Image style transfer and image release for tourism promotion in local governments

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Abstract

In recent years, the declining birthrate and aging population have been accelerating in Japan. Municipalities need to utilize data and provide evidence-based policymaking (EBPM) to maintain and improve the quality of resident services with limited resources and financial resources. Therefore, we aim to utilize open image data for tourism appeal in local governments through industry-government-academia collaboration. Currently, the utilization of open image data is not progressing in local governments due to problems such as portrait rights and privacy of images. Therefore, we transfer the image data style, consider the anonymization of the image, and aim to utilize it for tourism. Also, we verified the image style transfer results through demonstration experiments in a local government. As a result, this study demonstrates the feasibility and effectiveness of the proposed approach to local government image data. We believe that this will lead to the utilization of open image data. Furthermore, we aim to deepen the understanding of artificial intelligence technology and the utilization of images in local governments.

Keywords

open image data, local governments, deep learning, image style transfer, data utilization

1. Introduction

In recent years, Information and Communication Technology (ICT), such as artificial intelligence (AI), have been actively utilized in various fields for better development. The government has formulated the "6th Science, Technology, and Innovation Basic Plan" in the administrative area. This plan actively promotes science and technology innovation policies and utilization of big data in local governments [Government of Japan, 2021]. Local governments resourcefully use ICT and large-scale data for evidence-based policy-making (EBPM) [Cabinet Secretariat, 2019]. Some studies have pointed out that the future of tourism is not to increase the number of tourists but to design high-quality tourism experience and increase both domestic and foreign tourism demand. Meanwhile, the tourism digital transformation (DX) using ICT for tourism is essential [Kohsaka, 2020].

In the related works of utilizing ICT for tourism, many efforts are being made to avoid crowds in tourist areas and on the move. For example, it is possible to avoid close contact with tourist spots and on the move by observing and predicting the number of people using IoT devices [JTB, 2021]. Furthermore, to create tourist areas and revitalize local tourism, it is necessary to appeal to tourists with the uniqueness of that region. Therefore, we utilize AI and image data to create tourism materials specialized for areas through industry-government-academia collaboration and use them for tourism PR. Through this, the demand for regional tourism will increase, leading to the activation of regional tourism. In addition, we aim to promote tourism DX by showing examples of ICT utilization for regional tourism. We believe this study can increase interest and understanding of data science and AI in local governments.

2. Open image data

2.1 Significance of open data

Local governments are actively promoting the disclosure and utilization of data since data-based policy-making is essential for local governments. Therefore, the promotion and utilization of open data are necessary because it is easy to use and circulate. Open data can be used for secondary purposes regardless of whether it is for commercial purposes. Also, the data can be used free of charge and is readable by machine [IT Strategic Headquarters, 2017]. The government has created an electronic administration open data strategy to promote open data operation [IT Strategic Headquarters, 2012]. In principle, each ministry and agency need to publish openable data to bring out the value of the data. In addition, the Digital Agency has set out a "comprehensive data strategy" and places the promotion of open data as an important position [Digital Agency, 2021].

The data released as open data is used in various situations. For example, the Disaster Prevention Awareness Map (2020) is intended to enlighten evacuation sites and methods at the time of evacuation by utilizing open data on disaster prevention published by seven cities and towns near Nagoya City. In addition, Kanematsu et al. proposed a plan to promote the health of citizens and revitalize tourism by utilizing open data in Suzaka City, Nagano Prefecture [Kanematu et al., 2021]. They have developed applications that use open data and materials related to tourism. They promoted health as well as tourism by utilizing open data. Besides these cases, there are many cases of open data utilization, and efforts are underway to support people's lives.

2.2 Significance of open image data

Open image data is data such as illustration, photographic,

and moving images converted into open data. This study mainly targets photographic data. Municipalities can gain many advantages in promoting open image data. Firstly, local governments and businesses can visually express the attractions of sightseeing places and events. Through disclosure of images, a wide variety of entities can transmit attractive image information, which will lead to the activation of city promotion. In addition, citizens and businesses can freely use it as material for posters and pamphlets to appeal goodness of local governments. By enabling the secondary use of data, we believe that the transmission from local governments and the message from citizens and businesses will lead to the region's revitalization. Secondly, image is an information format that transcends the language barrier, making them easy to use for communication. Images can convey information that cannot be described in words in an easy-to-understand manner, so it is possible to provide information to foreigners who do not understand Japanese. Therefore, we believe that information disclosure using illustration, photography, and moving images will help foreigners understand the information in tourism.

