Special Contribution

Science and Art Today

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Limits of Imagination

Considering that one of the functions of modern art is rediscovering or extending the *world* based on the concept of *beauty* or *sublimity*, it is hard to imagine that the conventional method, in which artists have been creating something by themselves based on their own imaginations, is still effective. This is because the picture of the world presented by science is unusual and goes against common sense to the extent that it goes beyond the scope of artists' imagination.

Programming as a Technique of Expression

Artists have always been working with technology. Needless to say, technology includes a pencil, a brush, and a sheet of white paper. Digital technology is a remarkable modern technology. There are a number of techniques of expression utilizing digital environments. However, drawing a picture on the screen with a computer mouse —though it is an analogy of reality—cannot be considered a technique utilizing the essential nature of the computer as computing machinery, for instance. An effective method to extract the power of a computer as a piece of computing machinery is computer programming. As far as we rely on GUI (graphical user interface) we cannot create what exceed our physical abilities, but writing computer code makes it possible to exploit the computer's computing power with its amazing velocity and accuracy that far exceed our abilities for creating something.

"Computation" as a Technology

What is the most fundamental technology involved when we represent something by writing a program? Considering that a single algorithm can be expressed by multiple programming languages,





we understand that programming itself is not an essential technology. A truly essential technology must be "computation" itself. I think it is the most primitive technology created by human beings who can handle symbols.

Does "Computation" Create Artwork beyond Imagination?

What is the crucial difference between creating something by letting the computer compute and that by our own hands based on imagination? I think, ultimately, it is whether or not the created result is what we expected. As long as human beings create something with their hands, they have images of final drawings no matter how crude they may be, and these final drawings are drawn by imagination. On the other hand, when we create something through programming, we can think of a sequence of operations such as "for all the pixels of a given digital image data, divide the green value by the red value, and substitute the result for the *blue value*," but it is difficult to predict the result. However, it is possible to write an entire program without knowing the result, based on the logical system of a programming language. If the entire program is logically consistent, it is executable. Upon looking at the result of the executed program, then, there emerges a feedback structure which becomes key to going beyond imagination in creating artwork. It is an infinite loop of modifying the initial values or the algorithm of the program

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as a result of computation and then executing the modified program. I think this is one of the purposes of creating representations by computer technology —to discover *beauty* or *sublimity* that surpasses human imagination.

Artist-in-Residence at the Kavli IPMU

During my residency at the Kavli IPMU, I spent time thinking about what to create by how to compute what, with a hint of the concept of *dimension*. As a result, I managed to formulate one idea. It is the idea of considering a digital image as a set of points in 5-dimensional Euclidean space, by interpreting the five numbers that each pixel has—coordinates X and Y, representing the position on the image, and R, G, and B (red, green, and blue), representing pixel's color—as the coordinates of a point in 5-dimensional Euclidean space, and to observe a different aspect of the image by rotating it in this 5-dimensional Euclidean space. Mathematically, rotation conserves the distance between any two pixels, and of course inverse rotation restores the original image. In other words, it is something like watching a sculpture as you are walking around it. Mathematically, this is a feasible idea, but, again, it was not possible for me to imagine what kind of image was obtained by rotation. However, while I was addressing this program during my residency, it was possible for me to empirically learn which plane of rotation corresponds to what kind of change on the image.

Work created during the residency: "sunset" [(from left to right) gradation, complexity, spot] 2016, digital C type print series, 680 × 680 (mm).

These images are outputs from different input data (photographs of sunsets) with arbitrary parameter values of 5-dimensional rotation (see below). It is assumed that the "beauty of the sunset" unconsciously felt by us can be represented by the following three factors or their combinations:

- 1. Color gradation of the sky as compared to the ground,
- 2. Complexity of the shape and shadow of the cloud, and
- 3. The sun itself, felt as a white bright circle.

Considering digital pixels as 5-dimensional points (XY+RGB), the shape and the color gradation can be interchanged. Using this fact, I searched for the "beauty of the sunset," which can be felt even if the "sunset" itself cannot be recognized as a result of the rotation.

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(Upper left) A workshop was held for Kavli IPMU scientists. First, participants evaluated artworks of 14 media artists based on 10 items such as *simplicity*. This way, they understood the viewpoints for evaluating artworks. They then thought out ideas of installation artworks. Four scientists (astronomer, theoretical physicist, mathematician, etc.) participated the workshop and enjoyed the discussion.

(Upper right) An occasion of showing how the artist was working in the office to Kavli IPMU scientists. The artist explained his theme and progress of the work at this residency, using projected images.

(Left) A total of about 2800 people visited Open Campus Kashiwa 2016. On this occasion, the outcomes of residency were exhibited. Through two days of Open Campus, the artist explained his artworks to visitors. According to questionnaire from visitors, this exhibition gained a very good reputation with impressions such as "Fantastic!" and "Interesting though difficult."

