Fostering Interest and Enthusiasm in Literary Appreciation Through Character Mosaics

Yuming Bai* and Nobuyuki Umezu

Graduate School of Science and Engineering, Ibaraki University, Hitachi, Japan
Email: 22nd306n@vc.ibaraki.ac.jp (Y.B.); nobuyuki.umezu.cs@vc.ibaraki.ac.jp (N.U.)
*Corresponding author
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***Abstract*—Recent surveys show that people's enthusiasm for literary works has been waning gradually. Along this decline in reading habits, difficulties in remembering how to write certain characters are emerging, despite regular usage. To explore whether a novel form of literary appreciation can rekindle interest in literature, we refine our "character mosaics" method, which arranges thousands of adaptively scaled characters into motifs based on image brightness. Unlike traditional photographic mosaics, this ensures text readability while preserving the literary essence. In this study, we applied our method to 14 notable Japanese literary works, creating mosaic posters that maintain the original reading order of Japanese novels.**

***Keywords*—character mosaics, novels, literary appreciation, text-based art, experiment**

I. Introduction

In the rapidly evolving digital era, traditional literacy practices face challenges with fewer people engaging in regular reading. Recent surveys reveal that over 60% of Japanese participants do not read books at all [1], while nearly half of American adults (48.5%) have not read any books for over a year [2]. According to the findings from our user evaluation experiment, 64% (32 out of 50 respondents) reported that they rarely read books. This highlights that a significant proportion of the population is not engaged in regular reading, underscoring the widespread decline in literary engagement.

In recent times, people have become increasingly familiar with computers and digital devices. Chinese characters for example, are automatically converted when typing on a keyboard, allowing for instant judgment of correctness using algorithms. However, when attempting to write letters or reports by hand, particularly in non-alphabetic scripts such as Chinese and Japanese, recalling these characters can be challenging.

This phenomenon is referred to as "Tip-of-the-Pen" (TOP) [3, 4], where individuals know a character but fail to fully write it by hand. This is related to character amnesia, which is the general inability to write a character by hand despite being able to recognize it. Previous studies have shown that word frequency and contextual familiarity are the most influential factors, and exposure to printed text positively affects both TOP and character amnesia [5]. Additionally, some common words and expressions are gradually being replaced by buzzwords from social media [6], leading to loss of their original beauty.

In particular, it is important to promote the value of traditional works such as poems and novels to increase engagement with characters and to showcase their beauty through attractive appreciation methods. Making literature accessible involves more than simply hanging it on walls or placing it on library shelves; it requires interactive engagement with the material.

To address these challenges, we improved the character mosaics method [7], which is a text-based artistic approach that integrates literary content with visual art. This method seeks to rekindle interest in literary works by combining text readability with visual representations.

To explore whether our generation method can foster interest and enthusiasm in literary appreciation, the effectiveness of character mosaics was evaluated using 14 Japanese novels as the foundation for mosaic generation and user feedback.

II. Related Work

A. Artistic Representations of Combined Elements

Various artworks incorporate multiple elements such as hybrid images [8] and photographic mosaics, which leverage the characteristics of the human visual system. When a picture is viewed closely, only the details are discernible and the overall features may be too large to be perceived. Conversely, when a picture is viewed from a distance, the details fade and broader patterns dominate our perceptions. This shift in perception based on the viewing distance is fundamental to many artistic representations.

Our character mosaic generation method is based on images such as photographic mosaics, which consist of a collection of small material images that form different motifs. It can also be considered as a specific type of hybrid image which typically blends high- and low-frequency components. In a character mosaic, high-frequency elements are composed of numerous small individual characters from the text without a direct depiction of the main subject. The collective arrangement of these scaled characters forms an overall pattern that outlines the subject, which appears as a blurred, low-frequency image recognizable only from a distance. The automatic generation of photographic mosaics has been studied using several methods [9–11]. These works, which are displayed on screens of computers and mobile devices for example, can be instantly magnified without changing the viewing distance.

Another form of expression known as the American Standard Code for Information Interchange (ASCII) has been widely studied [12–14]. This graphic design technique originally employed computers to create images composed of 95 printable characters as defined by the American Society of ASCII standards in 1963.

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These computer-generated images were constructed from characters available in standard 7-bit ASCII and other ASCII-compliant character sets, which included more than the original 128 characters. The characters used in ASCII art are corresponds to the brightness of the pixels, ignoring the order of the characters in the text.

In this study, we used Japanese novels as elements in mosaics while preserving their original context, to generate a new form that fosters literary appreciation. A comparison between these generation methods and character mosaics is presented in Table 1. For example, differences between elements used in hybrid images and photographic mosaics are images. Our novel method uses textual materials that are different from ASCII art and ignores textual meanings.

Table 1. Comparison of character mosaics with related artistic techniques

	Hybrid Images	Photographic Mosaics	ASCII Art	Character mosaics
Elements	images	images	characters	characters
Tone representation	frequency components	colors	shape	scaling
Placement	overlapping	context-free	shape arrangement	context-preserving
Motif: Elements	1 : 1	1 : N	1 : N	1 : N
Elements orderliness	Itself	Disordered	Disordered	Preserved

B. Augmented Reality, Virtual Reality, and Game

Several studies [15–17] have focused on the development and application of virtual reality (VR) literature and methods for integrating gaming elements into literary presentations [18, 19]. Various innovative literary presentation methods utilizing diverse media forms and technological approaches have been proposed to enhance readers' engagement and interest in literary works. However, some limitations exist, such as the need for VR equipment and restrictions on the number of participants, which hinder broad and frequent presentations that attract large audiences.