3. Current status of tourism in the field area

3.1 Hida City, Gifu Prefecture

In this paper, we are collaborating with Hida City, Gifu Prefecture, and are trying to utilize ICT in the tourism industry. We received image data and advice from Hida City and proceeded with the study. Hida City, Gifu Prefecture, is located in the northernmost part of Gifu Prefecture and the northern part of the Hida Highlands. The population is aging and declining along with a declining birthrate. As of April 2022, the total population is 22,790, and the aging rate is 39.97 % [Hida City, 2022].

In Hida City, the tourism industry, which has a broad economic spillover effect, is important to respond to the shrinking economy due to the declining population. The hospitality quality of tourist guides and accommodations, including the city hall, is highly evaluated. In addition, there are also drums and food stalls that are registered as a famous UNESCO Intangible Cultural Heritage. People can enjoy the natural scenery because the city is not developed as a tourist attraction. Also, there are many natural beauties, such as prefectural natural parks. In addition, there are contents with distinctive elements such as Gattan Go and Kamio Kamiokalab. Besides, Hida City has a unique food culture of many traditional foods such as Hida beef and Hida rice. Therefore, Hida City has high potential as a tourist place and has a high possibility for tourism promotion.

Hida City has been actively promoting tourism. Since 2018, Hida City has installed AI cameras in the parking lot of the city hall to measure vehicle license plates. Based on the measurement results, they collect where tourists came from and reflect them in tourism policies [Urata et al., 2020]. In Hida City, tourism is positioned as a comprehensive industry because tourism requires the support of the entire region and has a significant chain reaction.

3.2 Tourism issues in Hida City

While Hida City has a high potential as a sightseeing place, many issues exist [Hida City, 2021]. The tourism industry in Hida City was greatly affected by COVID-19, and the number of tourists decreased by 48.6 % from the previous year. It is the lowest value since statistics. In addition, traditional festivals have been cancelled or delayed, and the challenge is to pass them on to new generations. In previous years, events such as the Furukawa Festival were held yearly by Hida City, but due to the event's suspension, it may not be easy to hold in the future. Furthermore, it is not as well-known as the neighboring cities of Takayama City and Gero City as tourist destinations. Many people do not understand the difference between Hida Takayama and Hida. As a result, 56 % of tourists visiting Hida are people who stop by from other tourist destinations. Hida City has a lot of tourism elements, but it has not fully demonstrated its charm. Besides this, the city's public transport network and accommodation are underdeveloped. Overall, the economic scale of the tourism industry is still relatively small in Hida City.

Hida City has a lot of image data related to tourism. Hida City needs to efficiently sort out image data, promotes the conversion of image data into open data, and utilizes it in the tourism industry. Figure 1 and 2 are examples of open image data released by Hida City, who have published a total of 48 images [OpenPhoto, 2022]. We believe there is still room for more images. When publishing image data, the main issues are the categorization and anonymization of image data. Hida City has taken many photos of each event and place, but it is difficult for local government employees to grasp the content of each image. Therefore, the government needs algorithms to help their staff organize this massive size of image data. Then, when people appear in images, the government also face the challenges of protecting personal information and portrait rights before they can publish those images. Therefore, it is necessary to process images so that the anonymity of citizens is ensured. Furthermore, as a tourist destination, we would like to promote regional tourism by enhancing tourism promotional material with style-transformed images. We believe this will be useful not only for attracting tourists but also for cultivating the regional identity and pride.

3.3 Proposal and practices

We propose the method of image utilization using image style transfer by deep learning and disclose these images for tourism promotion in Hida city. Image style transfer is transforming the original image style into another style. We transform the style of images that captures the unique scenery of Hida City into various styles, such as Japanese ukiyo-e and anime style. We aim to promote the tourist spots and attract people after the epidemic by utilizing the image data in Hida City. We need to think about tourists and citizens together to

Figure 1: Hida City image open data example 1

Figure 2: Hida City image open data example 2

promote local tourism. We facilitate interest in natural scenery in Hida by publishing style-transformed images in addition to the original images as open data. This can appeal to people who have not been there with the transformed local sceneries. They can see the image before the style transformation and the transferred images side-by-side, and we think this work can enhance the attractiveness of the local site. Then, the style-transformation of local scenery into an artist's work or popular animation style could raise the reputation of these regions and make their citizens proud of their hometowns. Similarly, the privacy of individuals or cars can be protected from leakage by transforming the image style.

