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Informatics in Japanese Arts and Culture

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[Feature] Informatics in Japanese Arts and Culture

Reading into Japan with Historical Big Data

Ancient documents, believed to number in the hundreds of millions, have been preserved throughout the Japanese archipelago. These records are a valuable part of our cultural heritage and a source of information about the past, but they are unfamiliar to us today. Professor KITAMOTO, Asanobu is working to make these documents more familiar by combining informatics and digital technology. We talk to him about AI recognition technology to decipher Japanese cursive script from early modern times, constructing datasets of historical big data, and the further digital transformation that he envisages for humanities research.

KITAMOTO, Asanobu

Professor, Digital Content and Media Sciences Research Division, NII
Director, ROIS-DS Center for Open Data in the Humanities (CODH)

Interviewer:

MIYASHIRO, Eiichi

Asahi Shimbun Senior Staff Writer

Digital technology is changing research in the humanities

—How is digital technology utilized in your area of research, the humanities?

I personally think of it in terms of three aspects: input, processing and output. First, about input, previously the subjects of our research were only paper-based books, but these resources can now be photographed or scanned and used as digital data. In terms of processing, I think there are huge benefits to be gained from using AI to read cursive script in these digitalized images, as well as analyzing huge volumes of data simultaneously. Publishing these research results in the form of electronic journals or datasets is what I mean by output. The data can be used just as it is, without having to re-input it digitally, which I think is a major advantage.

If digitalization of all three aspects progresses in the humanities, it will take research to the next level. Looking to the future, I believe the very way we research history will change.

—What do you mean when you say research will change?

For example, the standard method of research used to involve going to a library or other specialized facility to look at pre-modern texts or historical documents. But as the coronavirus pandemic prevented us from going to libraries for so long, it has become more usual to view resources online.

One example of digital transformation in the humanities is the AI-based *kuzushiji* (cursive script) recognition service. Even people who were skeptical when we first started this research in 2018 are now coming to accept it, seeing how convenient it is. I think they have come to understand that AI and humans are not in conflict, or competing for superiority, but that AI can supplement human work if it is used in the right way.

AI *kuzushiji* recognition service boosts humanities research

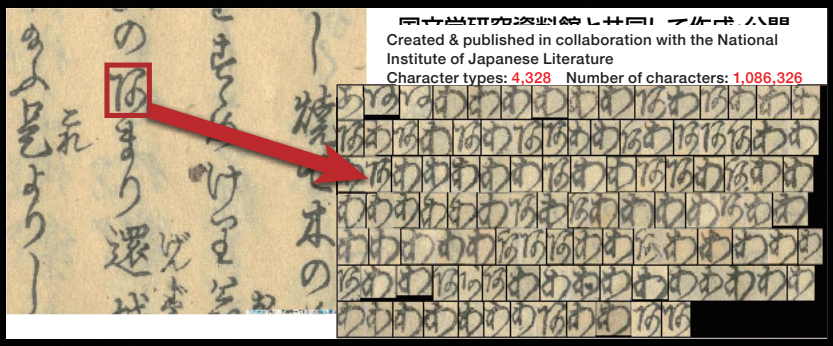
—Tell us about the Kuzushiji Dataset and *kuzushiji* recognition service.

There are said to be hundreds of millions of pre-modern texts and ancient documents preserved in Japan, but only a few thousand people—just 0.01% of the total population—can read *kuzushiji*, or Japanese cursive script from early-modern times. The National Institute of Japanese Literature (NIJL) and the Center for Open Data in the Humanities (CODH), of which I am Director, worked together to produce the *kuzushiji* Dataset, which has been available since 2016. We have collected over 4,000 character types and over 1 million *kuzushiji* character shapes, which are provided as a dataset. The AI *kuzushiji* recognition service uses AI trained on this dataset and is available free of charge. This service recognizes characters by applying object detection, the same technology used in face recognition and autonomous driving. When you input an image from a pre-modern text, it converts *kuzushiji* into modern characters at a rate of about one page per second, achieving over 95% accuracy under the right conditions.

—I believe you have also developed a smartphone app.

iOS and Android versions of our AI *kuzushiji* recognition app Miwo were released, free of charge, in August 2021. The name Miwo comes from the word "*miwotsukushi*" (waterway guideposts) which is the title of the 14th chapter of *The Tale of Genji*. We named the app Miwo in the hope that it will act as a guidepost for people wanting to read *kuzushiji*. The app has been downloaded over 150,000 times and *kuzushiji* recognition has been performed on over 2 million images.

When we first created the AI *kuzushiji* recognition service, we had not thought as far ahead as a smartphone app, but many people said they wanted to use the service on the spot when actually looking at ancient doc-



Kuzushiji Dataset: Images of characters are extracted from old documents and information is added. (This figure shows the modern hiragana あ .) The same character can have various different shapes in *hentaigana* (variant forms) which are collected together in the dataset. The AI *kuzushiji* recognition service uses AI trained on this dataset to estimate what characters are written in cursive script and convert them into modern characters.


Kuzushiji recognition display


Recognition result correction function


Resulting text output

Operation screens of Miwo, available as an Android and iOS app. Take a picture of a document using your smartphone camera and simply tap on the recognition button to convert *kuzushiji* (Japanese cursive script) into modern characters. The app is free to use.

uments, so we decided to develop it. Users have expanded to include students and people at used bookstores, not just researchers. It is now in use constantly, about 2,000 to 4,000 times a day.

The biggest benefit of Miwo is that it lets anyone easily read *kuzushiji*, which breaks down the distance between users and pre-modern texts.

—You also provide a service to convert modern Japanese into *kuzushiji*, is that right?

Yes. This service is called Soan and was released in August 2023. The idea has been around for a long time. In fact, NIJL started a service called "kuzushiji Iro-Iro" that is still available today. It pieces together images of general *kuzushiji* characters as a collage, so the issue was that the characters were not all the same size. But we realized that it was possible to make the size of the characters uniform by using images of printed text from movable type (*kokatsuji-ban*) which I am involved in analyzing. The Soan service was developed using movable type from the Sagabon, considered to be among the most beautiful books in the history of publishing in Japan.

—What is the benefit of converting modern Japanese into *kuzushiji*?

I think to an extent, you learn characters by using them yourself. But if we wanted to use *kuzushiji* today, it would be difficult to memorize the characters without using a brush to write them one by one. However, with this service, anyone can easily write sentences in *kuzushiji*. One reason it has always been considered difficult to learn *kuzushiji* is that to people today, it was a string of characters whose content and cultural background they did not understand. But Soan lets people create *kuzushiji* text for sentences that they understand the content and background of.

There is also talk of making Soan available in the popular social media app LINE. By helping people to communicate using *kuzushiji*, this might make the humanities more familiar.

—What are the future challenges for *kuzushiji* recognition?

The next challenge is to go beyond converting *kuzushiji* to modern characters and automatically translate it into modern Japanese. I have been trying out inputting ancient text into ChatGPT and so on, to see whether it will turn it into modern text. Sometimes it works, and sometimes it doesn't.

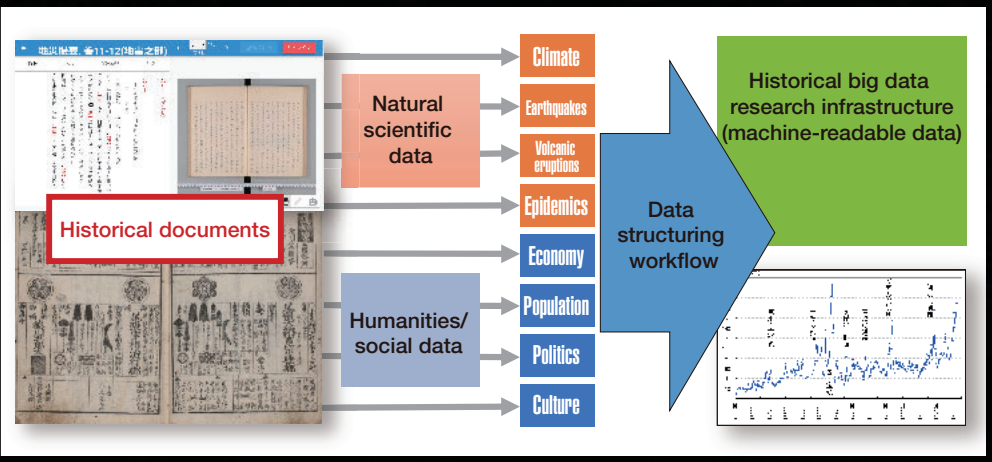
It seems that it is harder for ChatGPT to translate sentences mostly written in hiragana than sentences mostly written in kanji. It is very different from modern text, with no punctuation, so ChatGPT cannot infer the flow of the text. If you rewrite the text to include kanji and input it again, the results become more readable, but we don't currently have the resources to do this.

Unearthing hidden historical facts with historical big data

—What is the historical big data project that you are currently working on?

This is a project funded by the Ministry of Education, Culture, Sports, Science and Technology (MEXT), focusing on records related to early modern historical earthquakes and *bukan* (blue books from the Edo period). Specifically, we are looking at diaries, tile block print newspapers, and books written about major earthquakes, deciphering and inputting the contents. There are quite a lot of surviving records relating to the Ansei Great Earthquakes in the late Edo period (1850s). By comparing the written records with old maps of Edo and the like, we can find out where fires started after the earthquakes and how people escaped.