We aim to maintain a connection between traditional paper-based appreciation methods and contemporary digital experiences. This aligns with Huang's perspective. "At the handwrite level, individuals experience more TOP and character amnesia when exposed to more digital content and less pen or print exposure" [3]. By presenting literary works such as novels as character mosaic posters, we hope to effectively captivate a wide audience.

C. Exhibitions

To enhance interest in literary works and increase opportunities for appreciation and engagement, Kimihara et al. collaborated on a project centered on literary works and media art and explored the potential within. The series, titled "Dimension Rendez-vous: Literature tt" [20], incorporates fragments of text quoted from literary works into multimedia videos. These videos were continuously displayed on a photo frame terminal positioned upright, featuring a square window at the top and a cubic crystal glass placed above it. Crystalline glass creates a kaleidoscopic effect through internal reflection. The videos could only be viewed from above, requiring viewers to approach and peer down through the windows.

Additionally, British interdisciplinary artist J. Benson creatively intervened in existing literary and artistic works. She interpreted and combined sentences from essays by Quammen and writings by the 18th-century philosopher B. d'Holbach, transforming them into visual and auditory expressions. Benson's artwork, displayed at the Paula Cooper Gallery in Florida, featured handwritten reproductions, with sections removed to reveal coded elements or new languages. She reconstructed literary texts by extracting syllables corresponding to musical notes such as do, re, mi, fa, so, la, and ti, thereby uncovering the embedded musical scores within the texts [21].

New York-based graphic designer E. Robertson drew inspiration from snippets of text by his favorite authors, using their words as a springboard for new ideas and illustrations [22, 23]. He hosted literary poster exhibitions and his collection included art prints, books, and gifts. However, these exhibitions primarily offered novel expressions at the level of artistic innovation, and none effectively harmonized the author's image with that of literary works.

In this study, we generated character mosaics by utilizing text in paragraph form and combined it with related images of the authors, while ensuring the readability of the literary works.

III. Methods and Materials

Unlike photographic mosaics which can be generated by selecting any image without considering the context, character mosaics retain the context of the original text. Each character is used in a specific location to preserve the context of the original paragraph. In contrast to photographic mosaics, the only attribute available for reproducing tones in character mosaics was size.

A. Method Outline

The processing steps for generating character mosaics (Fig. 1) were as follows: first, the resolution of the input images was reduced to dimensions ranging from 50 × 50 to 100 × 100 pixels. Second, tone quantization was applied to reduce the number of tonal steps in the motif. This is particularly effective for motifs such as drawings or paintings with more subtle tone variations compared to photographs, which typically contain hundreds or thousands of distinct tones.

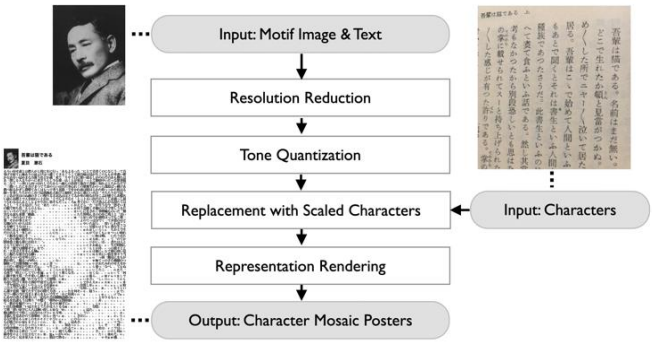

Fig. 1. Basic flow of character mosaic generation.

Third, each pixel in the downscaled motif image was replaced with a character extracted sequentially from a given literary work, which is another element of the character-mosaic generation process. The fourth and final output was produced by rendering these characters in an image format or by saving them as vector graphics in a Scalable Vector Graphics (SVG) format.

Photomosaics are typically created in raster graphic formats such as JPEG and PNG because the source images are in raster representation. Consequently, the jagged edges become apparent when a photomosaic is enlarged and displayed, rendering it unsuitable for significant enlargement. By contrast, this study focuses on generating character mosaics in a vector graphics format. Vector graphics are image representations based on mathematical formulas (e.g., points, lines, and curves) instead of pixels. Unlike raster formats such as JPEG and PNG, vector graphics can be infinitely scaled without loss of quality, ensuring that the image remains sharp and clear at any size. In character mosaic generation, vector formats such as SVG preserves the sharpness of character edges. This allows high-quality details even when significantly enlarged, making them ideal for high-resolution printing and large-scale displays.

This approach involves processing material images using operations optimized for scaling and rotation, effectively allowing unlimited resolution.

1) Resolution reduction

Resolution reduction refers to a decrease in the number of pixels in an image to reduce data complexity, while preserving key visual features. Proper resolution adjustment ensures that the overall contours remain clear while reducing the computational load and improving the processing efficiency, making character mosaic generation smoother and more precise.

The proposed method first reduced the resolution of the input image. An image typically requires approximately 1,000 pixels, or 32 × 32 pixels, for a square image to be sufficiently recognizable. However, 32 × 32 pixels are often sufficient for creating basic shapes and features that can be particularly useful in contexts such as icon design, simple graphics, and basic image-recognition tasks. Additional pixels are typically required to generate high-quality character mosaics. This is because each character is enlarged to reproduce the brightness and darkness of the motif, and each character has its own brightness [24]. Each character must fit the overall image proportionally, and simultaneously convey image details through shading variations.