We verify the effectiveness of proposed methods and clarify issues through demonstration experiments in Hida city. In addition, we promote the disclosure of image data as open data in local governments. Through these practices, we aim to lower

the hurdles for utilizing open image data for the tourism industry in local governments. In addition, we deepen the understanding of AI and data utilization among local employees by showing practical examples of using AI for the work of local governments.

4. Image style transfer

4.1 Development of artificial intelligence technology

AI research has been going on since the 1950s, with a boom and winter era. Now is the third boom that has continued since the 2000s [Ministry of Internal Affairs and Communications, 2016]. In its first boom, artificial intelligence technology could not adapt to complex problems, so it entered the winter period. In the second boom, humans had to write all the information they needed in a computer-processable way and put it in the computer. Therefore, it demanded significant cost and labour, but the result was only applicable in limited areas. Thus, in the third boom, the development of AI, such as deep learning, has made it possible to acquire characteristic knowledge from data automatically. As a result, in a wide range of fields, such as image recognition and natural language processing, practical applications using deep learning have progressed, and remarkable progress has been made compared to before [LeCun et al., 2015]. The technology called Generative Adversarial Network

(GAN) is attracting attention. GAN is a kind of generative model that generates non-existent data and transforms styles or domains according to the characteristics of existing data by learning from data [Goodfellow et al., 2014]. A model that transfers image styles and domains using GAN is called an image style transfer model [Gatys et al., 2016]. Users can change the seasons of images and transform line drawings into realistic images by using this kind of model. This study uses two image style transfer models to transfer natural landscape images of Hida city. There is no need to learn images of Hida City in advance, and we can feel free to use them.

4.2 Painter style transfer

We use two image style transfer models to transform images of Hida city. The first model transfers natural landscape images into the styles of famous painters and Japanese ukiyo-e [Zhu et al., 2017]. Figure 3 shows the implementation results. The first column shows the original images of the urban landscapes. Hida City has already released these images as open data. The images in the second column are results of style transfer to the style of Dutch painter Van Gogh. The images in the third column are images that transfer the original style to the style of French painter Claude Monet. The images in the fourth column are images that transfer the original style to the style of French
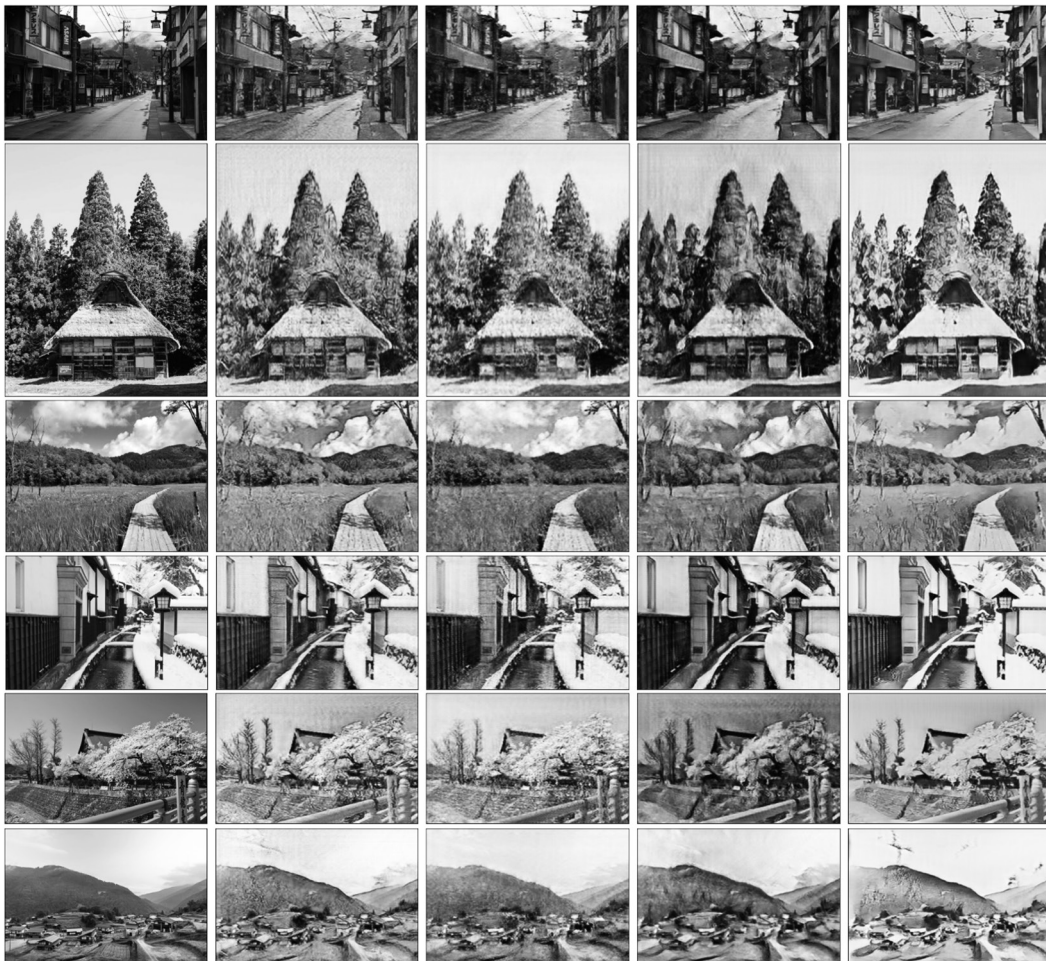

