where quantitative parameters of the artifacts are limited to the few elementary functions (constraining size, weight, mechanical stability or cost) and where not only aesthetics but also novelty, shocking, ideology, fashion are also important criteria, is more complicated.

Some case studies of famous architects lead to development of production systems, which are able to synthesize floor plans compatible with their canons (for example Palladian villas, L. Wright prairie house), but these methods are not general and they are more academic examples.

In eighties appeared publication about extrapolation shapes of the car from previous models. One approach, using semantical information on different parameters by the car designers is described in [17]. The system for "automatic" design of family houses, investigated by the research team of I. Petrovic from Belgrade [18] uses semantical differences and their evaluation by the neural network. In animation appeared goal oriented movement (based on data provided by the ballet or dance experts) or facial expressions generators (based on research in psychology). These methods allow learning by examples - procedures suitable in case of lacking formal rigorous theory at the particular area. That is a case of design and fine arts.

Experimenting with such systems requires time to train them before the first results are available. Many users are not patient to learn machines (nor to learn themselves to work with machines), they require immediate results. The similar phenomena existed in accepting expert systems in medicine, where physicians were also suspicious to give their know how to the machines. The learning process must be automatic and autonomous. The system has to have motivation, desire and freedom to learn and to have an access to the information which could be used to build its knowledge base.

MACHINE AESTHETICS AND COMPUTER ART

In so called computer art, machines are limited to the generation of patterns, using geometrical transformations, iterations, deterministic or stochastic automata, syntactical rules, and similar methods - invented and programmed by artists or scientists. Motivation, inspiration, methods, selection and evaluation of resulted artifacts is done by humans..

There were many approaches for automatic evaluation - "quantification " of aesthetic criteria like the magic or Fibonacci numbers, Golden section or harmonical proportions. In the Twenties, G. D. Birkhof wrote a book [2], where he described method of calculating numerical aesthetic measure of polygonal patterns. One year ago, Polish scientist E. Grabska generalized this method for fractals. This method is interesting, but nevertheless it is very limited to simple geometric structures. Information aesthetic, investigated in the Sixties and Seventies, dealt with criteria like novel, surprising or boring, but there exists bottlenecks in definition of structural elements of artifact, their automatic recognition (especially in case of "non geometric" art). The progress in image processing, pattern recognition, AI and computer technology could stimulate more interest in this theory.

Not only form (patterns with some space, time and color composition) but also semantical content of artifact must be considered. Image or geometrical model does not contain explicit semantical information. Picture is just matrix of picture elements, no relation between segments (pixel clusters belonging to the image, representing semantical entities) is given. Scanned geometrical model is just collection of 3D points with no explicit structure and hierarchy. Constrains, resulting from application domain can significantly help in process of pattern recognition. Textual information accompanying image could to help to understand abstract symbols, structure and composition of work and his meaning. But relation between textual information and specific pattern is not simply understandable, even the author of work might not be able to explain in words what he/she means.

"Aesthetic judgments come in two extremes - subjectivist and objectivist. For subjectivists, beauty is a feeling within an observer and need not be quality of an object....Objective assessments of aesthetics attempt to remove subjective elements. Can we really believe this ? ....There is no neutral way of appreciating a work of art of seeing nature, as we could expect" cites A. Miller words of E.W. Gombrich [9 p.14] . Creating and judging art works by artists and spectators is not only the question of measuring or revealing new forms. Meaning of experts, publicum, and media are also important - "..good designers to be those whose names are well known within their profession and whose work is frequently published and attracts awards or wins competitions" [8 p. 323]. Conventions and fashion changes. "Any evaluative criterion that is static will have limited value in field where values are changing all the time (something what is especially true of the arts)" [5 p.215].

The world of intelligent robots "..with desires and intentions, enabling them to perform hypothetical and defeasible reasoning, to solve problems creatively, to appreciate works of art, to achieve some form of cyberpleasure" [19 p.32]. In this world a new cyberculture, artificial art with criteria of cyberaesthetics could be simulated.

Installations or objects dealing with not only visual and aesthetic aspects in computer art are becoming part of installations at the art shows. Sometimes their cause controversial and even negative feelings of spectators (Is not it more science than art ? The understanding the concept of such project needs a deep knowledge of the field.). An example of such trends is activity of the Institute fur Neue Medien in Frankfurt, Germany in the Knowbotic Research [4].

CYBERGRAPHY - ON THE WAY TOWARDS AN ARTIFICIAL ART

In the late Sixties, A. Moles [10] analyzed possibility of the "artificial art" systems and mentioned automatic generation of text, patterns and music sequences using structuralism theory. By the evaluating of resulted works he suggested methods of information theory. In his time, computers were very limited and for example memory capacity (RAM as well as hard disc) of all computers in Slovakia was smaller than capacity of my home computer today.

The very important aspect of human intelligence, as mentioned earlier, is learning. Expert artificial intelligence systems, investigated in the Eighties gained their knowledge from experts. The selection what and how they learn depends on the user (passive learning). Creative activity needs freedom. Computers can not move freely and their perception system is limited to the active sensors (in case of experimental robotics systems), but the global networks (like Internet) with the capability of the "free" browsing of huge data bases, locally created and scattered all over the world, is an very important change comparing the situation twenty or thirty years ago. This is an example of the huge library or a long term memory of human mind.

Expert (artificial intelligence) system exploiting knowledge of art historians, aesthetic conventions used in different epochs or art styles, formalized and coded to computer algorithms, simulating artifact evolution in step by step improvement method and extrapolating development can be created. We can imagine computer "cybersurrealistic" program, which according to the Surrealist manifesto "l'automatisme psychique, constructif et graphique" generates time sequences and space compositions, which are patterns, resulting from the visual interpretation of abstract symbols and signs and which are records of the imaginations from their "cyberdreams" and "cybersubcounsciousness".

"Subcounsciousness processes, dreams, hallucinations and visions are composed of fractures of the long term memory. They are, less and more, mixed and reordered, like the figures in kaleidoscope, so they create something new, what we never before (illusory) saw or heard about. In order to revive these fragments, we need to weak the short term memory" writes the Russian psychiatrist V. L. Levi in his book "Hunting the thought". Computer subcounsciousness can be simulated by - incomplete structures or stochastic relations in the knowledge representation schemes (semantical networks, set of rules, frames, neural connections and transitions). Like in the fractal theory (which is used in simulating natural objects, where elements of the system are not generated fully randomly, but with the respect to the laws of physics), also the semantical units of "computer dreams" must obey some rules (for example syntactic structure).

Visualization and cyberrealistic rendering of resulting compositions of the abstract symbols is an example of virtual photography - CYBERGRAPHY, without optical system of camera, light and chemical processes. Cybergraphs can be created not only without real camera, objects of interest, but also without photographer and his intention what and how to photograph. Generators of Neosurrealistic prints or paintings, photographic collages from fragments of non existing scenes is the first step towards more complicated tasks.

EPILOGUE

The father of the cybernetics, N. Wiener told: "Let the people retain what is human and let the machine keeps what is its". The simulation of different aspects of the working concepts, models of creative thinking, behavior, motivations, associations, feelings in process of art creation are "terra incognita" and challenging theme for the crossdisciplinary research (art theory, computer science, semiotic, psychology, physiology). Creation of intelligent "artificial art" systems, integrating artists, scientists and engineers becomes art per se.

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