This introduced a new challenge: balancing the readability of the text with the reproducibility of the mosaics. This required finding a balance between resolution and character size to ensure that each character is clear and readable, while effectively recreating the visual effect of the overall image.

An example of resolution reduction using a photograph from Natsume Soseki, a famous Japanese novelist (1867–1916), is shown in Fig. 2. The number of pixels was reduced to 40 × 55 (from 1600 × 2200 pixels in the original image). Setting a resolution of approximately 50 × 50 pixels offered good balance, allowing for adequate detail in the mosaic and sufficient character readability. Although this resolution was relatively low, it was still effective for displays such as printed posters.

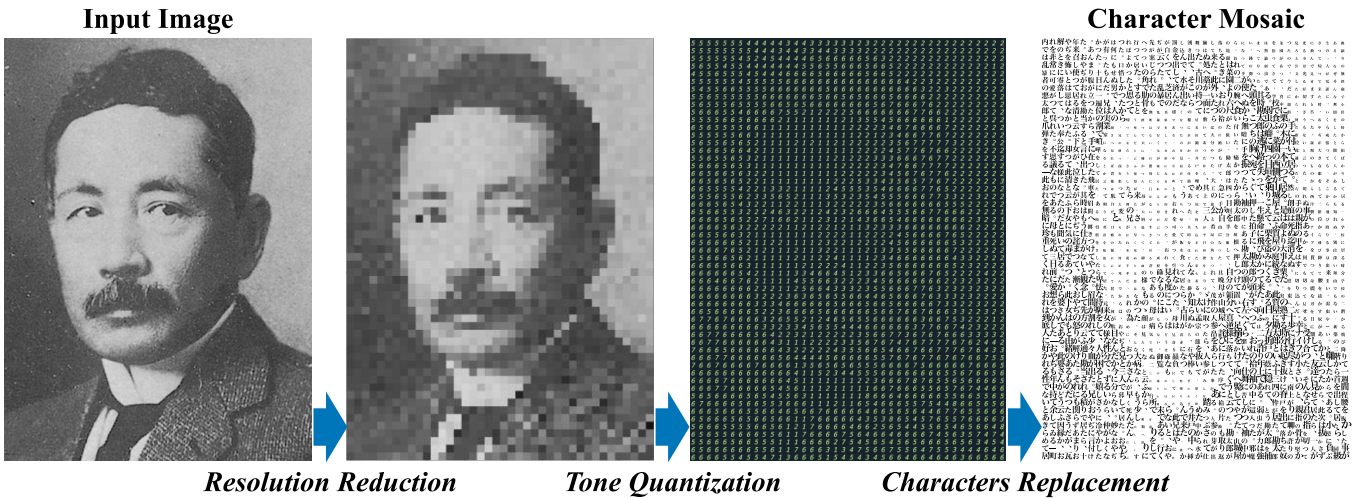

Fig. 2. Illustration of the process from image input to mosaic output.

2) Tone quantization

Tone quantization reduces the number of tonal levels in an image and simplifies its brightness and color distributions. This allows different character sizes to represent the variations in light and shadows within a character mosaic. This process enhanced the depth and structure of the image, ensuring that the final mosaic retained both its visual meaning and textual readability.

To better visualize the mosaics generated from painted portraits or photographs, the brightness value of each pixel block was quantized in several discrete steps using the average brightness of the block. This process transformed the input image into a set of values within a limited range. A conceptual visualization of tone quantization is shown in Fig. 2, where each pixel in the reduced image is represented by a value between one and nine. This quantization process improves the reproduction quality of the resulting character mosaics, particularly when the input image is a painting or a drawing. This is because these types of images tend to have fewer tonal steps than photographs do.

3) Character replacement

Each character is sequentially extracted from the input text material, scaled according to the pixel value (brightness in a grayscale input image), and placed in a specific location in the resulting representation. This placement process continues until the entire image is covered with scaled characters extracted from the text.

