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Extraction of Choreography for Service robots from a Ningyo Joruri's Acting script by the Associative model

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Abstract

What we should do with service robots to attract people's attention and communicate more smoothly? We are proceeding with the robot OSONO project, which is referring to Japanese Joruri puppets, with the theme of utilizing expressions that incorporate the "Performing arts and technology" that has been passed down through the ages. In this paper, we propose the associative model that clarifies the correspondence between Ningyo Joruri's acting script of the performance, and the choreography, and its meaning. And using this method, we discover a number of choreographies that can be used for service robots from the performance record video. Then we will prototype robot OSONO2 and implement this choreography on it so that we confirm that it is possible to express typical poses and typical choreography comfortably by mainly static evaluation. As a result, a series of flows for extracting the choreography for service robots from the acting script / acting video will be established.

Keywords: Service Robot, Choreography, Joruri Puppets, Acting script, Associative model

1 Introduction

What we should do with service robots to attract people and communicate more smoothly? We are proceeding with the robot OSONO project with reference to Ningyo Joruri, Japanese traditional puppets performance, with the theme of utilizing expressions that incorporate the performing arts and technology that has been passed down through the ages. In this paper, we focus on the meaning of the choreography throughout one program and its implementation on robots. Traditionally, the performance is based on a script called Yukahon (Tsurusawa, 2017), which is the script (plain text) and

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interpretations and instructions for a narrator, called “tayu”, and shamisen player are added to it. However, there is no instruction for the puppeteer. That is, it is unclear and no hints on its choreography. In this paper, Chapter 2 introduces the current status of the OSONO project, and Chapter 3 clarifies the correspondence between the acting text, the choreography, and the meaning, by using the associative model concept. In addition, from the recorded video of the performance, based on this method, we will unearth enough non-standardized choreography (referred to here as "small gestures") that can be used for service robots and can be used in modern situations.

In Chapter 4, we will prototype a robot OSONO2 with 5 DOF (degree of freedom) for each hand and arm, and in Chapter 5, we will implement the small gestures and confirm that it is possible to express typical poses and extracted typical choreography comfortably by mainly static evaluation, and considering to proceed the dynamic evaluation. As a result, we achieve that a series of flows for extracting the choreography for service robots from the acting script / the recorded video of the performance has been established.

2 OSONO project

We have independently developed a design method for "Kashira"(head) with reference to Ningyo Joruri (Narita, An Essay on the Physical Properties of Signage Robots, 2017), and are developing a robot OSONO with physicality (Narita & Nakagawa, Physical Properties and choreography of Service Robot with reference to Joruri Puppets, 2019). We have implemented gesture to waving and greeting on OSONO and are exhibiting at international robot exhibitions. In 2019, we implemented the beginning of the famous scene "OSONO no KUDOKI " with a small number of actuators. This OSONO and choreography are highly evaluated as "attractive" through a questionnaire to a group of puppeteers and ordinary people (Narita & Nakagawa, Development of OSONO, a service robot with reference



Figure 1: OSONO in “robot showcase” online hosted by the Ministry of Education, Culture, Sports, Science and Technology

to“Joruri puppet”, and its Choreography, 2020) (Narita & Nakagawa, Evaluations of service robots referring to Joruri puppets, and a remote evaluations system, 2021). Compared to the research on the mechanism with the motif of Bunraku dolls (Nakagawa, 2013), the feature of this research is that it targets a comprehensive system of doll design, kimono(clothes), and the choreography. On the other hand, since the beginning of 2020, it has become difficult to carry out conventional face-to-face evaluation due to the pandemic of COVID-19, and as a solution, we have proposed and developed a remote acting system using transferring video data in real time and control OSOONO using RSNP (Robot Service Network Protocol). and we are conducting demonstration experiments. In 2021, we exhibited at “robot showcase” online, synchronizing TOKYO Olympic Games, hosted by the Ministry of Education, Culture, Sports, Science and Technology of JAPAN Government (Figure 1) (Narita, Nakagawa, Izui, & Matsuhira, 2021).