We are also looking at *bukan*, yearbooks that recorded the



Integrated analysis of historical big data: A project is underway to build a historical big data research infrastructure by structuring natural scientific data and humanities/social data in historical documents.
http://codh.rois.ac.jp/historical-big-data/

names, *kokudaka* (land values) and other details of daimyos and shogunate officials during the Edo period. NIJL has 380 *bukan* that have been completely digitized, but many of them do not include the year of publication, so the date is unknown. We are working on estimating the dates in chronological order by comparing the contents and revisions.

By putting together the changes in the details recorded in the *bukan* for each individual name, it is possible to trace when a person rose through the ranks and what positions they held.

—What is the aim of digital transformation of the humanities?

The aim is to reveal new historical facts that we would not have known without using digital technology. We are currently at the stage of constructing the basic data, but as the total amount of resources reaches a larger scale, I think new discoveries will emerge.

Big data requires the 4 V's: Volume, Velocity, Variety and Veracity. I believe that Variety is the most important of these when it comes to historical big data.

Social phenomena are connected in various ways. For example, cold summers are said to have poor rice harvests, causing the price of rice to increase, which results in famine or riots, leading to political instability. But we do not actually know if these events really happened in this order. I believe that constructing big data, accumulating resources one by one, and comparing them against each other will give us a detailed and accurate view of the situation.

The theoretical framework of science is said to have changed from experimental science to theoretical science to computational science, known as the first, second, and third paradigms. Following on from these, science using machine learning to leverage huge amounts of data is the fourth paradigm.

The pre-modern texts and historical documents that our ancestors left behind were originally created for humans to read; but in future, there will come a time when computers will read them too. Machines will provide support for the aspects that humans find difficult, so machines and humans will help each other.

Japan is rare in having hundreds of millions of surviving pre-modern texts and historical documents. I believe that the construction and analysis of historical big data is necessary to make full use of these precious assets that our ancestors have left to us, rather than leaving them buried.

A Word from the Interviewer

Seven years ago, I wrote an article about a department store in Tokyo selling egg and tofu dishes based on recipes from an Edo-era cookbook deciphered by researchers at NIJL. I was amazed to find out that the recipes used were from the Dataset of Edo Cooking Recipes, which Dr. KITAMOTO was involved in launching, in order to bring Edo culinary culture to modern cooks. If the full-scale digital transformation of historical studies progresses, it could completely change our view of every period of history, not just early modern times. I hope historical researchers will make full use of this.

MIYASHIRO, Eiichi
Asahi Shimbun Senior Staff Writer

PhD in History from Meiji University Graduate School. Joined Asahi Shimbun in 1989. Specialist reporter on history, archaeology, antique art, the collection/utilization of cultural properties, etc. Co-author of "Kuhaku no Nihon Kodai-shi (Takarajimasha, Inc.)" and other books.

Photo by SUGISAKI, Kyoichi

Data Reveals the Beauty in Artworks

Léonard Tsuguharu Foujita used a unique technique to paint highly acclaimed opalescent skin tones. Numerous researchers have studied his painting materials, but because many of his works were restored or coated with protective varnish, it is often impossible to tell what kind of skin texture Foujita really intended. In a new project, a research team used fluorescence spectroscopy to analyze an untouched work, "Nude on a Bed with a Dog," to explore the artist's creative intention from within the painting. Professor SATO, Imari and Project Researcher ISHIHARA, Shin talk about this research, which marks a new approach to works of art.

Project members: UCHIRO, Hiroyuki (Pola Museum of Art); MIKI, Manabu (Visionarist Co., Ltd.); NAKAMOTO, Shota (University of Tokyo); ASANO, Yuta (National Institute of Informatics); TAIRA, Yuichiro (Tokyo University of the Arts); NISHIDA, Shinya (Kyoto University)

SATOH, Imari
Professor/Director,
Digital Content and Media Sciences Research Division, NII

ISHIHARA, Shin
Project Researcher,
Digital Content and Media Sciences Research Division, NII

The significance of seeing the beauty in a work of art from data

— Could you first explain the background and how this research came about?

SATOH: We had an enquiry from the Pola Museum of Art, which houses a large collection of Foujita's works, and started looking at Foujita's techniques for expressing skin texture. Previous research did not go as far as examining spatial distribution such as detailed placement and combinations of pigments.

I have always loved arts and crafts, being attracted to the colors and texture of lacquer and the like. Since my time at graduate school (Graduate School of Interdisciplinary Information Studies, the University of Tokyo), I have been interested in analyzing "What is beauty in a work of art?" – a question which blends science and art. So I felt it was very significant to scientifically analyze the texture of artworks through this research.

ISHIHARA: Since I was a gradu-

ate student at Tokyo Institute of Technology, I have been researching how to explain light phenomena as information. By combining image analysis technology in the field of computer vision with specialist expertise in optics, I performed calculations based on, for example, wavelength analysis of light underwater. The Foujita project is rather different from what I have done before, but Professor Satoh invited me to take part and I accepted, as I thought it would be interesting to study light phenomena created by an artist as a work of art.

SATOH: Because Ishihara's postgraduate research involved analyzing wavelengths of light such as ultraviolet, visible light, and near-infrared light, I thought he would be a perfect fit for this research focusing on the wavelength of light, and that's how it began.

Capturing textures invisible to the naked eye

—— Tell us about the research results into techniques to express skin texture in Foujita's famous opalescent skin.

SATOH: In this research project, we focused particularly on Foujita's "Nude on a Bed with a Dog" (1921, Pola Museum of Art). This painting was selected for analysis for two reasons: firstly, of all Foujita's works, the white of the skin and sheets is considered particularly beautiful; and secondly, this painting has not been restored or varnished, so its original condition has been preserved. When we exposed this work to ultraviolet light, we found that multiple pigments were used in different places. (Figure 1)

ISHIHARA: Previous research had already shown that several types of white were used in works from this period. But however hard I looked at the actual painting, I could not tell the difference with the naked eye. I can still remember how stunned I was when I saw the actual painting for the first time. Whatever angle I looked at it from, it was just white, and I could hardly tell any difference.

—— Is that how you arrived at the possibility that Foujita intentionally used pigments that show different florescence under ultraviolet light?

SATOH: Yes. There is actually a lot of fluorescence in our daily lives, but it is difficult to see fluorescent colors with the naked eye, except for objects that mainly consist of fluorescent components. It is known that there are pigments that emit fluorescence, but I believe this research is the first attempt to develop information processing technology based on fluorescence and analyze a work of art by applying the technique of separating the fluorescent colors observed when it is exposed to ultraviolet light. Having said that, we did not originally intend to go this far with the analysis of Foujita's painting, but Ishihara suggested, with something in his mind, "Let's just try applying ultraviolet light…"

"Nude on a Bed with a Dog" by Léonard Tsuguharu Foujita (1921)

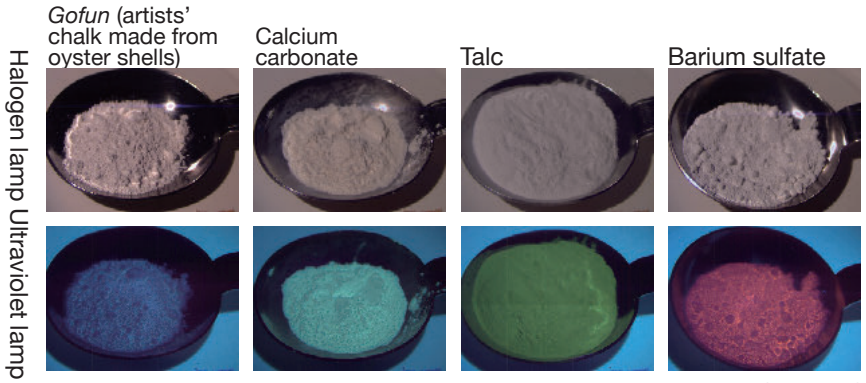
Normal appearance
(with a white light source)

When lit with an ultraviolet light source (Figure 1)

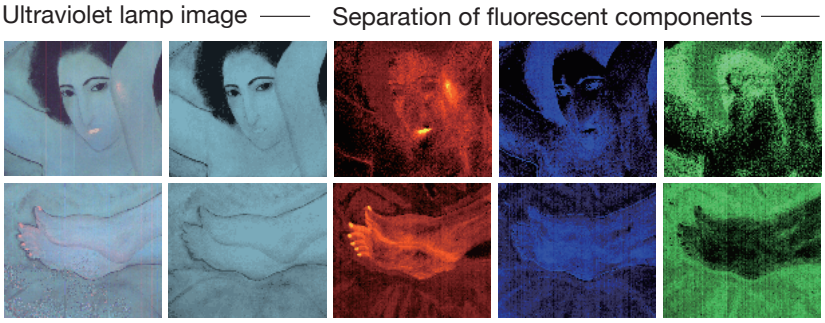
ISHIHARA: Because the skin is described as "opalescent white," at first I thought perhaps we could use a technique to separate scattered light from the skin. Sources have suggested that Foujita used baby powder as an art material, so at first I wondered whether he had used powder to produce scattering of light similar to real human skin. But in reality, the layer of paint is very thin and does not scatter light in the same way as human skin. That's when we tried fluorescence analysis using ultraviolet light, and found that the four white pigments shone completely differently. I realized that this might be related to the skin texture in Foujita's paintings.