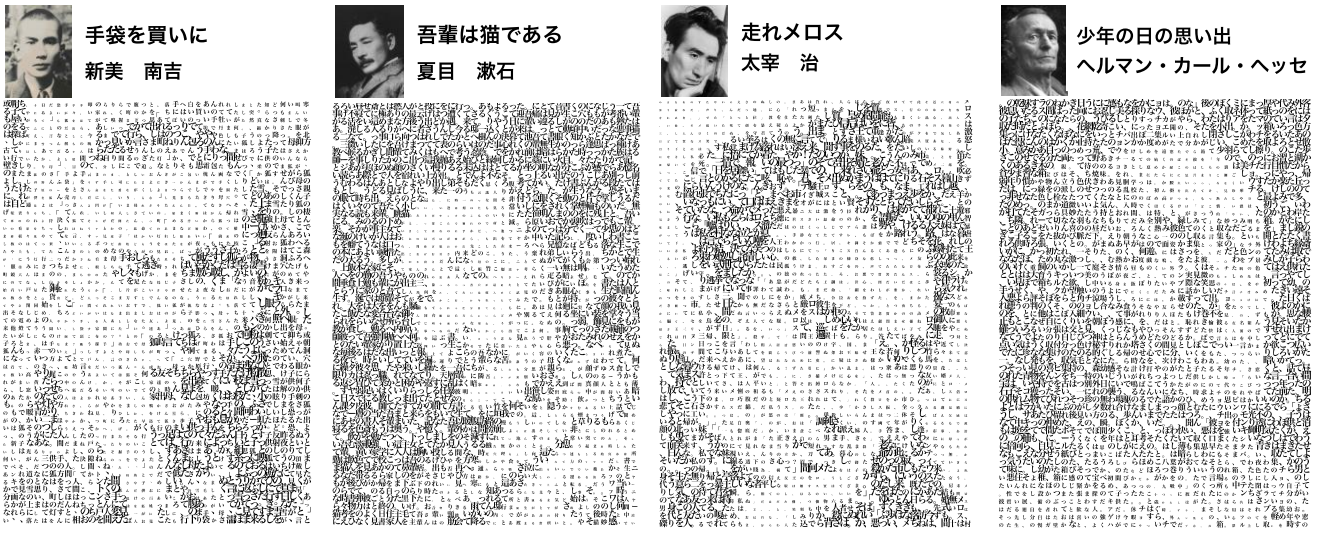

Fig. 3. Examples of our mosaic generation, using Japanese material novels combined with authors' portrait photographs.

This method treats graphical objects using their geometries, making it more suitable for geometric operations such as translation, scaling, and rotation, thus allowing unlimited resolution. This advantage ensures that the character materials are read without dissonance.

In contrast to existing methods such as ASCII art, which rely on a limited set of characters to represent images with minimal detail, our character mosaic approach uses a diverse range of adaptively scaled characters to form complex and highly readable images. This allows for a richer and more nuanced visual representation, while maintaining text integrity. This is something that ASCII art often struggles to preserve because of its reliance on basic symbols.

Additionally, our method differs significantly from AI-based text-to-image approaches, which generate images using machine-learning algorithms trained on vast datasets. While these approaches can create high-quality visuals, they lack the inherent connection to literature and the textual meaning established by character mosaics. In our method, each character used in the mosaic not only contributes to the visual composition, but also serves as an integral part of the literary context, enhancing the viewer's engagement.

Furthermore, our approach ensures readability, which is often compromised in other artistic forms such as photographic mosaics or AI-generated images where visual appeal may overshadow textual clarity. By focusing on preserving the reading order and meaning of the original text, our method strikes a balance between the aesthetic value and textual accessibility, making it particularly suitable for use in literary exhibitions and artistic displays.

B. Material Selection

Prior to generating character mosaics, we conducted a preliminary survey with university students asking the following four questions:

- Are you interested in literary works?
- What work or author can you remember immediately?
- What are your favorite examples?
- How about the difficult or disliked ones?

Fourteen literary works were selected (Table 2), including the four most frequently mentioned in the survey results and ten highly rated works from "*Tear-jerking textbook masterpieces that you want to read again*" [25]. Considering the size of the generated works and the spatial constraints of the available venue, only approximately 10 posters could be displayed simultaneously. However, we selected more than 10 literary works with a few serving as backup. This included a German novel translated into Japanese called *Jugendgedenken*. These novels are available at *Aozora Bunko*[1], a Japanese digital library also known as an Open-Air Library, which offers over 15,100 copyright-expired books or works that the authors wish to make freely available.

The input images were representative photographs and portraits of their authors, all of which were downloaded from *Wikipedia*[2]. Representative examples of selected content and posters were generated using the proposed approach as shown in Fig. 3.

In Japanese novels, the reading direction is from right to left and top to bottom. In addition, the fonts used for vertical and horizontal writing on computers differ. Fonts designed for vertical writing are adapted to the layout of characters from top to bottom, especially punctuation marks and brackets, which are displayed in a manner that suits vertical text. However, fonts for horizontal writing are optimized for computer screens and documents laid out from left to right, resulting in a different visual balance compared to vertical writing. Therefore, these differences must be considered during generation and adjustments must be made accordingly. For example, when adapting punctuation marks like Japanese commas (、) and periods (。), their positioning needs to shift from their typical placement at the bottom left of the character area, as seen in horizontal writing, to the top right to

[1] https://www.aozora.gr.jp

[2] https://www.wikipedia.org

align with the vertical flow of the text. This repositioning ensure that the marks do not disrupt the natural reading rhythm. Quotation marks (「) and (」) also need to be rotated 90 degrees clockwise to maintain proper orientation in vertical writing. These adjustments ensure a better reading experience for users during appreciation (Fig. 4).

Table 2. Selections of material novels together with authors' names

Literary Works	Authors
Jugendgedenken	***Hermann Karl Hesse***
No Longer Human 「人間失格」 ***Run, Melos!*** 「走れメロス」	***Dazai Osamu*** (太宰 治)
Botchan 「坊っちゃん」 ***I Am a Cat*** 「吾輩は猫である」	***Natsume Sōseki*** (夏目 漱石)
Light, Wind and Dreams 「光と風と夢」 ***The Moon Over the Mountain*** 「山月記」	***Atsushi Nakajima*** (中島 敦)
Tu Tze-chun 「杜子春」	***Ryūnosuke Akutagawa*** (芥川 龍之介)
Katachi 「形」	***Hiroshi Kikuchi*** (菊池 寛)
Tsuzumi Kurabe 「鼓くらべ」	***Yamamoto Shūgorō*** (山本 周五郎)
Buying Mittens 「手袋を買いに」	***Niimi Nankichi*** (新美 南吉)
Wild Rose 「野ばら」	***Ogawa Mimei*** (小川 未明)
The Restaurant of Many Orders 「注文の多い料理店」 ***Night on the Galactic Railroad*** 「銀河鉄道の夜」	***Miyazawa Kenji*** (宮沢 賢治)

