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User Perception of Ai Self-Organizing Natural Image Generation Analyzed by Cognitive Paradigm

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Abstract

The algorithm is applied on the premise that the image generated by AI can be recognized and used smoothly by the user. Other assets are not exposed to the user or discarded because they are unnecessary or unfamiliar. This study aims to expand the scope of the utility of the image generated by AI, which is used as a high-level tool in the design field. To this end, we first examined human information processing and reflection in AI by the cognitive paradigm by examining previous studies and cases, and discussed the value of expansion by focusing on creativity and bottom-up processing of AI's self-organization. Considering the human recogmition process that instinctively grasps an object, the following AI usability was proposed. It is to utilize AI as a high-level tool applied appropriately to human perception, or to utilize the derivative itself by bottom-up self-organization. In addition, it is to set the algorithm to the minimum intervention so that basic elements such as shape, color, size, texture, and movement are composed of figure-ground according to the human perception process that instinctively grasps an object, and to utilize the results. Limiting the use of AI to a tool suitable for human perception and information processing or production by designers or general users is to operate only a part of the convenience and usability of AI. The image creation through AI's self-organization, as seen from the cognitive paradigm, is a step toward opening a new era of design where technical aesthetics meets devices, just as design has been constantly developing in pursuit of novelty and differentiation due to its nature.

Keywords: *AI self-organizing natural image, Figure-ground, Bottom-up processing, Design*

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1. INTRODUCTION

The rapid development of the Fourth Industrial Revolution and advancements in science and technology are transforming both the current and future landscapes of life and design. One of the most notable changes is the emergence of Artificial Intelligence (AI), which is being applied across all stages from ideation to design production. As AI is actively utilized across various fields, it must be beneficial to humans; thus, it is inherently connected to human cognitive processes, necessitating that AI algorithms be designed for maximal usability. However, in the field of design, beyond usability, new and diverse formativeness such as creativity and aesthetics are also pursued. Therefore, a perspective is required to reflect the potential and unexpectedness of vast amounts of data in the AI information processing process in design and ideation. This study philologized the phenomenon of emergence through AI self-organization and design, which minimizes humanities intervention when using AI in design, from a humanities perspective.

2. COGNITIVE PARADIGM

The cognitive paradigm, which conceptualizes the human mind as essentially an information processing system, emerged as a scientific framework following the 1956 symposium at MIT [1], [2]. This symposium convened researchers from a range of disciplines, including psychology, linguistics, electrical engineering, computer engineering, neuroscience, and information theory. These scholars shared a common view that a multidisciplinary and collaborative approach could effectively address the problem of the mind, or information processing [3]. Cybernetics [4], which proposes that interactions among neural cells can be represented through propositional logic systems, and Simon's perspective [5], which likens computers to human symbol manipulation systems, offered pathways for extending information processing to artificial intelligence (AI). Building on these ideas, Newell and Simon developed a more detailed model, which Lee has summarized (Figure 1). Their theoretical framework delineates various levels of information processing that occur between stages of basic information processing. These levels include the discrimination process, comparative verification process, new symbol creation process, symbolic structure production process, copying and transformation of symbolic structures, the process of mapping internal symbols to external stimuli or generating explicit responses to internal symbolic structures, symbol referencing, frame of reference, pointing, connection processes, and the storage of symbolic structures, among others. Newell and Simon posited that the information processing mechanisms characteristic of human cognition could also be implemented in computers [6].

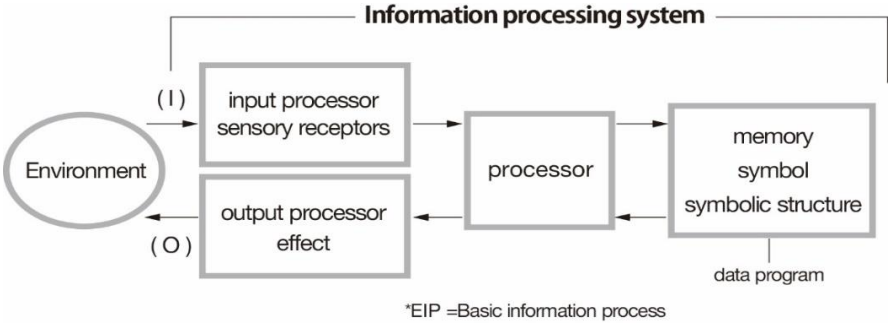

Figure 1. Basic Information Processing Model [3]

3. SELF-ORGANIZATION OF AI AND DESIGN

Wiener also addressed the concept of self-organization while establishing the theory of cybernetics, and Johnson notably emphasized the role of upward processing within self-organization [7]. It has been argued that rather than focusing on a limited number of significant changes, the emergent outcomes from the self-organization of a large number of individuals—similar to an organism—can foster new perspectives, be disseminated within society, and establish new norms. Johnson viewed the progression from low-dimensional laws to high-dimensional complex systems as an emergent phenomenon and stressed that such development should be recognized as a paradigm shift achieved through bottom-up processing.