Art & Science

Art & Science, or Art-Science collaboration, may be taken as something good, but I think it is actually very difficult, or rather almost impossible. First of all, science and art are different systems, each describing the *world* using a different language. This inevitably leads to the situation that the more they deepen, the more mutual understanding becomes difficult and the less they need each other. At the present time, science does not need art; it is a system that has developed in this way. On the other hand, art does not need to understand cutting-edge science, and painting has developed by sharpening subjectivity rather than objective realism since appearance of the camera. The meaning of Art & Science is not selfevident. However, it is obvious that the motivating power of some scientists and artists comes from such common fundamental questions as "What is the world made of?" "What is time?" and "Where do we come from?" I wonder what it does mean.

Artist Interview

(by Kavli IPMU Public Relations staff)

What pieces of artwork are you creating?

Mostly I create installation artworks using images obtained using computer programming. While combining various materials such as algorithms and real photographed images, I am thinking, for example, about how I can create what cannot be produced by human hands only, or whether it is possible to represent something by continuing the computing process itself.

How did you find creating artwork under the "condition" of residency at the Kavli IPMU?

As there were a variety of scientists, it was possible for me to ask some of

them questions as needed in trying an algorithm that I had not tried before. So, expecting that the algorithm itself would change while it was developed, I intentionally tried to think and create something without setting goals as much as possible. In the end, I was advised on how the same algorithm can be used rather than changing it, and to what motif I should apply it to expect interesting results.

Also, I think it was one of the conditions to, as much as possible, create something as an accumulation of processes that can be logically explained, without an artistic jump or a connection of thought. I think it was not intentionally imposed, but rather it occurred spontaneously owing to the environment of residency at the Kavli IPMU, a research institute in fundamental science. After the residency, now I think it was very constrained. However, we rarely experience this kind of thing in the world of art and artists only. When I returned to everyday life, suddenly memories of experiences at the residency came back, and the way of thinking I had learned there showed itself as pieces of work after a long time. I would say that these are the outcomes of the residence.

You are highly recognized for huge video installation pieces, which somehow conceptually or philosophically examine and present the laws that control nature, by using the computer's "computing function," and you are regarded as a young leader of media art in the contemporary art world. How do you evaluate your pieces "sunset" created from the viewpoint of a programmer who designs computing, and from the viewpoint of an artist who completes the computed results as pieces of work?

As a programmer who designs computing, I evaluate "sunset" as follows. It is a program dealing with a five-dimensional digital image data having spacial coordinates X and Y and color coordinates R, G, and B, but I have developed it as a program applicable to any dimensions depending on the computing resource. In fact, I have already created and exhibited the piece "datum" by dealing with image data pixels as digital points in six-dimensional Euclidean space. I would say that it is a success in the sense that it was designed and developed as a general program which, in principle, can deal with Euclidean space of any dimension. Regarding your second guestion with respect to the level of completion of my work. I could see that a curve in the spatial coordinate system appears as gradation in the color coordinate system and vice versa, as a result of five-dimensional rotation which mixes spatial and color coordinates. However, I have to say that it is insufficient to refer to whether these two are also interchangeable to the human eye which recognizes beauty. Further, I think that while it would be possible to see if they are interchangeable by means of a method which is somehow similar to scientific one, a jump of subjective thinking would be needed to make pieces of work as art based on these observations. So, it is likely that this would become something that takes a very long time, like my life work.

You obtain the image data of three primary colors in the twodimensional plane by taking certain four-dimensional space-time pictures in this *world* by means of an optical instrument (camera), and reconstruct them by regarding these data as a set of points in the five-dimensional Euclidean space. Was it possible for you to get some clues about the relation between things and truth (the laws of physics or beauty) while you were having the experience of transforming several hundred times the familiar outputs of three primary colors in the two-dimensional plane into the outputs obtained through rotations in the five-dimensional space, of which humans cannot recognize all the directions at the same time?

While I have been repeating my work, at a certain point it came to me that I could expect - though not completely, but to some extent - the image that can be obtained by rotating the original one in the coordinate system which combined the color coordinates and spatial coordinates, both visible in my eyesight. Then I felt how the potential of human brains is constrained by the phenomena occurring in the world which we are looking at and appealing to our senses. If phenomena occurring before our eyes are sufficiently rich. human brains can sense something from them and learn their pattern. Conversely, I have come to feel as if the real phenomena we can observe at the respective places in this universe are very restrictive, and this constrains the potential of the human brain. I feel that there are visual experiences which never result from observation of natural phenomena before our eyes, but which bear logically explainable beauty; namely, there exists beauty or sublimity beyond the universe as a totality of the nature that is observable by the mankind.

What is your plan for the future?

As for a big plan, I will hold a personal exhibition in Breslau, Poland in March, 2017, so I am preparing for that. It will be a big opportunity to present the outcomes of my residency at the Kavli IPMU as a package of artworks.

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