—What types of white pigments were used in this research, and how did the artist use each of them differently?

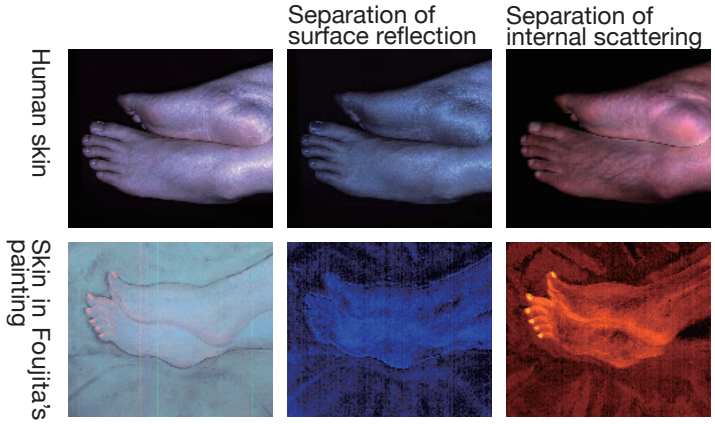
SATOH: From past investigation and literature, we assumed that the white pigments in Foujita's paintings used calcium carbonate, talc, and barium sulfate. If you compare these under a halogen lamp, the wavelengths that they emit all overlap in an almost horizontal straight line. The light from a halogen lamp has almost the same wavelength as the light visible to humans, so when viewed with the naked eye, they all appear as pure white with almost no difference



(Figure 2)



(Figure 3)



(Figure 4)

in color. However, when we shone an ultraviolet lamp on them, the calcium carbonate emitted blue-green fluorescence, the talc emitted green fluorescence, and the barium sulfate emitted red fluorescence. *Gofun* (artist's chalk made from oyster shells), whose main component is calcium carbonate, emitted blue fluorescence. (Figure 2)

Multiple pigments are used in different parts of "Nude on a Bed with a Dog": blue fluorescence mainly on the abdomen, red fluorescence on prominent parts like the nipples, toenails, and dog's paws, and green fluorescence on the sheets. The resulting image looks much more sensuous and seductive than when seen under normal light. This was a surprise. (Figure 3) A curator at the Pola Museum of Art said they were amazed to see the clear difference in fluorescent color between the background and skin. To separate out the fluorescent components used as pigments, NAKAMOTO, Shota, who was enrolled in the Department of Computer Science at the University of Tokyo's Graduate School of Information Science and Technology at the time, worked on developing a robust separation technique that would not be affected by noise.

ISHIHARA: Our hypothesis was that Foujita might have used fluorescence to reproduce the optical phenomenon of human skin, so we tried out a technique to observe the surface reflection and internal scattering components of human skin. We found that it was similar to the parts where red colors were used in Foujita's painting. This suggests that Foujita was aware of the internal scattering of light of real human skin and was optically reproducing this effect in his paintings. (Figure 4)

We tried analyzing works by other artists of the same era, but we did not find any other paintings that showed beautiful fluorescent colors like Foujita's works. Normally, the fluorescence in the base layer is lost as two or three coats of paint are applied. For example, when we looked in the same way at paintings by other artists like Renoir and KURODA, Seiki, who taught Foujita, we could see highlights of fluorescent components in small areas, but we did not find any evidence of intentional use. Strangely, in the works of Raphaël Collin, who KURODA studied under, red fluorescent components seemed to be used intentionally, although Collin only used one color. In Foujita's works, he clearly distinguishes between multiple fluorescent components, so I think we can say that this style is truly unique to Foujita.

We do not actually know whether Foujita was fully aware of fluorescence. But unlike artists like KURODA or Renoir, Foujita did not repaint in multiple layers. I think we have been able to observe this because of his method of deciding on the placement of colors in advance, similar to a Japanese-style painting.

A new approach to connect precious works of art to the

future

— Looking back on this research project, what did you find hard and what made you happy?

SATOH: The fact that previous research had already clarified what materials Foujita used as white pigments was a major factor. I don't think our results would have been possible without that. But it was also thanks to Ishihara's persistence in going back to the materials and confirming their characteristics that enabled us to clarify the differences.

One difficulty was that paintings cannot be exposed to strong ultraviolet light, as it causes deterioration, so it was a challenge to work out how to isolate weak fluorescence and remove noise.

What made me happy was that

in the course of this project, many people in the art world were very positive towards optical analysis and cooperated with our research.

— In terms of future outlook, how would you like to utilize this research?

SATOH: In art education, I hope that finding out that such scientific analysis exists will lead to the creation of new works and research.

An attempt is already underway to create a replica of the work based on this analysis, reproducing the composition of the pigments, the areas where they are applied, the thickness, and so on.

We cannot look at a painting in a gallery in the original condition the same as when Foujita painted it. To prevent deterioration, paintings need to be protected from ultraviolet light and not exposed to strong light. But the real painting might have given a different impression depending on whether it was viewed in the morning, afternoon, or evening. By creating a replica incorporating the new analysis results, perhaps we can verify the work that Foujita really saw or painted. This is the next step in our research. Of course we do not know how intentionally Foujita himself distinguished between these pigments, but at the very least, I think knowing about these differences is meaningful to people who study art.

ISHIHARA: I believe it is also important to digitally record data in more detail, based on the latest analysis such as this research. For old works of art, past measurements and analysis are sometimes insufficient as data, plus original data are gradually lost due to repeated restoration and similar causes. I think we must preserve all kinds of information in order to pass precious works of art on to future generations. Based on the results of this research, perhaps there is an increasing need to consider the materials that the artist used, as well as placement of colors in the painting, more carefully.

— Are there any other research projects that you are currently working on?

SATOH: When performing analysis, it has always involved considerable setup, such as bringing in large measuring instruments or cutting off part of a work for analysis. This has been a major burden in many ways, and has limited the conditions for performing analysis on site. With research funding from the JST Mirai Program, we are currently working with Professor KAWANO, Yukio of Chuo University to develop a camera that can easily perform optical analysis, even for 3D objects, without moving or damaging the artworks.

The optical analysis camera that we are developing is sheet-shaped, lightweight, portable, flexible, bendable, and stretchable, so it can be wrapped around the object of analysis.

When analyzing works of art, there will always be blind spots when looking at 3D objects, unlike paintings, but by using this flexible optical analysis camera, it will be possible to perform material analysis to find out what a 3D object is made of, as well as measuring its internal structure. One day, we might be able to analyze works of art that cannot be moved, like large murals. Once it is completed, it will be possible to analyze various works of art "anytime, anywhere" so I am looking forward to that.

This research was supported by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) Grant-in-Aid for Transformative Research Areas (A) "Analysis and synthesis of deep SHITSUKAN information in the real world" (20H05950) and the Japan Science and Technology Agency (JST) Mirai Program "Establishment of customizable optical sensing and creation of advanced use of optical information that brings new value to society and daily life" (JPMJMI23G1).

Interview/Written by KAWABATA, Hideki Photo by HASHIMOTO, Mika

Informatics and Video Technology to Make Theatre Pillars Transparent

Now that live streaming is commonplace, the feeling of being at a live theatre performance is a special shared experience of time and space between performers and audience. However, one problem remains: in a theatre, depending on your seat, your view can be blocked by pillars or equipment. Associate Professor KODAMA, Kazuya is researching how to make these obstacles "transparent." We asked him what this means, and about other ways this technology could contribute to society.

KODAMA, Kazuya

Associate Professor, Digital Content and Media Sciences Research Division, NII

If we could make pillars transparent, every viewer would enjoy immersive experience like on the best seat in the house

—What is the aim of your current research in video technology and informatics?

I am researching ways of using multiple cameras or special cameras to capture a variety of information about light fields and use the information for observing a scene from a free perspective and focus,different from the shooting conditions. Even if your view is physically blocked by a wall, pillar or other obstacle, this technology will allow you to see the scene behind the obstacle as if it had become transparent.

—Specifically, what will become possible as a result of this research?

In old theatres, concert halls and live music venues, for example, there are often pillars in the seating area to reinforce the structure of the building, which can restrict the view from certain seats. If all seats are priced the same, people who are assigned to these seats and have to see the stage with a restricted view would probably feel it is unfair.

In some theatres, displays are installed on the pillars and images of the whole stage are shown by the displays, but this still means people who have made the effort to go and see the live performance lose out on the sense of being there. Being able to see the scene on the other side of the pillar as 3D images in real time would give everyone the same immersive experience.

In my research, I am combining multi-view/multi-focus imaging with display technology to make it possible to virtually see through pillars.

Incidentally, some commercially available portable game con-

soles show 3D images, but you can only see in 3D from two fixed viewpoints: the left and right eyes. However, with the technology I am researching, the aim is to allow about around a hundred audience members to view the stage in 3D from any direction, both vertically and horizontally, while freely moving around.

—Has such technology never existed before?

