# Creating a White Noise Instrument for Collaborative Improvisation

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## Abstract

This paper introduces *shiki*, a virtual instrument developed for performing *Renga for White Noise*, an interdisciplinary project that transmediates Japanese *renga* poetry principles into a framework for collaborative improvisation with human and AI agents. We discuss two areas: (1) our transmediation of *renga*'s structuring principles into *shiki*'s design (2) the technical aspects behind the AI agent's performance with *shiki*. Through its interdisciplinary and intercultural entanglements with *renga*, transmediation as a method can illuminate new perspectives on the design and performance of NIMEs.

## Keywords

Instrument design, Japanese *renga* poetry, white noise, collaborative improvisation, evolutionary algorithms

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## 1 Introduction

*Renga* is a 14th century genre of Japanese poetry involving poets improvising verses in a call-and-response. It flourished against the cultural backdrop of Zen Buddhism [11, p. 30, 37, 114, 145-151] and was the most sophisticated form of Japanese poetry, practiced until the 20th century [11, p. 61]. *Renga* was a recited performance; the written text is its "fossil" (Figure 1) [8, p. 444]. A verse was recited by a poet, then repeated by the scribe if they judged it worthy of the sequence [8, p. 444, 454]. A *sōshō* (renga master) "acted both as principal musician and as conductor…like a famous guest artist performing with a local ensemble" [8, p. 455]. A session traditionally involved 7-8 poets [8, p. 447], although there are famous cases of solo, duet, and other configurations[11, p. 227, 340, 171].

Contemporary engagements with *renga* diverge from the history of *renga* as a performance. These include novels and short stories by Nobel laureate Kawabata Yasunari [17], English *renga* by amateurs and interdisciplinary researchers [9, 12], and multilingual *renga* in Spanish, English, and French, led by Octavio Paz, another Nobel Laureate [2, 16]. Our project is culturally entangled with these works but differs because it highlights the reality of *renga* as a performance [8, p. 444] and transmediates

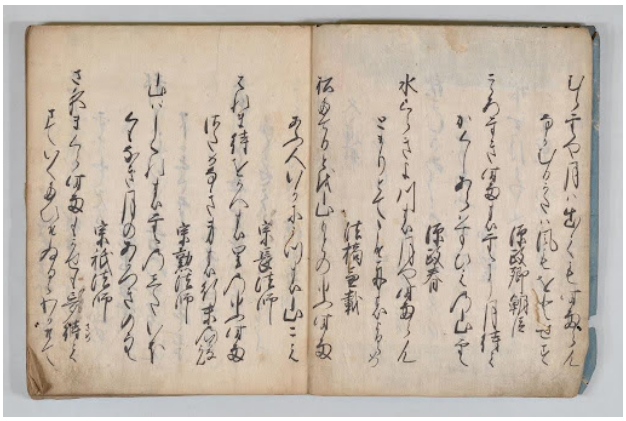

**Figure 1: Page from the *Tsukubashū* (*Tsukuba* Anthology) of *renga* [3]**

*renga* into music. Here, we discuss the duet premiere with 1 human and 1 AI collaborator at CNMAT in October 2024 [1] (Figure 2) which serves as a touchstone as our project evolves from infancy toward maturity in performances beyond the scope of this paper—involving additional human and AI agents, telematic and audio-visual contexts, and refinement of the NIME's sound design with attention to Japanese and French musical aesthetics [5, 7].

**Figure 2: 2024 Duet Premiere of our *renga* project with 1 Human and 1 AI performing with 1 *shiki***

## 2 Transmediation of *Renga* Principles

Using transmediation as our method, as opposed to other methods of fusing live electronics with traditional performing arts [6, 7], *renga* principles were appropriated into *Renga for White Noise* and performed by the human and AI collaborator on one *shiki* in the duet. The *renga* framework is like a board game where players work towards a common goal: with rules for playing,

[1] https://vimeo.com/1021218658?share=copy


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different controllers, single and multiplayer formats, options to play with a computer (the AI), different styles of playing, different orders and lengths as happens in *renga*. Our approach to transmediation is informed by Michael Fowler's, John Cage's, and Kawabata's—respectively, a transmediation of a Zen rock garden into multi-channel installation [4], of another Zen rock garden into Western art music [4], and of *renga* principles into a novel [17].