Figure 3: Implementation results of painter style transfer

painter Paul Cézanne. The images in the fifth column are images that transfer the original style to the style of Japanese ukiyo-e style. Through these generated images, we became interested in each style. Also, we became interested in the local situation. There are obvious differences depending on the style of the images. In the case of Van Gogh, we had the impression that he used a relatively large amount of orange. Claude Monet and Paul Cézanne are very famous impressionist painters. The image has an Impressionist style as a whole and in part, and it is relatively blurry. Ukiyo-e uses a lot of pinks in painting and has a distinctly Japanese style, reminiscent of the Edo period in Japan.

4.3 Anime style transfer

The second model transfers landscape images into anime-like images [Chen et al., 2019: 242-256]. Figure 4 and 5 show the implementation results. The first column of Figure 4 is landscape images without people, the same images used in the first column of Figure 3. The second to fourth columns are the output images transformed to the anime style. The second column images result from the transfer to Hayao Miyazaki's "The Wind Rises" style. The third column images result from the transfer to Makoto Shinkai's "Your Name" and "Weathering with you" styles. The fourth column images result from the transfer to Satoshi Kon's "Paprika" style. Figure 5 shows landscape images with people. The first column of Figure 5 shows the input images. The images are displayed here with mosaics on the faces of the people due to the personal information involved. We process images without mosaics when generating anime styles. The realistic anime style is generated from the original natural scenery style, just like the scenery seen in anime. Hida City is one of the inspiration locations for the animated movie "Your Name." "Your Name" was prevalent and ranked second in the total box office of domestic film at that time. Therefore, people often come to Hida City to visit the scenes that the protagonist has been to in the animation, increasing the number of tourists. In this study, we transformed the scenery images of Hida City into anime styles, which can attract more people to go sightseeing. Moreover, it can be seen from the generation results in Figure 5 that the anime style transfer can not only maintain the scenery to a certain extent but also blur the appearance of human faces, making them unrecognizable. It is important to protect personal information when publishing transformed anime-like images as open data. We believe that anime-style transfer is helpful for attracting tourists and protecting personal information.

Takayama City, Gifu Prefecture, has introduced an application to provide real-time waiting status at the city hall [Takayama City Office, 2022]. This application takes photos of the office windows and the parking lot in the city hall with cameras, converts the image every 30 seconds into an anime style, and publishes it on the homepage [Animado, 2022]. Takayama City sends out waiting status in real-time to prevent congestion. Residents can see animated images in real-time through the

website provided by Takayama City. In addition, since the photos of the sceneries have been converted into an anime style, they can protect personal information while conveying the atmosphere.

This study aims to transform the scenic images of Hida City into anime style and release them as public data. We use this method to promote tourism and attract more people to visit the local area. When publishing images as open data, it has been difficult to publish images showing people and identifying individuals. Indeed, there is a way to mosaic the faces of all the people in photos. However, if there are many people, it is undesirable to apply many mosaics as they can affect the image. Therefore, we aim to transform the image into anime styles and publish the image as open data. We can convey the local atmosphere and make many people feel familiar with these methods. This proposal seeks to create a virtuous cycle of promoting open image data and tourism.