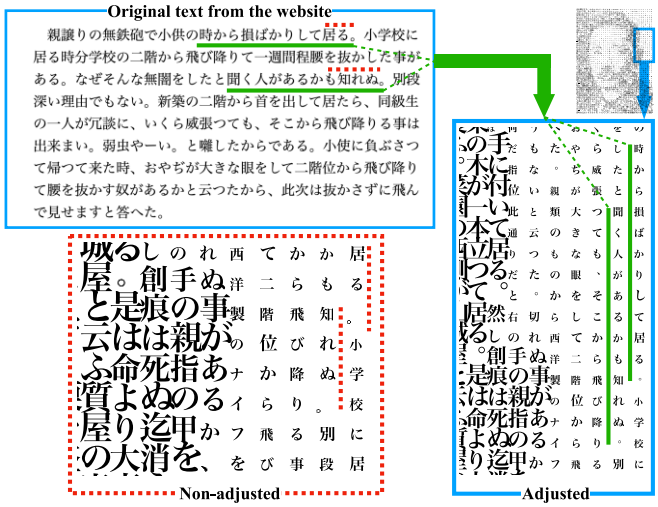

Fig. 4. Comparison of adjusted and non-adjusted mosaics. The top-left shows the original text from the website; the right side displays the adjusted mosaic example with a magnified view of the details; the bottom-left presents a non-adjusted example.

C. Resolution Selections

To examine the balance between the readability of characters and their recognition as illustrations, we conducted a user experiment with 15 participants using the proposed mosaic-generation method (Fig. 5). To provide a higher resolution than that of a computer screen and allow for the simultaneous comparison of multiple images, examples of mosaics were printed on A4 paper and presented to the participants.

The generated examples consisted of 138 images, which included:

- Four levels of brightness (4, 16, 64, and 256) × four resolutions (approximately 20 × 20 to 100 × 100) × two categories (portrait photos and drawings).
- Four brightness levels (4, 16, 64, and 256) × three resolutions (approximately 20 × 20 to 100 × 100) × one category (landscape photo).
- Two handwritten character mosaics.
- Four examples of character mosaics generated by English text.

Fig. 5. Resolution selection experiment.

For character mosaics using portrait photographs, 93.3% of participants (14 or 15) chose a resolution of 50 × 50 pixels or higher. Some of the results are shown in Fig. 6. A resolution of at least 50 × 50 pixels is necessary to reproduce facial contours and details accurately, suggesting that a higher resolution is preferable. Various brightness levels were selected, which indicated that the number of brightness gradations did not significantly affect the quality of the character mosaics.

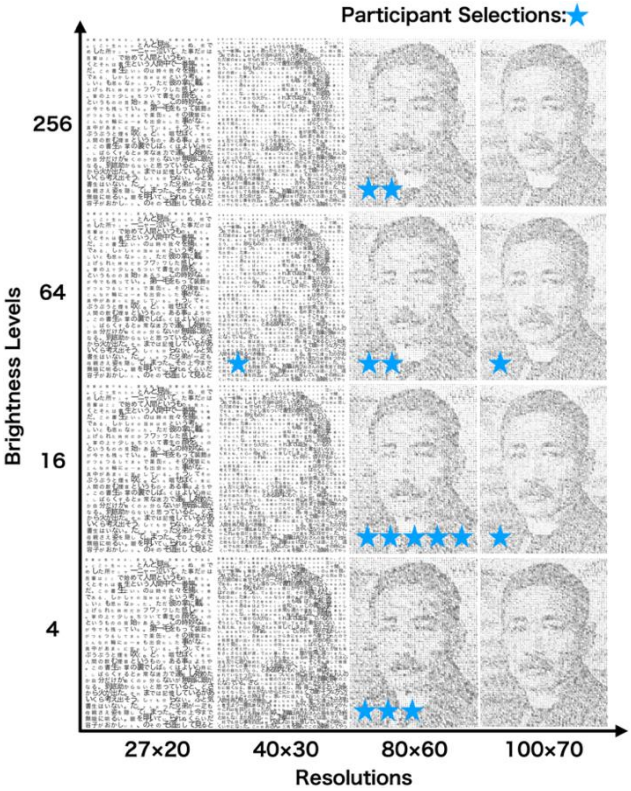

Fig. 6. Participant selection for portrait photograph of Natsume Soseki.

The following conclusions were drawn from the resolution selection experiment (Table 3) which informed our

evaluation experiment for generating mosaic posters.

Table 3. Conclusions drawn from the selection experiment results

Type of source images	Range of resolutions
Portrait	50×50 pixels or higher is required
Upper-body painting	50×50 pixels or lower is required
Full-body portrait	As many pixels as possible
Landscape	High resolution is required

Examples of different stage values are shown in Fig. 7. As computers typically use binaries for storage and computation, the brightness levels tend to increase at powers of two (4, 16, 64 and 256). Therefore, we adopted these four levels for brightness selection.