3 Systematization of the choreography by an associative model

In order for a robot designer to consider the choreography of a robot, it is required a choreography guideline, and a system that helps understand the meaning of each choreography, and providing various choreography. Since the guideline has already been proposed by us as "Ningyo-Joruri's gesture generation model" (Narita & Nakagawa, Physical properties of service robots which is referring to Joruri puppets, 2019), this chapter describes the methodology of systematizing choreography using an associative model and extraction choreography for service robot from an actual performance.

3.1 Ningyo Joruri's Form/Choreography with a Small Discovery

Based on the acting script and directing information, the choreography and basic movements such as "walking", "standing", and "sitting" are added to the acting. The choreography consists of classical forms which are traditional patterns of playing techniques, and unnamed forms (we call them "small gestures") or a combination of these. In classical forms, there are for male and female, and it is said that there are dozens of them, including the famous "Kurizu" and "Ushiro-buri" (Takeda, Koizumi, Arimichi,

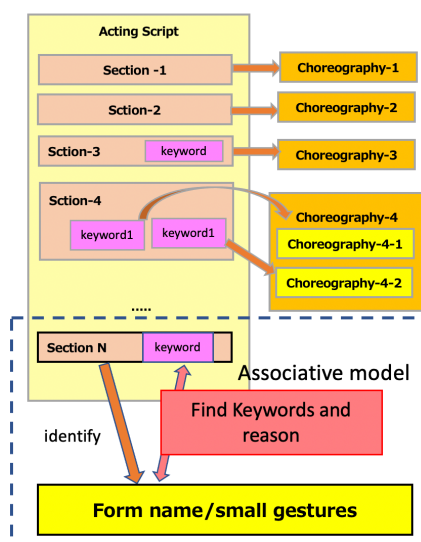


Figure 2: Proposed method for extracting the choreography by an associative model

Sato, & Ohyatsu, 2016). Sometimes small gestures are combined to create a new form suitable for the scene, according to a director of new programs (Ohyatsu, 2021), and an acting script is divided into

Table 1: Associative model on “OSONO no KUDOKI (OSONO says)”

No.	Text in each section and associate key words (in bold) [Japanese and English translation]	Reason on Choreography selection	Choreography (# marked is classical form)
1	今頃は半七様どこにどうしてござらうぞ。Hanshichi-san, where are you and what are you doing, now?	Look for, Worry	#Kurizu (Rotate the head deeply), Look around, Look far away
2	今更返らぬことながら, I can't get it back now,	move	(moving the position)
3	私といふ者ないならば, If I were not here,	I, Self	#Uchi-mi (Point to the chest)
		Deny	Shake hand in front of the face
4	舅御様もお通に免じ, I asking for my father-in-law,	Pointing, Request	To stage right, Bowing
5	子までなしたる, Having a child,	Dimly	“Nagashi” (Walk vaguely)
6	三勝殿を,Sankatu-dono(name)	Point	Point to the stage right
7	とくにも呼び入れさしやんしたら, If you call in her early.	Call in	# Maneki (Call in)
8	半七様の身持ちも直り, Hanshichi's behavior is improved	Embarrassed	Right sleeves toward mouth, Lean the body
9	御勘当もあるまいに, Disownment will be forgiven	Request	Bowing
10	思へば／＼, Remember	I, Think	#Aburaya (Put the left hand up and the right hand gently on the left elbow. After spending time, spread both sleeves, rotate the head deeply and cover with both sleeves)
11	去年の秋の煩ひに, In the disease of last autumn,	Disease	Raise the palms up, praying, and fall down to the left, and up again and to the right
12	いつそ死んでしまったら, If I could be dead	Battle	#Kata-uchi (Put the left hand forward and rub the left arm twice with the right hand to hit it once. Next, do the same operation in the opposite direction)
13	かうした難儀は, such hardship	Heart-ache	Heart-to-heart
14	出来まいも, would not have occurred	Regret	#Yoshida naki (Crying violently)
15	お気に入らぬと知りながら, Knowing that you don't like me	Deny	Shak hand in front of the face
16	未練な私が輪廻ゆる。Because I can't give up,	I, Self	Sode awase (Match sleeves)
		worry	# Kurizu (Rotate the head deeply)
17	添ひ臥しは叶はずとも, even if not allowed to sleep aside	My wish	“Soto-mi” (Perform "Sugata" while sitting)
18	お傍にゐたいと辛抱して, I've put up with because I want to be with you.	Request	Bowing
		(move)	(moving the position)
		(prepare)	(prepare)
19	これまであなたのお身の仇, It's very hard because I've been doing that so far.	Sad	#Ushiro-buri (see above)
20	今の思ひにくらぶれば, Comparing to what I think now,	(return)	(return)
21	一年前にこの圖が死ぬる心がエ、まつかなんだ,	I, Think	Put the right hand in the collar
		Dimly	Nagashi (Walk vaguely)
22	A year ago, I couldn't decide to die	Sad, Regret	# Ushiro-buri (see above)
23	堪へてたべ半七様, 私 やこのやうに思うてゐる, I'm patient. I think like this.	I, Think	#Sugata (Seeing self in the water mirror at the feet)