There is one technique called a camera array, but there are several problems in putting it into practice. With a camera array, multiple video cameras, arranged in a grid pattern, simultaneously capture information of a scene from different angles (viewpoints) to obtain multiple parallax images and the images are sent to a computer to be analyzed. This technique makes it possible to see sides of the object that cannot be captured from the front alone, the object's placement in 3D space, and so on. But the first issue is the amount of data for information processing. Even images from a single camera consume several hundred megabytes per second, which means that images from hundreds of cameras would equate to tens of gigabytes. It is extremely difficult to transmit or put together this much information on a computer. Plus, to process this information in real time and create 3D images in various directions, using current high-performance GPUs, would involve parallel processing on several or even dozens of units.

Camera arrays are also very expensive, costing tens of millions of yen, if we include the peripheral equipment. As the array is made up of several cameras, there is a risk of frequent camera failures, making the 3D images unstable. Having to repair cameras every time they break makes this solution even more expensive. Instead of spending so much money on technology to make the pillars transparent, it would be better to simply renovate the building.

There is another technique that involves each viewer wearing goggles displaying superimposed images of the space behind the pillar, but this physically restricts viewers around the stage and distracts them from the performance.

A 3D display that doesn't require viewers to wear special glasses would be preferable. Of course, to show 3D images when the content is changing by a viewpoint vertically as well as horizontally is difficult in terms of processing. If one person wants to see images from a certain viewpoint, it is not too difficult to process the data to show a specific view for that person; but when several viewers want to see images from several different viewpoints, doing this just by extending the conventional technology would require the equipment to be made a lot bigger.

—It does not sound as if it would be very realistic to use either of these techniques in a cultural arts venue.

That's right. I once went to a live music event where there was a big pillar blocking the view of the stage, making it hard for both the performers and the audience. That's what originally gave me the idea of researching technology to make obstacles "transparent." I wondered if it would be possible to combine existing technology with my research to create the technology that users really need.

3D imaging technology designed to add 3D effects to visual media, like 3D TV, has already been developed, but it has not really caught on. I think this is because in the situations where this technology has been used, there was not really much point in making the images 3D.

But I personally feel that making pillars "transparent" is a technology that addresses a real need. That's why in my research, I aim to keep the solution as inexpensive as possible, as well as non-restrictive to the audience, so that it can actually be put to use. I hope it will be used in venues that support promising new artists in the in-

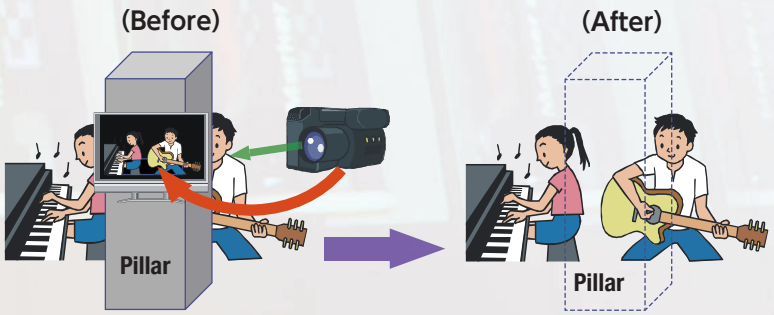


Illustration of making a theatre pillar "transparent":
(Before) Some viewers in some seats cannot see the performers due to obstacles such as pillars, so video images of the performers are displayed on monitors installed on the pillars.
(After) Multi-view imaging system combining a mirror array with a glassless 3D display will make pillars "transparent," resulting in an immersive experience of every viewer.

die scene, both in music and the theatre, so I am working on an architecture that will be available for a few hundred thousand yen or less.

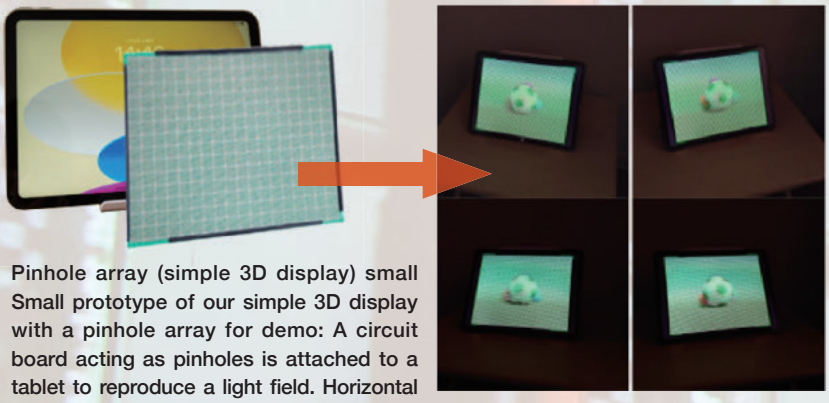
Mirror arrays make existing multi-view imaging more compact

—What kind of technology are you using to overcome these challenges and make obstacles "transparent"?

Since my university days, I have been researching light field image processing and how to create an all-in-focus image from two differently focused images. From this research, we have found that multi-view and multi-focus can be converted into each other. We have developed essential technique in signal processing to make this more efficient, so we are working on interpolation and compression of 3D images, applying this technique.

We are trying to make pillars "transparent" by combining this research with the camera array technology that I already mentioned.

First of all, there is a method of using a lens array to capture images from multiple viewpoints at once without using an expensive, large-scale camera array. This method uses a single camera and an array of lenses arranged in a grid pattern. The captured data can be easily imported to a computer, which makes processing easier. One example of a lens array is a system called a light field camera. In this system, the individual lenses have small apertures, so they can only take in a small amount of light. This means it is possible to capture a still image and view it later in 3D, but the image will essentially be dark. If we were to create a video made up of frames only taking in a small amount of light, there would be too much noise to use it as a 3D image in real time.



Pinhole array (simple 3D display) small Small prototype of our simple 3D display with a pinhole array for demo: A circuit board acting as pinholes is attached to a tablet to reproduce a light field. Horizontal and vertical parallax is supported. The light field image passes through the pinholes

The system that I have designed and developed to overcome this issue is a mirror array, consisting of mirrors arranged in a grid pattern along a parabolic surface, like a parabolic antenna. A mirror array can keep costs down, and images can be taken from multiple viewpoints with sufficient light. It only uses a single camera so there is no overhead in data transmission, and image processing can be done on a gaming computer with a simple GPU. At the development stage, we do not require a high-performance display or large-scale equipment to display the 3D images, either. By simply covering the surface of a high-brightness tablet PC with a board of pinholes, it ispossible to display 3D images viewed from different directions. As device technology develops and costs fall, the quality will improve, so we are currently focusing on real-time processing to make objects transparent.

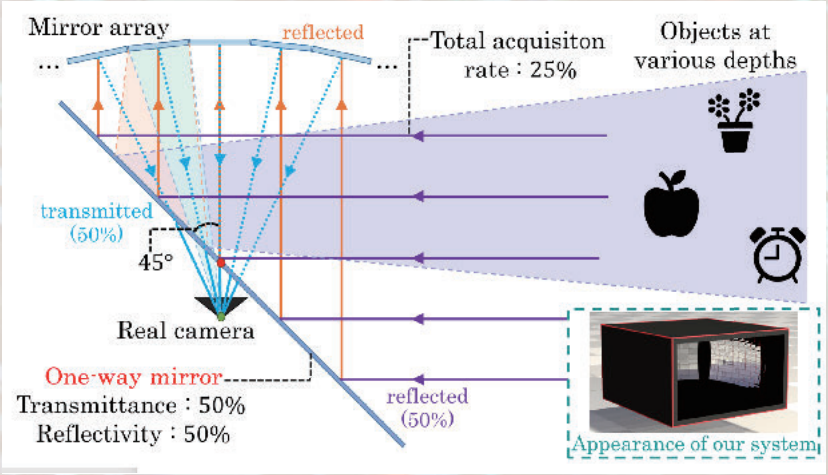
—How is this different from conventional technology to produce 3D images?

In the past, efforts have focused on creating 3D images that jump out at the viewer, as an attraction. But as I mentioned just now, such images have limited uses. What I am researching is 3D imaging technology that creates a sense of depth, blending in with the space you are actually looking at.

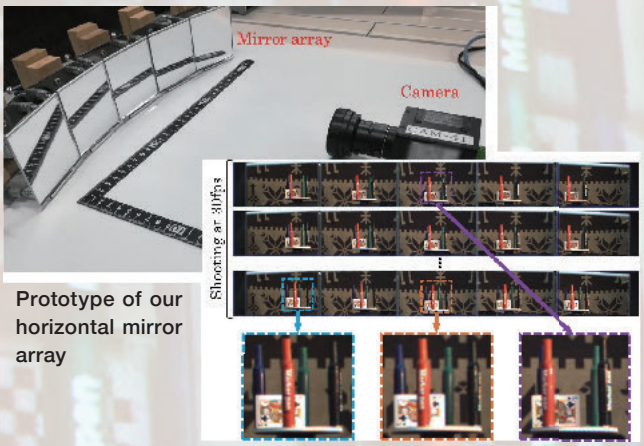
Potential use in museums and tours of cultural heritage sites

—There must be other possible uses for such technology, besides making obstacles transparent to stop them from blocking an audience's view.