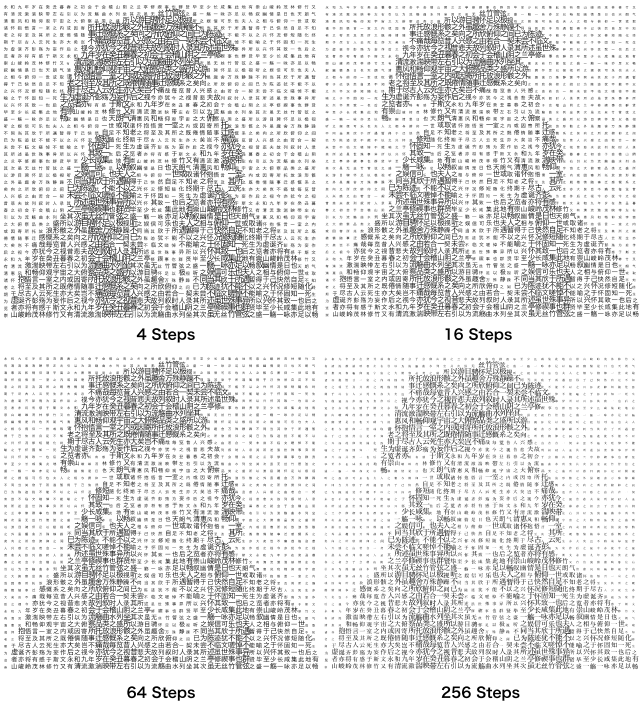

Fig. 7. Comparison of different step values, where the resolution experiment exhibits little impact on the final presentation.

Although the contour reproduction became more refined as the number of steps increased, the resolution experiment results did not reveal a significant impact on the final presentation. Additionally, to achieve a better reproduction of facial contours in character mosaic posters, we chose to use 256 steps as the maximum step value in the generation.

Since the source images in our main experiment were portrait photographs, the preliminary experiment suggested that a resolution of approximately 50×50 pixels was suitable. Thus, this resolution range was used in the subsequent experiments.

IV. Evaluation Experiment

We exhibited character mosaic posters at the Hitachi Civic Science Museum for two days, and simultaneously conducted a user evaluation experiment (Fig. 8). Responses were collected from 50 participants. The arrangement of the generated posters was based on the order of the first characters in their titles in Japanese syllabaries.

The 50 participants had sufficient diversity to ensure a broad and representative feedback range. We investigated participants' age, educational level, and other demographic characteristics in further experiments.

Despite the fact that a number of recent methods [26–28] involved text-to-image art (commonly referred to as "AI art"), including generation of portraits from text descriptions, none have successfully produced works using entire literary materials. During conversations with visitors at the science museum, they mentioned having never seen such an exhibition format before. They also expressed being attracted from a distance when they saw a display of portraits by various authors, sparking their curiosity regarding our poster exhibition.

Fig. 8. The scene of the evaluation experiment at Hitachi Civic Science Museum.

To verify whether the mosaic posters would enhance people's interest in, and enthusiasm for literature, we conducted a user survey consisting of the following three questions:

1) How frequently do you read literary works?
2) How much more inclined are you to read "character mosaics" compared to ordinary ways?
3) What kinds of works (such as artists) would you like to have been generated by character mosaics? If so, how much would you pay to buy it?

Question 1 was designed to understand the reading frequency of the participants in the experiment, including how often they engaged with different types of literary works such as novels, poetry, and digital literature. This assessment helped to gauge the demand for new forms of appreciation that can enhance interest in reading.

Through Question 2, we sought to determine whether the proposed method would gain acceptance and to compare its impact on the willingness to appreciate traditional forms such as books, e-books, and smartphones.

Question 3 consisted of two parts: whether participants would purchase character mosaics featuring their preferred authors or literary works, and how much they would pay for them. Both parts were open-ended, and the prices were determined in Japanese yen (¥) since our experimental participants were all Japanese. This two-part question allowed us to assess the level of interest in creative works and the potential market value assigned to them.

V. Results and Discussion

A. Reading Frequency

The results of the first question are shown in Fig. 9. Despite our anticipation that the reading frequency in the experimental results would predominantly fall into the third category (several days per month), we were surprised to find that 64% of participants (32 of 50) reported that they rarely read books.

Although our sample size for reading frequency was significantly smaller than those of other surveys [1, 2], it offered a general understanding of participants' responses in our experiment. This allowed us to reflect on the importance of enhancing people's interest in reading and enabled us to implement appropriate measures such as introducing new formats of literary appreciation, to engage a wider audience and to inspire passion for reading.

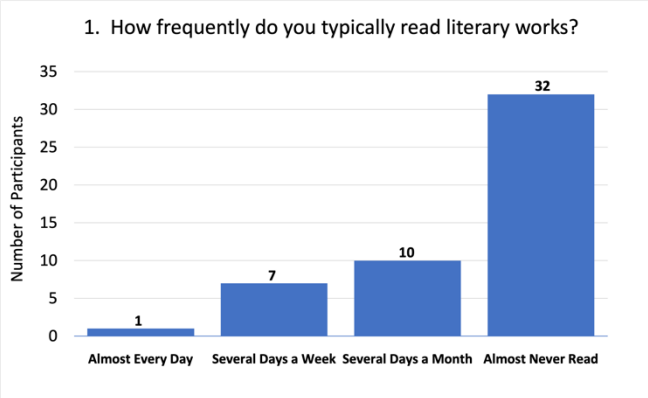

Fig. 9. Approximately 64% of participants reported that they almost never read books from our evaluation experiment.

B. Evaluations

While visitors were reading novels alongside our artworks, we conducted a seven-scale rating between -3 and +3 to assess the impact of character mosaics on enhancing literary appreciation. The results for Question 2 are shown in Fig. 10, indicating that 32 participants (64%) responded that our approach had a positive impact compared to traditional appreciation methods.