sections and the above choreography are assigned to each section. Particularly, it is a small discovery that one choreography assigned to one keyword in the session. Particularly, it is a small discovery that one specific keyword in the session is mapped one choreography. Also, there is the case where two or more choreography is assigned to the session, the we will find multiple keywords where each of keyword is mapped to each choreography.

3.2 Associative model and Extraction of the Choreography

With reference to previous research in 3.1, we propose a method for extracting the choreography from an acting script by an associative model (Narita & Nakagawa, Systematizing the choreography of Ningyo Joruri by an Association Model from the perspective of a Service Robot, 2021).

- (1) As the first step, divide the acting scrip of one act into appropriate sections of about 30 seconds with seven-and-five syllable meter*. Some choreography may extend before and after the division, but priority is given to the division by acting scrip.

*Note: Seven-and-five syllable meter is a popular form of poem in which words of seven syllables and five syllables repeat one after another. This is widely used not only in Japanese poetry also in Ningyo Joruri's acting script.

It should be remarkable here that, as it might be obvious to puppeteers, the entire play of Ningyo Joruri is composed of almost Seven-and-five syllable meter, and actual division result of the acting script is also based on Seven-and-five syllable meter.

- (2) If a famous classical form is used for a divided section, specify the name of the form. If not, identify the small gesture. A small gesture may be associated with the form and/or may consist of multiple small gestures. Actually, the number of small gestures included in one section is 2 or less. If it is a well-known play, performance records (Ohnishi, 1968) are available, and various performance videos can also be available. If there exists an acting script (Hayashi, 2019) created for the inheritance of tradition, the description is very valuable.
- (3) In each session, find the keywords that are associated with the choreography, the interpretations and reasons that lead to the choreography. Ultimately, the correspondence between this keyword and the reason / interpretation and choreography is the Associative model.

Figure 2 shows an overview of the above method.

Table 1 is an Associative model on "OSONO no KUDOKI (OSONO says)" of a performance by Shimonaka-za (Hayashi, 2019), which we created by the above method. The first column is the section number, the second column is the result of dividing the entire text according to (1), a word in bold is the keyword which reminiscent of the choreography. The third column is the interpretation/reason that derives the choreography. The 4th column is description of small gesture, or the name of the form (# marked). For example, in the section 1, the text is "Hanshichi-san, where are you and what are you doing, now?", The choreography in the 4th column is that stretches, looks around and look far away. This is thought to be a choreography associated with the "where and why" in part of the text. In other words, from the words "where and why", the interpretation is "searching" and "worrying". As the result, choreography "stretch and look around" are selected. With this model, if you are a puppeteer, you can easily recall the choreography of this play. Although, there is no instruction to the puppeteer in the script Yukahon, if the puppeteer remembers this associative model, these instructions may not be

necessary. Moreover, using this model has the great advantage of being able to understand why and how the choreography is selected.