Design inherently involves key elements of creativity, such as novelty, reconstruction, and originality, and investigates visual composition from various perspectives to produce design outcomes based on conceptual ideas. Consequently, top-down processing, wherein pre-determined designs are shared or followed, is fundamentally at odds with the design process. Designers organize fundamental elements, such as shape, color, size, spatial relationships, texture, and movement, in a manner analogous to an organism, and these elements are continually restructured into visual expressions according to the intentions of numerous designers.

Currently, prominent image-related AIs, such as Deep Dream Generator, Midjourney, and Runway, produce results that can be visually assessed incrementally, allowing users to make selections. However, the unsuitable products—those that are not usable—remain invisible. Designs can vary significantly based on the designer's perception and interpretation in order to visually differentiate ideas. It is crucial to pay attention to assets that are not optimized for human use, rather than relying solely on top-down approaches exemplified by the aforementioned image-generating AIs. Johnson's conceptualization of emergence values outcomes generated from bottom-up processes by minimizing human control over the system. In line with this view, if the algorithm is not specifically designed to create the image products required for design and human intervention is minimized, the assets derived from the AI self-organization process may be as immediately unusable as junk DNA. However, as the functions of junk DNA—which comprises 90% of the human genome and was previously thought to lack genetic information—are progressively revealed [9]. Similarly, designers might uncover previously overlooked aspects in unpresented AI products [10] or explore new visualizations through technological integrations that require minimal human intervention.

4. USER RECOGNITION AND FIGURE-GROUND APPLICATION

Previous studies that apply figure-ground principles to AI and self-organization research have been explored, investigated, and elaborated upon with respect to human perception. This includes examining the shapes that form objects perceptible by humans and analyzing color responses. Previous studies on the application of the figure-ground principle in AI and self-organization research have extensively examined human perception. This includes investigating the shapes that constitute objects perceptible to humans and their color responses. The figure-ground principle is a key concept in Gestalt psychology and refers to a set of principles applied to the user's visual perception process [11]. Elements such as shape, color, size, texture, and spatial orientation are grouped into similar or proximate categories and are perceived by users. In this process, the figure-ground relationship accentuates the object for the user, facilitating its recognition as a distinct entity. The differentiation between figure and ground is determined by perceptual elements observed through vision and by cognitive factors, such as prior experience [12]. The aggregated form becomes the figure, while the

remainder is perceived as the ground. More precisely, the figure corresponds to the part that distinctly stands out to the user's perception, whereas the ground refers to the less prominent background elements.

Research applying the figure-ground principle to AI algorithm design has illuminated the potential for previously undisclosed visual formativeness, in addition to the limited results typically presented [13]. <Figure 2> illustrates a dynamic image resulting from the application of minimal conditions for AI self-organization. Specifically, this involves designing the algorithm to self-organize during subsequent iterations by specifying only the initial parameters of the system. This visualization captures the sporadic and unstructured nature of the AI's self-organization process, which continues to evolve in a manner akin to a biological organism. Even in the absence of a predefined target, or without imposing top-down conditions on the algorithm, elements such as shape, color, size, spatial perception, and texture self-organize into a specific form with movement as the central focus [14]. This results in the emergence of a distinct figure. Each element is composed in diverse ways based on rotational movement, including geometric shapes like circles and semicircles, smaller patterns juxtaposed with squares, larger patterns combining these elements, and transitions from curves to straight lines. This demonstrates the potential for generating an array of shapes. Conversely, <Figure 3> depicts a scenario where thousands of small robots self-organize and assemble to form specific shapes or letters as per design [14]. Although these robots, initially aggregated, eventually align to create recognizable figures such as a star or the letter 'K,' they are unlikely to be perceived as other shapes.

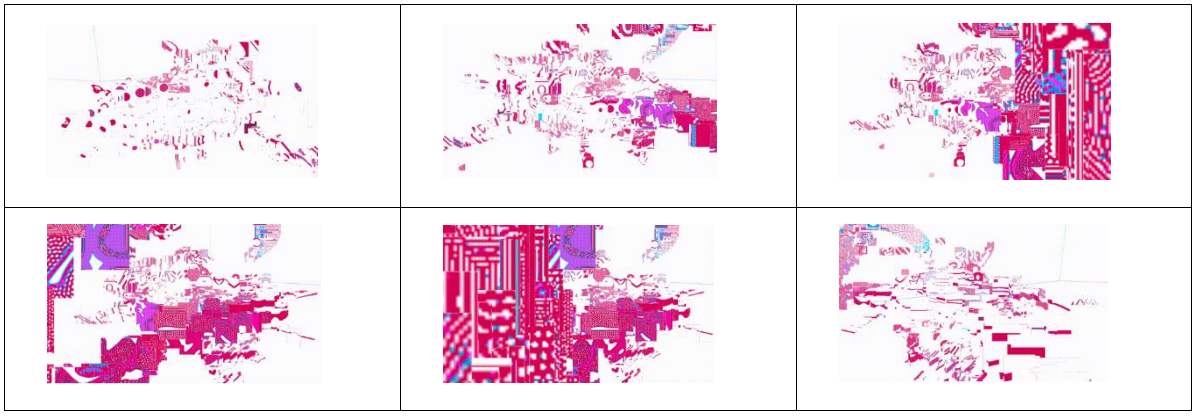

Figure 2. Automatically discovered self-organizing patterns in the continuous cellular automata system Lenia [13]