5. Discussion

We proposed methods of transforming the style of images and disclosing these images to stimulate travel demand to promote tourism. We think this is useful not only for attracting tourists but also for cultivating the belongingness of citizens towards their own town. Hida City regards tourism as an essential industry and has a lot of image data related to tourism. With the proposal of this study, we effectively used these data and led to tourism promotion. Firstly, we transformed the style of the image data using deep learning. Hida City is surrounded by abundant nature. We transformed these beautiful natural images into the styles of famous painters and ukiyo-e. It was an excellent opportunity to promote traditional Japanese ukiyo-e while experiencing the local sceneries with different image styles. Also, the photos previously only had the natural image style in Hida City, but by transforming them into a variety of styles, it is now possible to choose different image styles depending on the situation. Furthermore, we also transformed the image of Hida City into various anime styles. We believe it is also an opportunity to promote the anime director's work to tourists who are unfamiliar with their anime movies. Hida City is the filming location for the animation movie "Your Name". The film, which was screened in 2016, was a big hit and many tourists came to Hida City. Taking this opportunity, many people came to know about Hida City. Therefore, through this initiative, we created multiple tourism content by converting the style of images and videos into anime-like styles. We believe this will be a good opportunity to promote the old townscape of Hida City. We aim to display the scenery of Hida city in anime styles and protect personal information and privacy by style transfer. For example, the animated image can change or blur the human face, making it impossible to identify someone. This may make it difficult to understand people's facial expressions. Therefore, before performing image style transfer, we want to use AI to read people's facial expressions. We would like to tag the image if there is a happy expression. Also, it can

Figure 4: Implementation results of anime style transfer without people

blur the license plate in images to obscure certain information. These methods protect the personal information and privacy of public images. Therefore, we publish the style-transformed images as open data and utilize them for tourism promotion. We believe that seeing the city view in different image styles than usual can stimulate travel domestically and abroad.

6. Conclusion

We discussed with local government staff and proposed a plan to utilize image data using ICT to promote tourism in the area. Local governments are willing to release much of their data to promote and utilize open data in Japan. Images can convey information that cannot be conveyed in words in an easy-to-understand manner and can provide information to foreigners who do not understand Japanese. Therefore, images can be used in various areas to improve communication. This

proposal shows practical examples of tourism promotion by utilizing the image data provided by local governments without acquiring new data. We received much positive feedback from Hida City regarding this study and the results of image style transfer. Also, they are very motivated to implement the outcome of this study in practice. Specifically, their feedback is summarized below.

• Evaluation of style-transformed images
  They presented two points of view. First, the result of image transformation was highly appreciated by the Hida City staff since the style-transformed images were beautifully done. From now on, we would like to transfer more image data of Hida City and test the precision of this program with a larger quantity of dataset. Second, the city would like all images in the city database to be processed through the image style

Figure 5: Implementation results of anime style transfer with people

transformation in the future.

- Utilization of style-transformed images

  The Hida City listed three requests. The city would like to implement the style-transformed images for tourism promotion. Second, although the image style transformation will not be a regular demand, the transformation of images will be largely used for promotion among children. Third, they would be grateful if people could utilize style-transformed images and videos as open data.

- Issue

  The Hida City proposed a concern about the precision of styles transformation in related to the image quality. Images with good image quality can expected to be successfully transformed into painter styles or anime styles. However, the transformation of images with low quality requires further testing, research, and improvement.

We plan to absorb their opinions above in the development of our future studies. We want to continue this research and verify the image style transformation with a larger set of data. Then, we aim to enhance the quality of the old image and check the results. In addition, we will conduct surveys of tourists and citizens to verify the results of image style transformation and the effects of our study. Based on the outcome of the questionnaire, we will adopt different image style targeting specific audience groups. Through this method, we can enhance the tourism

contents of local governments with more niched advertisement placement. Furthermore, we plan to create tourism content for each tourist destination and promote the unrecognized sceneries. Also, this effort could deepen the understanding of AI utilization for local government staff. Even with different municipalities, the proposed implementation method will hardly change, so we believe the method and system devised in this study can be smoothly adopted by other local governments.

In addition, we consider applying the proposed method not only to images but also to videos. For example, it is possible to transform videos of some tourist spots in the town into anime styles and release them for public use. Through promotional videos, local governments can better introduce local scenery and attract tourists to visit.

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