3.3 Systematization of Choreography

In 3.2, the choreography is extracted, and the associative model made it possible to understand the meaning of choreography in the act. From the view point of the robot designer, it is indispensable not only this, but also systematization that allows to choose the choreography from the meaning and message you want to express. To do this, take out the interpretation / reason that leads to the association in the third column and the choreography in the fourth column in Table 1, and sort them by the third column. As a result, a choreography systematized table appears (Table 2). To enhance this system table, create an associative model for other programs and merge it to this system table. Comparing the number of classical forms of Ningyo Joruri with the number of classical forms included in one act, it is considered that almost all classical forms can be covered by additional analysis of two or three acts.

3.4 Extract the choreography for service robot

Messages and gestures that are likely to be used by service robots that come into contact with visitors are listed as follows: welcome, call-in / alert, point / guidance, gratitude, consent / nod, decline / denial, apology, embarrassment / surprise, request, and soothing customers, holding hands, giving a signal / look, bowing (Narita & Nakagawa, An Implementation and a collection/systematization of the choreography for service robots -Knowledge obtained with reference to Joruri Puppet-, 2020). On the other hand, according to Tables 1 and 2, in "OSONO no KUDOKI", 11 of these gestures are included, although, welcome, soothing customers, consent / nod are not included, which is considered that these are directly relates to others, because this scene is performed alone. Therefore, almost choreography required by the service robot can be supplied from this performance.

Figure 3 shows a sketch of call-in and point (section number 7 in Table 1) extracted from the performance. The first one is "Ready", the second is "Maneki"(call-in), and the 3rd one is "Pointing". The sketch, we define, is the set of the poses (still images) that are characteristic of the chronological and arranged in time order, to in order to express dynamic gesture as static in a document. As in the form "Maneki"(call-in) form, the gestures to invite and the gestures to point to are repeated twice on the left and right, we treat by each gesture as small gestures.

Table 2 System table of choreographies

Tag to choreographies	Choreographies
I, Self (from a third-party perspective)	"Uchi-mi" (Point to the chest), "Sugata-mi"(see Table 1), "Sode-awase"(Match sleeves), "Soto-mi"(see Table 1)
Deny, No	Shake hand in front of the face, the head violently, both hands and feet
Sad, Heart-ache, Heart-to-heart, Painful	"Kurizu" (Rotate the head deeply)
Embarrassed	Right sleeves toward mouth, Lean the body
Regret, Thinking	Cry with her hands on her knees, or, attached to her sleeves,
Request	Bowing with pointing to the other party or its direction
Dimly	"Nagashi" (Walk vaguely)
Disease, Suffering	Praying, fall down
Call in	Call in



Figure 3: Sketch of “call-in and point” from OSONO no KUDOKI by the performance of Shimonaka-za (Hayashi, 2019)

As the same way, collecting sketches for the small gesture corresponding to the section number in Table 1 and classifying the similar poses into one class, we get the typical poses for small gestures of "OSONO no KUDOKI" as Figure 4. The number “X-Y” in each pose of Figure 4 is the pose number. X is the section number in Table 1, Y is the sequence number in the same section. In fact, we got 53 poses and 15 classes in total.

Regarding the extraction, in the past case, we used Open Pose, but this case, a person extracted the pose using a hand-made pose editor. The reason is that analyzing one act of Ningyo Joruri by Open Pose, it recognizes not only one puppet but also three puppeteers, and it becomes necessary to remove the movements of these puppeteers in the post-processing, and it takes too a very long time.