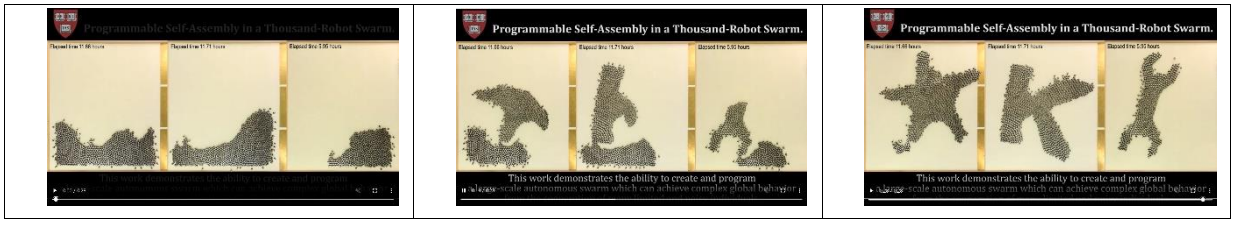

Figure 3. A swarm of a thousand kilobots self-assembling into different shapes [15]

5. New Formativeness and AI in Design

If emergence is incorporated into AI algorithms, autonomy can be maximized by employing bottom-up information processing, which minimizes human intervention, rather than relying on top-down processing that aligns with human cognition during the self-organization process. This approach facilitates the derivation of new forms of visual expression from the emergent properties of AI and serves as a constructive stimulus for designers and users in the AI era. As previously discussed, bottom-up emergence possesses the capacity for self-organization across a range of possibilities, leading to the development of new visual expression rules within the professional design field and eventually becoming applicable to general users [Sujin Lee, 2008]. This is analogous to design concepts that were once only speculative but have become realizable through the untapped potential of computers, resulting in significant advancements in new technologies and visualization.

Basic elements such as shape, color, size, sense of space, texture, and movement present limitations in recognition by general users during the bottom-up information processing phase. This difficulty arises because the organization of these elements lacks a predefined specific target, making it challenging to derive ideas or emotions. However, akin to how JUNK DNA reveals its functions, the characteristics of AI-derived elements can be instrumental for designers in the design production process. Therefore, it is necessary to extend AI towards bottom-up organization rather than confining it to generating top-down results that align with human perception. In this process, by considering videos implemented on digital devices, it is possible to achieve figure perception with minimal intervention by applying the figure-ground principle with a focus on movement within the algorithm. By extending the application of AI beyond its current role as a tool for everyday human activities, work, and production, to include the utilization of products derived from the self-organization of detailed elements, or by employing algorithms with minimal intervention, we embrace a more diversified methodology. It is essential to also direct attention toward the effective utilization of these advancements.

4. CONCLUSION

The cognitive paradigm, which similarly applies the concept of the human mind as an information processing system to artificial intelligence (AI), prompts reflection on user perceptions of AI assets, particularly in the context of non-face-to-face social interactions. Specifically, this involves understanding users' perceptions and cognition of these, but more broadly, it encompasses the recognition of their value and utility. Currently, the focus on AI is on the usability of humans being able to recognize and judge assets. This study posits that in the field of design—where creativity is a fundamental characteristic—products that are not yet fully refined and might be overlooked by existing AI algorithms can offer new possibilities for design ideas or expressions. Consequently, bottom-up processing that minimizes user intervention in AI self-organization, by applying the concepts of emergence and self-organization, is deemed appropriate. This approach emphasizes the value of uncovering potential opportunities in areas that might be missed by human perception. In self-organization, whether by chance or design, it is underscored that new visualizations can emerge that are distinct from those previously encountered. Consequently, it is essential to broaden the application of AI, which is currently employed as a high-dimensional tool, to better align with human perceptual processes. The derivative itself can be utilized through bottom-up self-organization. Additionally, minimal intervention should be applied to the algorithm to configure basic elements such as shape, color, size, texture, and movement according to the figure-ground principle, in line with the human perceptual process that instinctively recognizes objects. Consideration should be given to leveraging the resulting outcomes. Restricting the use of AI to designers or

general users as a tool merely suited for human perception, information processing, or production only partially harnesses the full potential and usability of AI. The creation of images through AI self-organization, when analyzed through a cognitive paradigm, represents a significant phase where the integration of technological aesthetics with devices is being actively pursued. This approach mirrors the evolution of design, which has continually advanced through the relentless quest for innovation and differentiation.

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