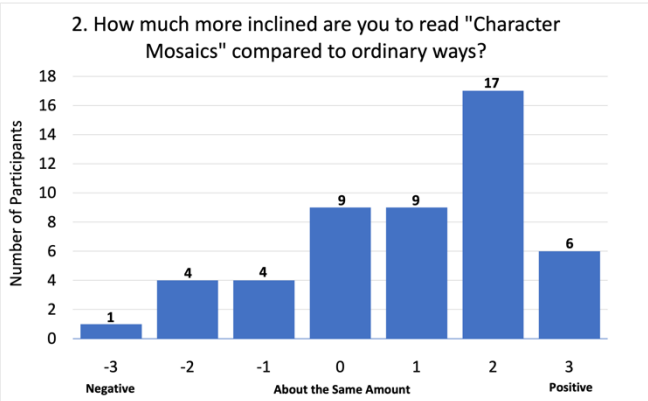

Fig. 10. Rating received from 50 participants on the character mosaics, 64% of which are positive.

We questioned the participant who gave a rating of -3, and found that this individual reads almost every day. The reason for this evaluation was that the mosaic posters felt somewhat superfluous and were not as easy to read as traditional books. We further analyzed the correlation between Questions 1 and 2 and found that this might be related to high-frequency readers'strong dependence on the text content itself, where they prefer to obtain literary information through traditional methods rather than through the visual arts.

Individuals with higher reading frequency tended to respond that our approach had a negative impact on literary appreciation, suggesting that as reading frequency decreased, the demand for new forms of literary appreciation increased. That is, the evaluation of character mosaics was more positive for those who read less frequently. We suggest that personalized mosaic display methods for different user groups can be designed to satisfy the needs of different appreciation habits.

C. Will You Purchase One?

We asked Question 3 because we were unable to directly determine the actual value of an artwork; we could only compare it to similar works on the market by asking for its perceived price. The question, "What kind of works (such as artists' works) generated by character mosaics would you like to have?", was added to estimate the hypothetical values of the character mosaics.

More than half of the responses were still related to literary works and authors despite options given such as "actors," "singers," "idols," and "cartoon characters." This indicated that literary works continue to play a significant role in people's minds.

All the participants provided specific amounts or price ranges. Consequently, we categorized the responses into six segments (Fig. 11): one segment for 0 yen, four segments for amounts ranging from 0 to 10,000 yen, and one segment for amounts exceeding 10,000 yen. Some responses were either zero or priceless.

Fig. 11. Distribution of estimated monetary value of character mosaics.

Although we were more interested in their impact than their monetary value, the results indicate that character mosaics held a certain value, at least among the participants in this experiment. This indirectly demonstrates the relatively positive impact of character mosaics, suggesting that our new appreciation method can encourage greater exposure to printed materials and reduce the reliance on electronic devices.

The results of our evaluation experiment indicate that character mosaics can attract people's attention and generate interest in literary works. Additionally, the poster exhibition format is only one aspect of our study, since the benefits of SVG formats, particularly when displayed on electronic devices such as PowerPoint presentations, enhance clarity and make the content more intuitive. This suggests potential applications in educational settings, particularly in language and literature curricula. Like researches in digital literacy practices [29, 30], our character mosaics also could be a new tool used in language education such as Japanese and Chinese to reinforce character recognition, helping students better retain complex kanji characters through repeated visual exposure. Additionally, integrating this technique into digital

literacy programs could enhance students' ability to engage with text in creative and analytical ways, fostering a deeper appreciation for both classical and contemporary literary works.

D. Possible Biases in Results

Several potential biases may have influenced our experimental results, stemming from factors such as participant backgrounds, environmental conditions, and the inherent characteristics of the materials used. These biases could have shaped the way the participants perceived and interacted with character mosaics, potentially affecting the validity and generalizability of our findings. The key identified biases include the following:

- Pre-existing preferences for authors: Some participants may have been familiar with, or particularly accustomed to the authors used in our experiment, which could have influenced their responses.
- Order and environmental factors: The sequence in which the works were presented as well as exhibition factors such as arrangement and lighting may have affected the participants' impressions.
- Representative selection of images: The selected images may not have fully captured the essence of the respective authors, potentially shaping participants' interpretations.
- Reading medium preferences: Frequent readers' primary reading media (e.g., printed books vs. digital screens such as Kindle) may have impacted their evaluation of character mosaics.
- Participant demographics: Visitors to science museums, whether adults or parents accompanying children, may not be representative of the general population, introducing a potential selection bias.

By acknowledging these potential biases, future studies can refine their experimental designs by implementing more controlled conditions, diversifying participant demographics, and by exploring alternative presentation methods. These improvements will contribute to more generalizable and robust conclusions, ensuring that the results reflect the broader audience's responses more accurately.

VI. Summary and Future Work

A. Summary

We present a method for generating innovative mosaic art that combines image-processing techniques, visual art, and characters. In evaluating the potential of text-mosaic generation techniques in the field of education, our method maintains text readability while creating artistic works, thereby enhancing people's interest in literary appreciation. We refine our mosaic generation method to assemble thousands of enlarged characters from Japanese novels into motifs using the brightness of the input images. Our unique approach to text-based artistic representation ensures the legibility of the textual content, diverging from traditional photographic mosaic techniques.