Using the definition of transmediation as "when a sign system in one media is reappropriated into another" [4], we transmediated *renga* into electroacoustic music across semiotic, signal, and sensory dimensions [13, p. 4-7]. Here, will elucidate our approach to the first two dimensions, then share our plans for the last dimension in our conclusion. In the semiotic dimension, *renga*'s two topics (seasonal or non-seasonal), with one topic for any given verse [11, p. 67] are transmediated into two musical topics and instrument control types (timbre and rhythm). *Renga*'s alternating three and two-line-verses [11, p. 185-188], which structures its call-and-response sequence, are transmediated into 30 and 20-second-long musical phrases. The 5-7-5/7-7 mora count[2] of *renga* verses [11, p. 185-188] is transmediated into *shiki*'s rhythms. Lastly, underpinning all of this is the conceptual framework of *degrees of impressiveness* (1-4) and *degrees of relatedness* (1-4) that *renga* scholars use to analyze sequences [11, p. 72], which is transmediated into two "performance ideals" for the generative system. These two ideals determine: (i) how impressive a phrase can be depending on the stage of the sequence (ii) how closely or distantly the next phrase can link to the current phrase [11, p. 72-74] (iii) the space required between the most impressive imagery/sounds in a verse/phrase [11, p. 65-67]. Relatedness is the link between two adjacent phrases only. Two phrases can be closely or distantly related in topic (timbre or rhythm) and degree of impressiveness.

An impressiveness 1 verse involves evocative imagery and/or emotions (e.g. the word "dream" (*yume*) makes a verse impressiveness 1 and can only be used in "seven-stanza intervals") [11, p. 81]. Impressiveness 4 verses, in contrast, convey something plainly. Varying impressiveness and relatedness is what creates a quality *renga* sequence; it is undesirable to have too many impressiveness 1 verses or too many relatedness 1 links [11, p. 72-73]. Moments of intensity (impressiveness 1 or 2) are enhanced by moments of ordinariness (impressiveness 3 or 4). Likewise, the way that topics continue or change—relatedness 1 or 2 (continuing from timbre to timbre or rhythm to rhythm) or relatedness 3 or 4 (changing from timbre to rhythm or vice versa)—should vary. Sōgi, the pre-eminent *renga* master, was celebrated for his impressiveness 4 verses [11, p. 73, 254-256] and Shinkei, another eminent *renga* master, was renowned for his relatedness 4 links [14, p. 71].

Signal transmediation is between the organic sound from the spoken *renga* verse which influences the upcoming poet's phrase, and the way the AI collaborative agent works with the other performers in *Renga for White Noise*. For our AI collaborative agent, organic movements on the dial turns are turned into digital information that are used to influence the evolutionary algorithm's output in response to the human's call.

[2]In Japanese, moras are the primary unit of rhythm rather than syllables; generally speaking, a short vowel is one mora and a long vowel is two moras.

## 2.1 Creating *shiki*: A White Noise Musical Instrument

*Shiki*'s rhythm and timbre controls are programmed in Max for two white noise oscillators. Rhythm: volume, acceleration, deceleration, phasing, and note lengthening. Timbre: four filter types (low pass, high pass, bandpass, and band-stop), filter sweeping and widening, reverb, LFO, and attack. In the premiere, 11 dial-based timbre and rhythm controls in Max were MIDI-mapped to the 11 dials on the top row of an Ableton Push 2 interface across 5 rhythm dials and 6 timbre dials. 22 buttons were also MIDI-mapped[3] for various controls (e.g. fast/medium/slow rhythms) (Figure 3). *Renga*'s 5-7-5/7-7 mora count is required for *Renga for White Noise*, with each unit starting with an accented note that scales proportionally during a crescendo or decrescendo. All controls can also be customized for diverse works beyond this project. A version of *shiki* for musicians generally is available on GitHub[4], and the version for performing *Renga for White Noise* will become available soon.


**Figure 3: *shiki*'s rhythm and timbre controls MIDI-mapped to Ableton Push**

## 2.2 Generative system for Collaborative Improvisation with AIs in our *Renga* Project

The generative system used with *shiki* was developed around the "two performance ideals" as discussed in Section 2: the framework of *degrees of impressiveness* and *degrees of relatedness* transmediated from *renga*. Each ideal was assigned a level from 1 to 4 based on this framework used by *renga* scholars in their analysis of sequences [11, p. 72].