Figure 4: Typical poses of small gestures that characterize "OSONO no KUDOKI". The poses were extracted by the method of this paper from the performance of Shimonaka-za (Hayashi, 2019).

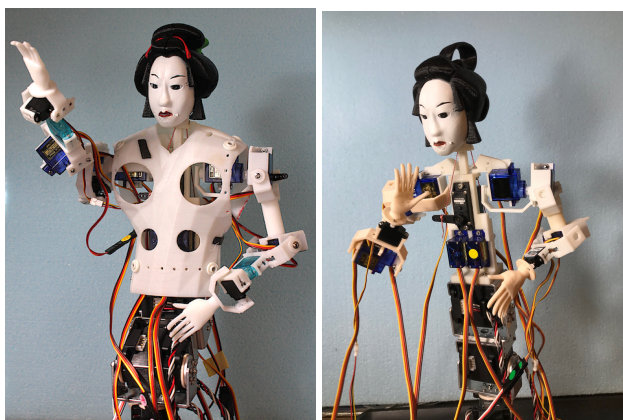


Figure 5: 1/4 model robot OSONO2. (LEFT) OSONO25 with 5 actuators to each arm, and OSONO24 with 4 actuators to each arm (RIGHT)

4 Robot implementation

In this chapter, we will examine the physical robot required to implement the extracted and systematized small gestures, and implement them as OSONO2 robot.

4.1 Arm and shoulder movements

The OSONO choreography introduced at the beginning of this paper is a scene hung by a lantern. Her hands are tied to the lantern, and there are no actuators on the arm and shoulder joints, and they hang with a thread and move freely as the torso moves. However, in order to implement multiple scenes and various choreography, it is necessary to have many controllable joints, and it is also important that the range of motion of the joints is large.

On the other hand, from a design point of view, it should be avoided that the design is sacrificed by the number, size, and joint drive method of the actuators. We developed OSONO2 (Figure 5) by expanding "Joruri Robo", which is the 1/4 model (1/4 the size of a human being, the height to the waist is about 23 cm) with 3 joints and 2 actuators on an arm. In order to expand the range of motion of the joints, we try to drive the three joints directly with three servomotors. The robot, referencing Joruri puppet, wears a loose "kimono" (Japanese clothes), so even if actuators are equipped on her arms, there is a limit, but the design unnaturalness is reduced. In addition, when the hands and arms become heavier, the moment of the arms increases and a hunting phenomenon, which causes unexpected vibration, occurs, so OSONO2 adopts 2g, 4g, and 9g ultra-small servomotors to avoid them. On the other hand, the arm of the Joruri puppet does not have a special mechanism described here because the puppeteer directly holds the forearm part and move it.

4.2 Wrist movements

Wrist movements include rotation and bending (extension, flexion). Suppose that we turn our palm up to invite in one scene, but in the next scene we are pointing something, we need to rotate our wrist. Bending of the hand is used to emphasize the intention, to express a symbolic expression such as ordering to stop, to make a decisive pose. In the Joruri puppet, levers are on both arms to express the extension and the flexion of wrist, and these levers are operated by the main puppeteer and the left

puppeteer. In other cases, bending the wrist is sometimes used to turn the hand greatly inward, such as putting the hand together or putting the hand on the chest. Wrist bending is extremely important from the perspective of expression, says the puppeteer. However, due to the bending of the wrist, the number of actuators increases and the moment of the arm becomes larger, which will make the design unnatural and has a disadvantage in mounting. In OSONO2, it is decided to implement the rotation of the wrist and evaluate the effect of the implementation for the hand bending.

4.3 Knee movement

Techniques for improving the appearance of the choreography by expressing large movements such as standing, “seiza” sitting, half-sitting, and bowing are widely used. Thus, in OSONO2, an actuator that assumes bending of the knee has been added to the rotation of the waist position and the back and forth movement. Since the weight of the entire fuselage is applied to this part, a high-power servo motor is used.