More performances have recently started to use projection mapping to display backdrops, but the projected image looks flat when viewed from the side and is blocked when people walk across it, which limits movement on stage. Our technology could be used to create stage backdrops with a sense of depth to further improve the flexibility of expression. It would also be possible to take images of one artist in Tokyo with another in Osaka and combine them together at a concert venue, allowing audiences to enjoy



Overview of a simple imaging system made up of a mirror array and a monocular camera. Objects reflected in the half mirror (magic mirror) are further reflected by each mirror in the mirror array (flat mirrors with different angles). The images are acquired by on a monocular camera and output as a 3D image.



Prototype of our horizontal mirror array

immersive experience of collaborations.

At museums and art galleries, it could allow viewers to see exhibits from any perspective, including from behind walls or pillars. It might be possible to put on virtual exhibitions of valuable works of art in rural areas. By virtually placing pottery vases and other objects inside transparent pillars at the venue, they could be viewed from any direction.

—It might be possible to see inside cultural heritage sites that tourists cannot normally enter.

Yes. It would be great to be able to take a peek inside a building from any angle through a display in front of the building. There are already some facilities where a video is captured inside the building and then played as a display, but the advantage of making the walls transparent is that tthere is no need to create such videos. It could be achieved just by installing a special camera inside the building, without capturing in advance.

This technique could also help create a safer society

—Could this technology be put to use in fields besides the cultural arts?

I am looking at safety, particularly the field of vehicle safety, which I think will become increasingly important. Various parts of cars are electronic these days, and there is even a challenge to replace rearview mirrors with electronic mirrors displaying camera images. But one problem with electronic mirrors is that long-sighted people have trouble with focus. A real rearview mirror reflects light, so if another car is twenty meters behind your car, when you look at it in the mirror, the focal point is still twenty meters away. But with an electronic mirror, you have to refocus your eyes on a display that is closer to you, so it is very dangerous for long-sighted people who have difficulty focusing at close range.

—That's where 3D images could be used, right?

Rather than an image, an entire field of light can be reconstructed and transmitted at ultra-high speed, which would solve the focus issue. In terms of contributing to a safer society, as well as vehicles, this technology could be used to make corners of buildings "transparent" to help drivers and pedestrians see through them, which could reduce traffic accidents.

—The images to be used in such situations would not need to be very detailed, would they?

That's right. This is an area where this technology would be meaningful even with lower image quality. At first, I think the level of image quality of an old-fashioned electronic sign would be good enough. Even at low resolution, it would allow people to virtually see things they could not see directly; so as long as it is consistent with real space, it will be fine.

There are still lots of problems to solve before this technology can be put into actual use, but I am determined to continue my research to make it a reality.

Interview/Written by MOTODA Koichi Photo by SUGISAKI Kyoichi

Dr. IKEHATA specializes in 3D sensing technology—an innovative technology using 3D sensors and cameras to accurately measure the depth and shape of objects and environments around us. This technology plays vital roles in many aspects of our daily lives: systems for self-driving cars to recognize roads and obstacles, acting as eyes for industrial robots to perform precision tasks, facial recognition systems for smartphones, gesture recognition in gaming, and so on. In medicine, it even allows the inside of a patient's body to be visualized in 3D, contributing to more accurate diagnosis and planning of treatment. However, the applications of 3D sensing technology are not limited to these practical applications; it also plays an important role in the digital archiving of cultural and artistic works. In this article, Dr. IKEHATA explains in detail how 3D sensing technology contributes to digital archiving of our cultural and artistic heritage.

3D Sensing Technology and Digital Archiving

IKEHATA, Satoshi
Associate Professor,
Digital Content and Media Sciences Research Division, NII

Digital archiving and 3D sensing

3D sensing technology has played an important role in preserving historical, cultural, and artistic objects and creating digital archives to allow public access to this heritage. It has become widely accepted as a tool for monitoring archaeological structures and conditions, archiving detailed records of changes to buildings and works of art, creating 3D models and animations for presentations at visitor centers and museums, and making replicas from digital geometric models of objects.

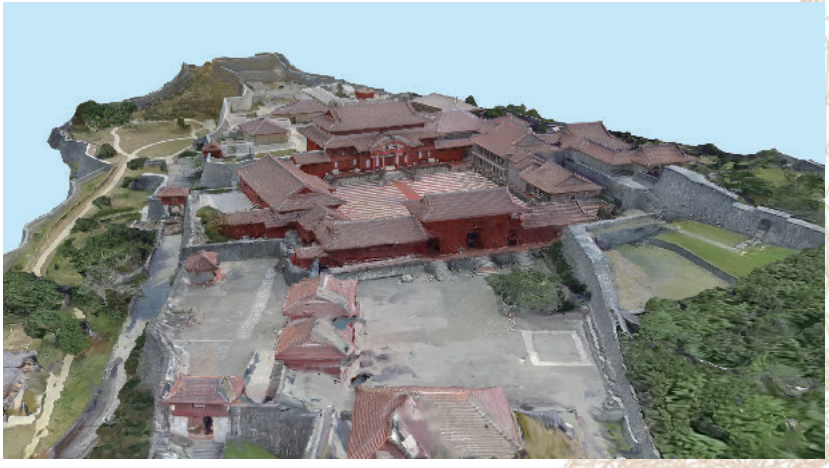
3D sensing technology has a long-established connection with digital archiving. In the early days it required expensive and complex equipment, particularly to digitize large-scale cultural and artistic heritage sites. Over time, information technologies such as computer vision and computational photography, as well as aerial photography technology like drones, have made 3D sensing easier and cheaper, enabling it to be applied to small-scale cultural and artistic heritage sites and inaccessible ruins.

Digital archives also provide an important record of cultural heritage in places that have been lost over time, or destroyed by natural disasters or human actions. One recent project that is fresh in my mind is the "OUR Shurijo" project (Figure 1a) which is using photos submitted by the public to create a CG reconstruction of Shuri castle after it was destroyed by fire. As well as measurement, digital archiving is linked with visualization technology. An example is the "Virtual Asukakyo" project (Figure 1b) at the University of Tokyo. In combination with virtual reality (VR) and augmented reality (AR) technology, it provides a new experience for education and public engagement, becoming a way to bring cultural heritage to a wider audience. Overall, 3D sensing technology has played a key role in digital archiving, fundamentally changing how our cultural heritage is preserved, studied, and presented.

Typical 3D sensing techniques used in digital archiving

Various 3D sensing techniques are used in digital archiving of cultural and artistic heritage, including laser scanning, photogrammetry, and structured-light scanning. Laser scanning is an active sensing method based on electromagnetic radiation before an earthquake. It is used to digitize the precise dimensions and shape of cultural and artistic heritage sites, helping to monitor damage and deterioration and formulate restoration plans. Photogrammetry is a passive sensing method using a digital camera and an ambient light source, suitable as an easy way to make detailed records of colors and details (Figure 2a). Structured-light scanning is a method of projecting a specific pattern of light onto an object and analyzing its reflection to obtain 3D data. This technique is used to measure smaller of cultural and artistic heritage. These technologies are vital in creating digital archives of cultural and artistic heritage, providing valuable resources for researchers and conservation experts.

While laser scanning and photogrammetry are ideal for measuring the shape of large-scale cultural and artistic heritage sites, these techniques are not necessarily suitable for recording and reproducing the beautiful glossy surface of some cultural and artistic objects or the fine texture of an oil painting. One method used to preserve these details is Reflectance Transformation Imaging, a technique developed by HP Labs in 2001. By taking multiple photos with the subject and the camera in fixed positions, changing the



(Figure 1a) An example of digital archiving using 3D sensing technology.
In the "OUR Shurijo" project (https://www.our-shurijo.org/) a team led by KAWAKAMI, Rei of Tokyo Institute of Technology are using photos submitted by the public to reconstruct Shuri Castle, which was destroyed by fire on October 31, 2019, as a 3D model.

(Figure 1b) An example of digital archiving using 3D sensing technology.
In AsukaLab's "Virtual Asukakyo" project (https://www.asukalab.co.jp/projects/virtual-asukakyo/) a team led by the Ikeuchi-Oishi Laboratory at the University of Tokyo has created a tourist guide system using a virtual reconstruction of ancient Asukakyo and mixed reality technology.

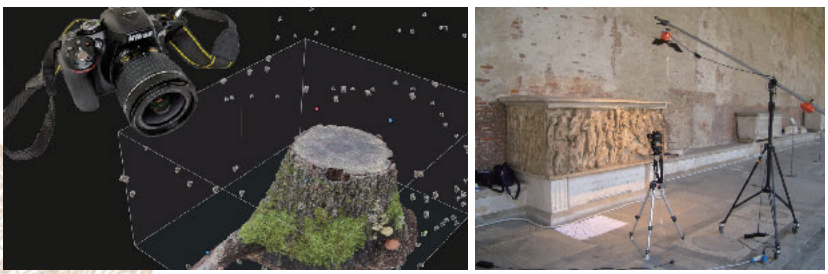
position of the light source, it can record surface reflections and changes in shape when lit from different angles (Figure 2b). The images are processed into a single file such that the subject can be viewed under different lighting conditions by controlling the direction of the light with a pointing device like a mouse. With its ability to capture the interaction between objects and light, reflection transformation imaging has been used as a key perceptual and cognitive cue in the analysis and research of reflective behavior and the characteristics of cultural and artistic objects including fossils, ancient stone tools, oil paintings, cuneiform tablets, coin collections, and the Antikythera Mechanism. The interaction between light and an object can often capture more interesting aspects than its shape.