The evolutionary algorithm works on *shiki*'s dials, not buttons. Dials facilitate gestural data for the generative algorithm system; during a phrase, the dial's positions are sampled at 24 frames per second and stored as a set of vectors. A dial turn

[3]The version of *shiki* on GitHub for musicians generally has 13 buttons MIDI-mapped, excluding the nine blue rhythm controls in Figure 3.
[4]https://github.com/ahar4301/Shiki

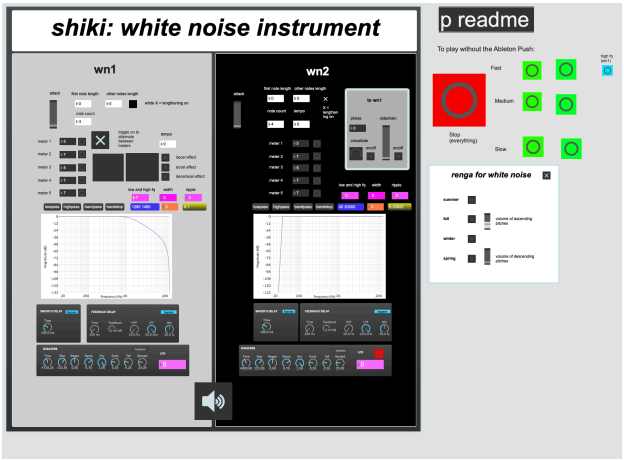


**Figure 4: Presentation Mode for *shiki* in Max**

is considered a vector by the direction (how far left or right it moves) and the number of frames (how long) the movement took. These vectors are considered a set of genes. Each set of genes is identifiable by the number of different dials used, the number of changes in direction, and the minimum and maximum ranges they turned. An example of a gene set for one phrase is shown in Figure 5.

```
[
  {
    "dialNo": 4,
    "vecCount": 2,
    "range": [
      0,
      23
    ],
    "genes": [
      {
        "mag": 237,
        "dir": 0
      },
      {
        "mag": 1263,
        "dir": 23
      }
    ]
  }
  ]
```

**Figure 5: A sample of genes as JSON. The dial remains still for 237 frames, then slowly turns right to the 23 steps. Every dial is ranged 0-127. The total magnitude (frames) is time stretched to accommodate a 20 or 30 second phrase**

Based on the relatedness of the AI's phrase (its "response" to a human's "call" in the premiere), dial turns are grabbed from either of the parents. A high relatedness grabs from the current phrase only; a low relatedness grabs from the memory of all previously performed phrases. The algorithm searches the gene pool and combines them to create a set of genes for its improvisation. After the algorithm has combined a set of genes they

| Phrase Number | Length | Topic | Impressiveness | Relatedness |
|---|---|---|---|---|
| 1 (Human starts improvising on shiki) | 30s | T | 1 | NA |
| 2 (AI responds on same shiki) | 20s | T | 1 or 2 | 1-2 |
| 3 (Human) | 30s | T | 2-4 | 1-2 |
| 4 (AI etc.) | 20s | T | 2-4 | 1-2 |
| 5 | 30s | R | 1-4 | 3-4 |
| 6 | 20s | R | 1-4 | 1-2 |
| 7 | 30s | T or R | 1-4 | 1-4 |
| 8 | 20s | T or R | 1-4 | 1-4 |
| 9 | 30s | T or R | 1-4 | 1-4 |
| 10 | 20s | T or R | 1-4 | 1-4 |
| 11 | 30s | T or R | 1-4 | 1-4 |
| 12 | 20s | T or R | 1-4 | 1-4 |
| 13 | 30s | T or R | 1-4 | 1-4 |
| 14 | 20s | T or R | 1-4 | 1-4 |
| 15 | 30s | T or R | 1-4 | 1-4 |
| 16 | 20s | T or R | 1-4 | 1-4 |
| 17 | 30s | T or R | 1-4 | 1-4 |
| 18 | 20s | T or R | 1-4 | 1-4 |
| 19 | 30s | T or R | 1-4 | 1-4 |
| 20 | 20s | T or R | 1-4 | 1-4 |
| 21 | 30s | T or R | 1-4 | 1-4 |
| 22 | 20s | T or R | 1-4 | 1-4 |
| 23 | 30s | T or R | 1-4 | 1-4 |

**Figure 6: Excerpt of Structure based on *Renga* Transmediation for the Duet Premiere with 1 Human and 1 AI on 1 *shiki***

are time-stretched to fit within the 20 or 30-second-long phrase, mutating the genes.