4.4 Kimono (Japanese clothes),

This prototyped Kimono is made of the left and right sleeves and kimono (top), kimono (bottom), and obi(belt) separately, and attached to the torso housing of OSONO2 with hooks and tape. Since servos are attached to the arm, the sleeves cannot be sewn, and the cuffs and sleeves are hooked after wearing. Since servo motors are on the shoulders and arms, the shoulders are wide and the sleeves are a little bit large, but the finish is less uncomfortable.

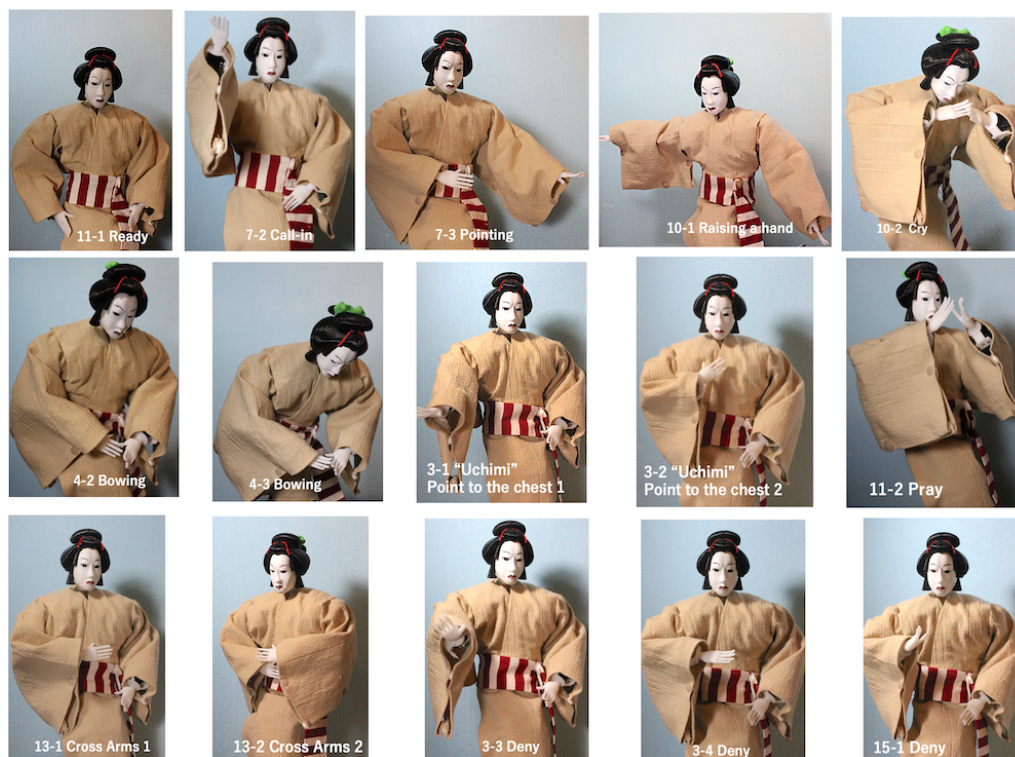


Figure 6: Typical poses of small gestures in "OSONO no KUDOKI" expressed by the robot OSONO25