In computer vision, there is a technique called photometric stereo that is closely related to reflection transformation imaging, and the two are often confused. This is a method of reconstructing the shape and material of an object from multiple photos taken under different lighting conditions. Both of these techniques involve taking multiple photos of an object lit from different angles and processing these images. But whereas the main purpose of reflection transformation imaging is to visualize how a cultural or artistic work interacts with light, the purpose of photometric stereo is to restore 3D information such as the shape and material of the object.

Generally, 3D reconstruction in computer vision has been developed with the aim of improving algorithms and increasing performance. Techniques like photogrammetry and Reflectance Transformation Imaging used in digital archiving are closely related to software development, and have been developed as complete packages including output formats and convenience for visualization, not just algorithms. In the context of archiving our cultural and artistic heritage, as well as simply measuring an object, being able to visualize it for human viewing is another extremely important aspect. Of course, in some cases the purpose may be to record the shape itself, but whether using photogrammetry or reflection transformation imaging, it is important to bear in mind that 3D sensing in digital archiving allows humans to appreciate heritage over time.

Digital archiving and Novel-view synthesis technology

A hot topic of research in the field of computer vision is Novel-view synthesis technology, which is expected to play a useful role in digital archiving of cultural and artistic heritage (Figure 3). Novel-view synthesis uses a set of images of an object photographed from different viewpoints to synthesize images from completely different viewpoints. Unlike multi-view 3D shape restoration



Photogrammetry and Reflectance Transformation Imaging
(Left: Figure 2a) Photogrammetry (https://blog.siggraph.org/2021/08/exploring-nature-as-a-resource-in-virtual-reality.html/) is a technology to reconstruct the detailed shape of an object using photos taken from multiple viewpoints with a digital camera. (Right: Figure 2b) Reflection transformation imaging (https://vcg.isti.cnr.it/Publications/2006/DCCS06/) is a technique of recording shadow information when a subject is lit from different angles. The resulting images are used for analysis and visualization.

(Figure 3) An example of digital archiving using Novel-view synthesis technology.
(https://isprs-archives.copernicus.org/articles/XLVIII-M-2-2023/453/2023/)
Novel-view synthesis based on Neural Radiance Fields (NeRF) (bottom) has been found to be particularly effective for complex shapes such as trees, which are challenging for photogrammetry (top).

techniques like the multi-view stereo method mainly used in photogrammetry, the focus is on image quality from arbitrary viewpoints.

Novel-view synthesis itself has been studied for many years in the fields of computer graphics and computer vision, but its applications were limited by high imaging/calculation costs and low quality. But with a new technology called Neural Radiance Fields (NeRF) unveiled by UC Berkeley in 2020, Novel-view synthesis has become a realistic prospect. This technology replaces conventional representations of 3D space, such as point clouds and meshes, with a neural network representing shapes and colors. By learning this network from various viewpoints, it allows the complex geometry of an object to be reproduced, and it also enables highly realistic Novel-view synthesis. Even viewpoint-dependent effects that are difficult with conventional Novel-view synthesis (such as surface reflections due to changes in viewpoint) can be reproduced extremely accurately. In other words, this technology combines the best of photogrammetry and Reflectance Transformation Imaging.

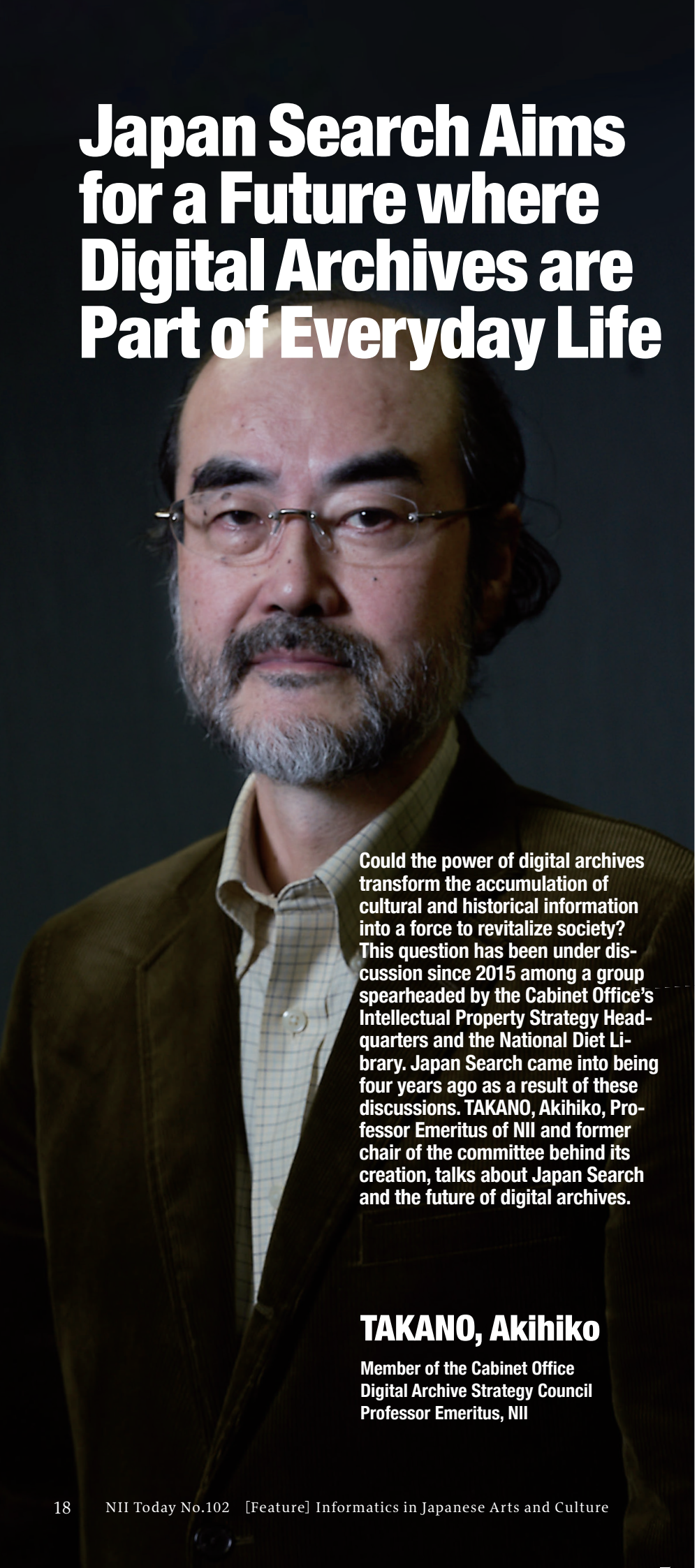
Researchers immediately recognized the potential of this technology, and various follow-up research has been conducted in the fields of computer vision and computer graphics. One limitation of NeRF was that although it offered high quality, the calculation cost was high and viewpoint synthesis could not be performed in real time. This has been significantly improved by a technique called Instant NGP developed by NVIDIA. Most notably, a new technology called Gaussian Splatting uses a superposition of lightweight Gaussian functions for spatial representation without the high computational cost of neural networks, allowing Novel-view synthesis to be processed in real time, even on a smartphone. Services like Luma AI are already making Novel-view synthesis technology available to anyone.

The evolution of Novel-view synthesis technology shows no signs of stopping. Previously, digital archiving was mainly limited to measuring and visualizing static objects and cultural and artistic heritage sites. But with Novel-view synthesis technology, it is becoming possible to record changes over time as well as space. PFN 4D Scan, provided by Preferred Networks, extends the NeRF technology described above to video images, which attracted a lot of attention when they gave a demo of recording and playing back artist performances in extremely high quality.

Conclusion

In this article, I have looked at how 3D sensing technology has been utilized in cultural and artistic heritage. In my specialist area of computer vision, digital archiving is given as an example of a real-world application of our research. In the past, there has been a disconnect between 3D sensing technology for digital archiving, which has been developed as a service for end users, including interfaces and software implementation, and computer vision, which has focused on unique algorithms and restoration performance. But with the development of Neural Radiance Fields (NeRF) and other Novel-view synthesis technologies, the boundaries are disappearing, and I expect to see further development with more mutual interaction between these two fields in future. In the field of computer vision, we are currently exploring the potential of large-scale modeling and generative AI for 3D reconstruction when observations are limited, which is being shown to be effective. Will the same connection be made in digital archiving, or not? I will be keeping a close eye on future developments.

Japan Search Aims for a Future where Digital Archives are Part of Everyday Life



Could the power of digital archives transform the accumulation of cultural and historical information into a force to revitalize society? This question has been under discussion since 2015 among a group spearheaded by the Cabinet Office's Intellectual Property Strategy Headquarters and the National Diet Library. Japan Search came into being four years ago as a result of these discussions. TAKANO, Akihiko, Professor Emeritus of NII and former chair of the committee behind its creation, talks about Japan Search and the future of digital archives.

TAKANO, Akihiko

Member of the Cabinet Office Digital Archive Strategy Council
Professor Emeritus, NII

Japan Search brings together Japan's digital archives

—— What are digital archives?