When the AI needs to generate a phrase, the first stage calculates the upcoming relatedness and impressiveness within the call-and-response sequence. For the 2024 premiere, a plan was made for the first four phrases, then left to an algorithm that gravitated towards an even distribution of impressiveness and relatedness levels (Figure 6. This is another transmediation of *renga*: the first one or two verses must be impressiveness 1, and three of the first four verses are usually seasonal (transmediated as timbre) rather than non-seasonal topics (transmediated as rhythm) [11, p. 73, 184-185, 234-235].

Impressiveness 1 and 2 engage the evolutionary algorithm using an approach inspired by Shiffman [15], as well as GenJam [1]. Firstly, two dials are randomly selected from a predetermined list of pairs (based on our experience of which dials sounded best). Selecting the specific dial turns in impressiveness 1 and 2 phrases was a compositional decision that shaped the sonic experience; we chose these dials to create a compelling musical experience (e.g. the LFO and reverb dials were given specific settings because pairing LFO with long reverb time did not sound good). For impressiveness 3 and 4 phrases, we programmed composed responses: un-impressive phrases with minimal dial movements that sounded good to break up a chain of impressive phrases. Nonetheless, we experienced significant unpredictability in the AI's responses due to it being trained on limited data for the premiere.

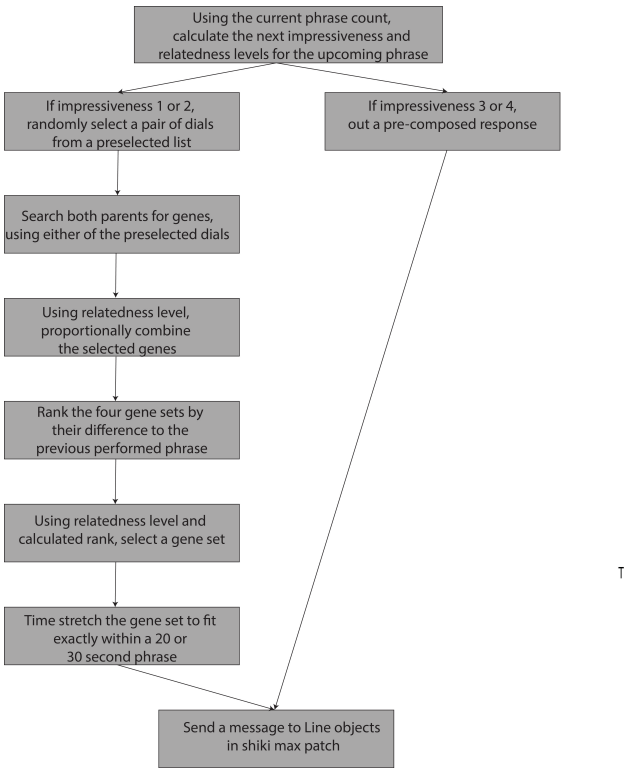


**Figure 7: Flow chart of the generative system in *shiki***

For impressiveness 1 and 2, the process of selecting a pair of dials and combining genes is repeated four times to create different sets of genes. Based on the current relatedness, the gene sets are ranked against the last phrase performed on the same *shiki* by the human improviser. The fitness of a gene set is ranked based on the number of changes in direction and range of dial turns covered as compared to the previous phrase (Figure 5). If the topic is the same for the AI's phrase, the dial chosen is selected using relatedness. Relatedness 1 selects the dial that was moved the most during the last phrase. Relatedness 2 searches for any other dial moved in the last phrase. If only one dial was moved in the current phrase, or if there is a change in topic in the current phrase from the previous phrase, or the relatedness is 3 or 4, the genes are applied to a randomly selected dial. Relatedness 1 selects the child most similar to the human's last phrase, and Relatedness 4 selects the child least similar. A summary of this is shown in Figure 7.

## 3 Conclusion

The creation of *shiki*, the AI, and the framework for collaborative improvisation were intertwined through the transmediation of *renga*. The integration of an AI agent into *renga*'s framework positions new technological inquiries, including the effectiveness of using gestural data in the creation of generative systems. Transmediation as a method, with its interdisciplinary and intercultural entanglements, can illuminate new perspectives on the design and creative practice of NIMEs. Sensory transmediation (aural to visual) [13, p. 5] is part of our plan for this project as it evolves from infancy toward maturity, involving advanced visualizations like our recent multimodal work [10]. Our work shows how transmediation can be used as a creative resource in the design of NIMEs, forming entanglements with highly specialized compositional frameworks and collaborative AI agents.

## 4 Statement of Ethics

This research adheres to the ethical guidelines established by the NIME community. The only human participants involved were the two authors, and the AI model was trained on ethically sourced, non-sensitive data.

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