Fourteen character mosaic posters were generated using materials from the novels and photographs of the authors. Although these works were created using relatively low resolution, they were still effective when displayed as printed posters.

In the evaluation experiment, 64% of the participants (32 out of 50) reported that they had almost never read books, indicating a low level of interest in, and enthusiasm for, literary appreciation among the general public. Therefore, there is a pressing need for innovative methods to increase involvement. In our experiment, 64% of the participants positively evaluated character mosaic posters as a new form of literary appreciation, with some expressing interest in hanging them on the walls of their homes if commercialized. This indirectly demonstrates that the proposed approach has artistic value.

More innovative and interactive methods of appreciation can better stimulate people's interest. However, we aimed to keep our approach far from the traditional appreciation methods. We also prevented the mosaic approach from becoming a primary method of literary appreciation. Our goal was to bridge the gap between the literature and the public through a novel display method that sparked interest. If audiences could view a literary work using our method and subsequently choose to actively seek it and learn more about it when they return home, this would truly validate the effectiveness of our research.

In the field of education, our technology can be used to help students more easily associate literary works with author-related images, such as portraits, and enhance appreciation enthusiasm through the dual sensory stimulation of vision and text. Character mosaics can be used in cultural exhibitions, art installations, and other contexts to enhance the cultural value of classical literary works.

B. Prospect

During the poster exhibition, many visitors mentioned that they would display mosaics made from their own photographs or pictures of loved ones at home. This made us think about the possibility of creating a "Mosaic Photo Studio" where customers could generate mosaic artworks from their favorite images. Additionally, we are exploring the use of mosaics for book covers, with the aim of attracting readers more quickly and increasing sales.

In addition to the Hitachi Civic Science Museum, we consider the possibility of promoting the local area through mosaic art using local images and other materials from the Tokai Village Museum. This is aimed at increasing the interest in the region's history and culture among local primary and secondary school students, as well as among people from other cities, fostering greater cultural exchange and educational engagement.

Beyond artistic exhibitions, we also envision the development of interactive digital tools based on the character mosaics technique. A promising application would be a web-based or mobile platform where users can input text passages and images, allowing the system to automatically generate personalized character mosaics. Such a tool could serve educational purposes, integrating seamlessly into literature classes, digital humanities research, and cultural heritage preservation projects.

Furthermore, future research could leverage machine learning techniques to refine process, optimizing brightness distribution and semantic alignment. This enhancement would improve both the visual clarity and textual integrity of

the mosaics, making them more effective for both artistic and educational applications.

For areas outside Japan, particularly countries with languages based on Chinese characters, such as China and Korea, character mosaics would have even more exciting presentations. For example, materials such as classical Chinese poetry, calligraphy, and ink paintings can be used to generate the artwork that is currently being explored. At the same time, we believe that these artworks will attract people from non-Chinese character cultures and spark their interest in learning Chinese characters. In addition, we did not wish to limit our method to the generation of mosaics using Chinese characters. As shown in Fig. 12, the generation of mosaics using English as the source material was also explored.

Fig. 12. English character mosaic with a photo of Einstein and a portion of the paper explaining the theory of relativity.

Many famous Chinese literary works are studied during school years, such as the well-known poems of Du Fu and Li Bai. These works are also part of Japan's compulsory curriculum as classics. However, despite their excellence, it is often difficult to remember the authors' names along with photos or images in their original form. For this reason, it would be useful to apply our method, which combines authors' photos or portraits with their works. When people view these kinds of artworks, they can immediately associate them with the authors. To help these excellent works to be better studied and disseminated, we plan to begin an evaluative experiment centered on such character mosaics in several middle schools in Hitachi City to assess the potential of our method in an educational context.

C. Future Work

Our future work will include improving mosaic generation by utilizing inherent characteristics such as the number of strokes in each character. Characters used in China and Japan generally have more strokes and lower grey scale values during image processing. Conversely, characters arranged within the same brightness value, such as "一" (one), "二" (two), and "人" (person), can significantly compromise brightness reproduction under the same average reference brightness and equal magnification rates. We plan to achieve a more balanced generation of character mosaics by controlling the magnification of different characters.

Additionally, the connection between character mosaics and digital-based learning technology can be further explored. Enhancing two-dimensional character mosaics by incorporating interactive techniques presents a promising approach for creating more engaging literary experiences. For example, a pseudo-3D representation was developed by adding depth information to present mosaics in three-dimensional spaces and by incorporating changes from the viewer's perspective, such as head tracking. This can effectively capture students' attention. In traditional literature classes such as those focused on ancient poetry, which are often seen as monotonous. Students' interest could be sparked through the dynamic presentation of interactive works generated by our method. As the saying goes, interest is the best teacher. Moreover, providing poster versions of these works can help students form a deeper connection with literary works.

Conflict of Interest

The authors declare no conflicts of interest.

Author Contributions

Conceptualization: Nobuyuki Umezu; Methodology: Yuming Bai; Software: Nobuyuki Umezu and Yuming Bai; Formal Analysis: Nobuyuki Umezu and Yuming Bai; Investigation: Yuming Bai; Resources: Nobuyuki Umezu; Data Curation: Yuming Bai; Writing-Original Draft Preparation: Yuming Bai; Writing-Review and Editing: Nobuyuki Umezu; Supervision: Nobuyuki Umezu; Project Administration: Nobuyuki Umezu. All the authors have read and agreed to the published version of this manuscript.

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