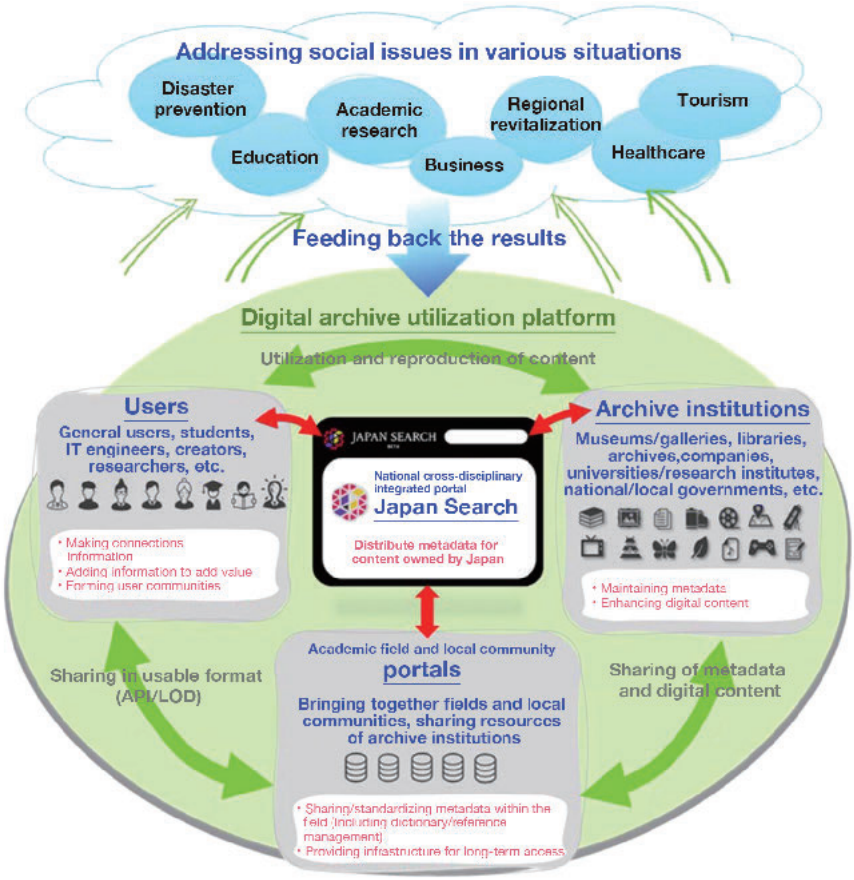
In the past, Japan's cultural and historical records have been preserved and handed down by museums, galleries, libraries, public archives, local governments, temples and shrines, universities, and so on. These institutions have also provided a place for people to use the actual materials. But thanks to advances in digital technology, services are being developed allowing users to remotely access high-definition images and full-text data, providing greater accessibility and convenience. This is not a strict definition, but these are called "digital archives" to distinguish them from conventional databases used to manage collections. It also refers to archiving records that have been passed down in various media since before computers were invented, by converting them to a format that can be handled by modern digital information technology, to store records as digital media.

—— Could you give us an outline of Japan Search?

In discussions between representatives of organizations related to digital archives, initiated by the Cabinet Office, it was agreed that the development and utilization of digital archives could make a significant contribution to revitalizing our society. The government's Intellectual Property Promotion Plan included "creating a digital archive society" as one of its goals. Japan Search is designed to be a cross-disciplinary integrated portal for digital archives maintained and published by various institutions in Japan,

and aims to provide a platform for searching, viewing, and utilizing these archives. Under the operational policy established by the Cabinet Office Committee, the National Diet Library is in charge of system construction and operation. As of the end of February 2024, Japan Search includes 147 organizations, 227 databases, and 29.5 million items of metadata (https://jpsearch.go.jp/stats).

The role of Japan Search is to provide a platform for utilizing digital archives, as an intermediary between archive institutions, portals, and users. Figure 1 shows an overview. In this diagram, "portal" refers to a service that aggregates, standardizes, and organizes metadata in each field, such as the Cultural Heritage Online site operated by the Agency for Cultural Affairs and NII.



(Figure 1) Sharing and utilizing digital archives

—— Is Japan Search a digital archive?

It's a common misunderstanding, but Japan Search itself is not a digital archive. Japan Search brings together and provides information from reliable digital archives in various fields, but it mainly collects metadata, thumbnails, and preview images, rather than content data provided by individual digital archives.

Although it looks like a normal search service, Japan Search's scope is limited to metadata of content provided by linked digital archives, rather than the entire Internet. You can find book images, bibliographic data, thumbnails of works of art, and so on, but to utilize the actual content, you would need to follow the link to the original site.

As a way of promoting content utilization, we recommend that the terms of use and license information be specified along with the metadata for individual contents. This allows users to perform a cross-disciplinary search for content to suit their purpose without having to check individual sites. I hope you will try it out.

Japan Search's strategic policy 2021-2015: "making digital archives part of everyday life"

—— Could you talk about the potential of digital archives to change our society?

I believe that digital archives have the power to significantly change our society by providing three values.

(1) Inheritance and reconstruction of records and memories, (2) Common knowledge base to support communities, and (3) Formation of new social networks.

For item (1), the important point is that copies of records that have been passed down separately are created in the same digital space, which will encourage the discovery of new relationships and the reconstruction of records. Item (2) means that by making more information accessible without time and space limitations, it will be easier to provide the shared knowledge base that we need to learn, think, and discuss. I believe that gathering together seemingly contradictory information is one of the unique values of digital archives. Item (3) means that linking digital archives across fields of expertise and regions will result in new connections between different fields and people.

—— What kind of future society does Japan Search envision?

The digital archive society that we should aim for in Japan is summarized in the Japan Search

(Figure 2) Japan Search Strategy 2021-2025

Strategy 2021-2025 (Figure 2). It lists the three values of digital archives mentioned above, and four actions that should be taken using Japan Search to maximize these values. The mission of Japan Search is defined as follows: "Through new information technology and archival collaboration, we will enhance the discoverability of Japan's cultural and academic contents and provide infrastructure that facilitates their use, thereby realizing a rich and creative society in which digital archives are integrated into everyday life."

—— What is meant by "making digital archives part of everyday life"?

Our Action Plan gives the following examples to illustrate the digital archive society that Japan aims to create (https://jpsearch.go.jp/about/actionplan 2021-2025).

· Digital archives have become an infrastructure for information and communication.

· Various platforms are mutually connected to each other's data and have become social infrastructure.

· Business use of digital archives has spread throughout society and is yielding results.

· Many people use digital archives without being aware of the term "digital archives."

· When people want to know something, they are accustomed to obtaining information from reliable sites/institutions.

· More and more people enjoy "seeing, knowing, and researching" using digital archives, and they are using them in their daily lives and learning.

The value of archives in connecting memories in times of disaster

—— What was the first digital archive you were involved with?

Going back several years, in autumn 2002 we released a service called Webcat Plus allowing users to search 1,000 university library catalogs with associative search technology being developed at my laboratory. Using information from the table of contents, users could search for similar books via free text or from a selected group of books. An official from the Agency for Cultural Affairs, who was interested in flexible search functions, approached NII, saying: "Keyword searches do not work very well for finding information about cultural properties at museums, galleries, temples, and shrines. Could associative search be used?" As we had developed the associative search technology at my laboratory, we took on the job of making a cultural heritage version of Webcat Plus.

The Agency for Cultural Affairs arranged for cultural institutions all over Japan to provide information and images of artworks. We created Cultural Heritage Online as a one-stop search and viewing site for data about designated cultural properties like national treasures and important cultural properties, Buddhist statues, paintings, and craft objects. The pilot version was released in 2004 and the official version in 2008, which was updated in 2022. It has now grown to become a staple site used by six million users annually (https://bunka.nii.ac.jp/). It is also linked with Japan Search as a portal for the field of cultural properties.

At the time, Cultural Heritage Online was a unique service in the world, attracting attention from institutions not only in Japan but also in other countries. Since then, the EU has launched Europeana to compete against Google, and in the US, several large-scale data platforms have been published for culture and the arts. In 2011, I went on a trip to the US, aiming to make Cultural Heritage Online into an international site. Along with MIYAZAKI, Motoko from Nara National Museum and MARUKAWA, Yuzo from the team that launched Cul-

tural Heritage Online, we visited the digital archive departments of the Smithsonian, MET and ARTSTOR to discuss the possibility of linking their data. Then on March 11, 2011, two days before we were due to return to Japan, I was at a hotel in New York City when I saw images of the Tōhoku earthquake and tsunami. I watched, speechless.

—— Did your view of digital archives change after the earthquake?