Table 3 Evaluation on the poses

Pose number	OSONO24 case	OSONO25 case	Explanation of the pose, comments
11-1	A	A	A pose of seiza sitting. By rotating the wrist. No unnaturalness.
7-2	A	A	A pose of invitation. As changing the palm direction. No unnaturalness.
7-3	A	A	Point to the left outside with both hands.
10-1	A	A	To put both hands together, put one hand at a time.
10-2	B	A	A pose to cry with both hands together. The orientation of both hands is a little unnatural in OSONO24.
4-2	A	A	A pose to align both hands to start bowing. No unnaturalness.
4-3	B	A	A pose in which the head and torso are tilted deeply by bowing. A little unnatural because the hand angle cannot be controlled only by rotating the wrist in OSONO24.
3-1	A	A	A pose to prepare for a gesture "Uchimi" (pointing myself). No problem.
3-2	C	A	A pose to pointing toward the chest(myself) in "Uchimi". Difficult to point the palm to the chest.
11-2	B	A	A pose to pray with both hands together. Hard to put both hands together enough in OSONO24 case
13-1	B	A	A pose to move the right hand to start crossing arms. It is hard to bend the arm toward the body side in OSONO24 case
13-2	C	B	A pose with arms crossed. Unable to cross arms enough. In OSONO24/OSONO25 cases
3-3	A	A	A pose with the hands facing outward as a negative gesture
3-4	A	A	A pose with the hands facing inward as a negative gesture
15-1	C	A	A pose with the hands facing outward as a negative gesture. A pose that emphasizes movement particularly by turning the hand away.

4.5 Summary

OSONO2 has 16 manipulators in total. They are for the front and back of the neck, blinking, opening and closing of the mouth, rotation and bending of the hands for both hands and arms, rotation for the waist and knees, and the front and back of the torso. Arduino MEGA, which supports many IO pins and larger memory capacity, is used to control actuators.

5 Tentative Evaluation of Poses and Choreography

In this chapter, to proceed OSONO project further, we will evaluate tentatively how far the choreography can be expressed when the choreography through whole of one act is implemented in a robot. There are two aspects to the evaluation, one is that the robot can statically pose according to the gesture, and the other is that it dynamically moves sufficiently as the choreography and is attractive. Here, we focus on evaluation the pose as the static evaluation, and we will examine whether there is

any discomfort in performance by dynamic evaluation. For the evaluation object is the choreography and poses extracted in chapter 3.

5.1 Pose evaluation

We compare poses expressed by OSONO2 with the typical poses of actual performance in Figure 4. Regarding the robot, we use OSONO2 with 4 actuators for each arm (we call OSONO24) and OSONO2 having 5 actuators for each arm (we call OSONO25). Figure 6 shows typical poses of small gestures in "OSONO no KUDOKI" expressed by the robot OSONO25. And Table 3 is the result of comparison of these poses in Figure 4 with the poses in Figure 6 of OSONO25, and comparison with correspondent poses of OSONO24. The number in each pose is the pose number as the same as Figures 4. If Robot's expression is close to the original, it is evaluated as acceptable "A", otherwise, depending on the degree, evaluated as somewhat difficult to accept "B" or as difficult to accept to accept "C".

The standing posture of 13-1, 13-2, the "seiza" sitting posture of 1-1, and the posture of t half-sitting of 7-1, 7-3 are easy to recognize and effective. Various expressions can be obtained by adding these movements. There is no unnaturalness in the positional relationship between the "obi"(band) and the servo motor.

As the result, we have confirmed that OSONO25 can represent typical small poses with no problem. OSONO24 is not good at moving hands together, putting hands together, or wrapping arms in front of the body. But fortunately, such movements are not used commonly in the choreography used in service robots. As a conclusion, a little awkwardness as a movement remains, but even OSONO24, which is equipped only with wrist rotation, can sufficiently represent the necessary gesture with the service robot. Furthermore, if the problem caused by the arm moment does not happen, OSONO25, which can bend the hand deeply, can well represent almost whole choreography in Ningyo Joruri acting script.

5.2 Dynamic Evaluation

We implemented "call-in and point" gesture described in 3.4 by arranging the 3 poses of sketch in Figure 3 along the original time interval (3.3 seconds/pose ,10 seconds in total), and linearly interpolating the position of each joint. This consists of (1) ready posture, (2) raising the right arm to "invite", and (3) "pointing" to the left with both hands. In "invite", the palm is moved up and down by bending the hand. As a result, it was realized that this gesture is almost natural, but might be seen a little bit simple. On the other hand, with "Kurizu" choreography explained in Chapter 2, the pose is updated about every 2 to 3 seconds, but it does not feel simple. This might be due to the low number of poses per unit time, but it's interesting. Further research is needed in the future.