After returning to Japan, for a while I had no sense of reality. I had previously thought experts were communicating scientific facts, but now I could not trust what they were saying. I observed many contradictions in people's perceptions of basic facts, even between experts. As a result, I lost confidence in my own ability to maintain an unshakable perception of facts, and came to the view that all facts are nothing more than a tentative interpretation. I had been pursuing information technology to enable individual users to independently pick out the truth, so I felt I had lost sight of the purpose of my research. During that time, MIYAZAKI, Motoko from Nara National Museum asked if my laboratory could produce a digital viewer to be used at an exhibition of the entire Genjō Sanzō (Illustrated hand scroll of the Monk Zuanzang, 12 scrolls, total length 190 m), a National Treasure of Japan (https://www.narahaku.go.jp/exhibition/special/201107_tenjiku/). When I first came face to face with these giant scrolls passed down from the Kamakura Period, the whole team became engrossed in creating a system to view the story of Genjō Sanzō on a large screen, which brought back my energy. At around the same time, we were happy to hear reports that the location data of cultural properties we had organized on Cultural Heritage Online had been very helpful to the cultural property rescue team after the disaster. I also noticed that tsunami monuments in various locations were registered on Cultural Heritage Online. I realized that these records that had been passed down without anyone noticing them during normal times had suddenly taken on an important meaning, speaking to people's hearts and minds.

311 Informatics: Digital archives as a medium to tell multiple stories

—— Can digital archives record the truth?

Perhaps because I had worked on Cultural Heritage Online, I was on several committees involved in creating archives related to the disaster, including the National Diet Library Great East Japan Earthquake Archive (HINAGIKU). It was a new challenge to create archives aiming to record ongoing activities from multiple perspectives, not just archiving records from the distant past.

Through this work, I met experts from totally different fields and learned ways to see facts from different angles. The new connections that we made later led to the Japan Society for Digital Archive.

I also co-authored a book entitled "311 Informatics" (published by Iwanami Shoten) in an attempt to put into words how I felt at that time about the limitations of specialized knowledge and experts. My argument is that "Stories told by experts reflect the teller's worldview. Individual stories will always be partial, and it is essentially difficult to grasp a full picture of an event from a single story. Perhaps what AKUTAGAWA Ryūnosuke portrayed in 'In a Grove' was that the real truth can only be told as a collection of mutually contradictory stories."

"We can say that creating an archive to remember the 'truth' means collecting multiple stories that may contain such contradictions, and recording them in relation to each other."

—— Tell us about your dream for the future of digital archives.

What I wrote in the afterword of that book is still my guiding principle today: "Digital archives recording in detail the gradual process of recovery from the damage caused by the earthquake and tsunami will act like a mirror reflecting the current state of Japanese society. Creating a good mirror that lets us see an image of ourselves that is close to the truth from various angles, contributing to making our future society more transparent and beautiful than now, that is the challenge for 311 informatics."

I dream of a future where we can continue to create digital archives, as a place where multiple true stories are recorded and handed down forever.

Reporting and writing by URASHIMA, Moyo Photo by SUGISAKI, Kyoichi

NII NEWS TOPICS

Period : December 1 (Fri.), 2023 → February 29 (Thu), 2024

More details about news items are available online.
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NEWS RELEASE

2024
Feb. 29 Enhanced database of educational materials on quantum technology
Promoting human resource development in quantum technology with Kyushu University, Keio University, Nagoya University, and the University of Tokyo

Jan. 30 Publication of "Future Approaches to Software Development," the latest edition in the NII Series

Jan. 19 Carbon nanotube eye captures silhouettes showing internal composition and structure of objects
Nanoscience meets information engineering, producing a breakthrough in non-destructive testing technology

2023
Dec. 18 Enhanced program of online learning from the Quantum Academy of Science and Technology
Promoting human resource development in quantum technology with Kyushu University, Keio University, Nagoya University, and the University of Tokyo

Dec. 7 Publication of AI to estimate biological sex from fundus images
Expected to be useful in research into diseases showing gender differences

AWARDS

2024
Feb. 22 Prof YOSHIDA, Yuichi (Principles of Informatics Research Division) awarded the Funai Award (Tetsuro Funai Special Award)

Feb. 6 Associate Prof HIRAHARA, Shuichi (Principles of Informatics Research Division) awarded the FY2023 IPSJ Microsoft Faculty Award

Feb. 2 A paper by YOSHIDA, Rino (Kodama Laboratory, Joint Researcher, Tokyo University of Science Graduate School) and KODAMA, Kazuya (Digital Content and Media Sciences Research Division) awarded IWAIT 2024 Best Paper Award

2023
Dec. 7 Prof ISHIKAWA, Yutaka (Information Systems Architecture Science Research Division) awarded IPSJ 2023 Computer Science Achievement Award

FY2023 NII Retirement Commemorative Lecture

Date: March 26, 2024 (Tuesday)
13:30–15:00
Format: Online (Live streamed)
Speaker: Prof SATOH, Ken
* See below for details and how to participate
www.nii.ac.jp/event/2024/0326.html

New Publication Guide

Facing the New Landscape of Software Crafting

(NII Series, No. 25)
By ISHIKAWA, Fuyuki; supervised by NII
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NII-IDR User Forum 2023

The IDR User Forum 2023 took place on Monday December 11, 2023. For the first time in four years, it was held as a face-to-face event at the Hitotsubashi Auditorium. Around 150 people attended in person and 30 people joined online. The event included 26 poster sessions by dataset users and 21 startup sessions. The executive committee selected eight of these research presentations to receive prizes. The event was a great success, with plenty of lively discussion about data utilization.

Around 150 people attended the event at Hitotsubashi Auditorium in Chiyoda-ku, Tokyo, including attendees from universities and companies providing datasets, as well as users giving poster presentations about their research.

The IDR User Forum is an opportunity for discussion between data providers and users through the Informatics Research Data Repository (IDR), a dataset-sharing service operated by NII's Center for Dataset Sharing and Collaborative Research (DSC). The forum is held annually around December with the aim of contributing to the further development of the research community.

A researcher giving a presentation to visitors at the poster session. Forty-seven posters were presented at the venue. Researchers explained their research results using datasets and answered questions in front of their posters.

The Informatics Research Data Repository (IDR) is a service providing researchers with various datasets supplied by private companies and university researchers. Details of the IDR User Forum, a list of the currently available datasets, and information about providing datasets are available on the website below. Please refer to the website if you would like to use the datasets, or if you represent a university or company wishing to provide a dataset.

essay

Data-Driven Research in the Humanities is Gaining Momentum with Pre-Modern Texts

OYAMA, Keizo

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Center for Data-Driven Research on Pre-Modern Japanese Texts,
National Institute of Japanese Literature (NIJL)
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Over a decade has passed since data science was proposed as the fourth paradigm of science, and efforts towards data-driven research are finally beginning in earnest in the humanities in Japan. "Model Building in the Humanities Through Data-Driven Problem Solving," one of the Ministry of Education, Culture, Sports, Science and Technology (MEXT)'s academic frontier projects, will be implemented by the National Institute of Japanese Literature (NIJL) as a ten-year plan starting in 2024. This follows on from the previous "Project to Build an International Collaborative Research Network for Pre-Modern Japanese Texts," which ran for the ten years ending 2023.

One of the major outcomes of the previous project was the construction of an image database of approximately 300,000 pre-modern texts (manuscripts and books from the Edo period and earlier), which was merged with existing databases and published as the Union Catalogue Database of Japanese Texts. This can be considered Japan's first full-scale digital archive of pre-modern texts.

As well as enhancing and expanding the functionality of the database, the new project aims to convert image data to text to build a foundation for data-driven research, expand to textual analysis which is a vital tool in humanities informatics, and conduct research such as content analysis and material analysis of pre-modern texts through collaboration between different fields. We also plan to roll out data-driven humanities in collaboration with the various institutions within the National Institutes for the Humanities, which NIJL belongs to.

I have been involved in project monitoring and evaluation from the start as an external member of the committee established at NIJL to promote the previous project. I am now Director of the Center for Data-Driven Research on Pre-modern Japanese Texts, established by NIJL in 2022, so I am responsible for promoting the new project within NIJL.

Looking back, the field of digital humanities has been gaining ground in Europe and the United States for about twenty years. Thanks to the construction of digital archives on a national level and good compatibility with OCR technology, it has become a major part of the humanities. Data-driven humanities can be considered a natural extension of this field.

Meanwhile in Japan, humanities informatics research has been ongoing for a similar period of time, but due to the nature of the Japanese language and delays in constructing digital archives, apart from some exceptions like the National Institute for Japanese Language and Linguistics (NINJAL)'s Japanese language corpora, progress in accumulating data has been sporadic, with efforts focusing instead on research and development of information processing methods. Against this backdrop, the Center for Open Data in the Humanities (CODH) was officially launched in 2017, and efforts towards data-driven research have begun through joint research with NIJL.

At the end of the day, the main object of research in the humanities is text, which means that large-scale, comprehensive text databases are essential for data-driven research. In the new project, we plan to use *kuzushiji* (cursive script) OCR technology to convert image data to text, but the character recognition accuracy currently averages around 95% and can drop significantly depending on the condition of the document and handwriting. Most humanities scholars agree that these OCR results cannot be used for research without human revision, and it is estimated that this job would take several hundred years or more. Therefore, some people believe that OCR cannot (or should not) be used, while others think it could be used somehow. I think this is where informatics researchers will come into play, combining their wisdom in this area.

There is a tendency to think that pre-modern texts are only used in certain academic fields like literature, history, and art. But in fact, they include all kinds of content that has value today, including business, disaster prevention, epidemiology, climate, earthquakes, and astronomy. Our ancestors' knowledge about various fields is buried in these documents. I have high hopes that informatics will help us unearth this valuable knowledge.

Weaving Information into Knowledge
NII

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