6 Conclusion

Targeting one act of Ningyo Joruri, we proposed a method of systematizing the choreography and a method of extracting gestures and poses using an associative model. In addition, we extracted gestures and typical poses by these methods from "OSONO no KUDOKI" as an example. Extracting these poses are done by the human instead of AI, because the current pose recognition should not fit for the puppet. Finally, we considered how to implement them on the robot OSONO2 evaluated poses, and considered the implemented gesture. As a result, it was confirmed that OSONO2 having 5 actuators for the arm can represent these poses and gestures almost well. Also, we found Kimono can naturally hide these number of actuators on the arm. However, OSONO2 having 4 actuators for the arm can be used naturally to some extent within the range of choreography required by service robots. Attritinary, this

systematization method suggests an answer to the question why "Yukahon"(acting script) has no instructions for puppeteers. And this method is considered to be very useful for projects to preserve traditional performing arts and to foster successors.

In the future, we will analyze more acts to expand the coverage and enhance the system, and verify that the robot can perform the choreography. And we continue to the Service robots and the robot user interface technology.

7 Acknowledgement

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References

- Akiko, T., Reiko, K., Motoko, A., Ayako, S., & Sanae, O. (2016). *The World of Sagami-Ningyo-Shibai (in Japanese)*. Showa Women's University Koyo Museum.
- Hayashi, M. (2019). *How to use puppets in Sagami Ningyo Shibai shimonaka-za(Demonstration records and handouts)*. Network-based Robot Service Research Committee, The Robotics Society of Japan.
- Nakagawa, S. (2013). *Finding the motion planning method which communicates the robot's emotion to human*. Journal of Osaka University.
- Narita, M. (2017). *An Essay on the Physical Properties of Signage Robots*. Bulletin of Advanced Institute of Industrial Technology.
- Narita, M., & Nakagawa, S. (2019). *Physical Properties and choreography of Service Robot with reference to Joruri Puppets*. Bulletin of Advanced Institute of Industrial Technology.
- Narita, M., & Nakagawa, S. (2019). *Physical properties of service robots which is referring to Joruri puppets*. YOGYA-KARTA: IEEE/IIAI AIT.
- Narita, M., & Nakagawa, S. (2020). *An Implementation and a collection/systematization of the choreography for service robots -Knowledge obtained with reference to Joruri Puppet-*. Bulletin of Advanced Institute of Industrial Technology.
- Narita, M., & Nakagawa, S. (2020). *Development of OSONO, a service robot with reference to "Joruri puppet", and its Choreography*. IJSKM International Journal of Service and Knowledge Management.
- Narita, M., & Nakagawa, S. (2021). *Evaluations of service robots referring to Joruri puppets, and a remote evaluations system*. IEEE/IIAI AIT 2021.
- Narita, M., & Nakagawa, S. (2021). *Systematizing the choreography of Ningyo Joruri by an Association Model from the perspective of a Service Robot*. Journal of the Robotics Society of Japan.
- Narita, M., Nakagawa, S., Izui, T., & Matsuhira, N. (2021). *Evaluations of service robots referring to Joruri puppets, and a remote evaluations system*. IEEE/IIAI AIT 2021.
- Ohnishi, S. (1968). *Arts of Bunraku puppets*. Engeki Shuppansha.
- Ohyatsu, S. (2021). *Ningyo Joruri's From and Choreography - From the case of Sagami puppet show-*. Network-based Robot Service Research Committee, The Robotics Society of Japan.
- Tsurusawa, H. (2017). *Yukahon shu*. <http://hachisuke.my.coocan.jp/yukahon.html>, [online].