Script Language for Embodied Agents as Personal Conversational Media in Online Communities

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ABSTRACT

In this paper, we propose a script language for embodied conversational agents that can function as personal conversational media in asynchronous community systems. One of the problems for the online community systems is that the environment is designed just for information exchange and lacks a social aspect. Against this problem, we developed an asynchronous community system that employs embodied conversational agents (ECAs) as conversational media. ECA is a character on a display that can represent various social expressions on behalf of a user. Therefore, we consider multiple ECAs can represent social and expressive "place" on the display. This "place" created by ECAs induces social psychological relationships between each ECA and users. In this paper, we call such ECAs as *Personified Media* (PM) and propose PMScript, a script language for PM. In media for asynchronous communication, participants in asynchronous community systems often have time to polish a script description for their PM. In addition to the features of ECAs, the social presence of PM can enhance users' community awareness in terms of the human environment. Therefore, conversations using PM should be smooth, expressive, informative, and social. On this assumption, we design a script language named PMScript. Through PMScript, a participant composes utterances via PM. In addition, PMScript is designed to analyze and accumulate social interaction from each utterance.

1. INTRODUCTION

When communicating with others, people represent their thoughts by integrating their full-body modalities such as voice, gesture, pose, gaze, and motion. Additionally, people use not only their own bodies, but also other objects around them such as pictures, books, clocks, landscapes, weather, and even what they have done and what they have talked about. Such body representations, environments, and contexts together establish a conversation "place"; common face-to-face conversations are based on such sense of "place."

This conversation "place" is important even when people interact with their computer systems. In this viewpoint, a major issue of the human-computer interface (HCI) is how to bring a sense of cognitive and social "place" among users and systems. Embodied conversational agents (ECAs) [2] are one of the most probable solutions. By employing one or more ECAs in an information system, a user of the system will recognize this sense of "place" between the user and ECA(s), and the user will be able to interact with his/her ECA(s) by using the contexts of the "place" to make good use of the system's functions.

There has been much research on ECAs in term of the user interface of their interactive systems. Some reports have argued for the validity of using the agents not only for information efficiency, but also for social interaction; e.g., agents in a social context induce a user's social behavior according to the context [6]. Here, it is important that not only users, but also agents can make good use of the contexts of the "place" to enhance their communication. For example, by means of full-body emotive expression and deictic representations in the "place" context, an embodied tutor agent COSMO [7] could enhance the users' learning effect.

We are interested in this kind of "place" represented by ECAs. However, we do not use ECAs as autonomous interface agents. We use them as personal conversational media in asynchronous online community systems (not in synchronous community systems like *avatars* in virtual worlds). In this paper, we use the term *Personified Media*, or PM, for such ECAs functioning as personal conversational media in community systems. By means of multiple PM, community systems can form into a social conversational "place," and participants can make both social and informative representations in the "place" context via their own PM.

Here, we focus on a script language for PM. To make good use of PM, we must know the attributes of PM representation. Through designing a script language for PM, we disclose the possibility of PM in this paper.
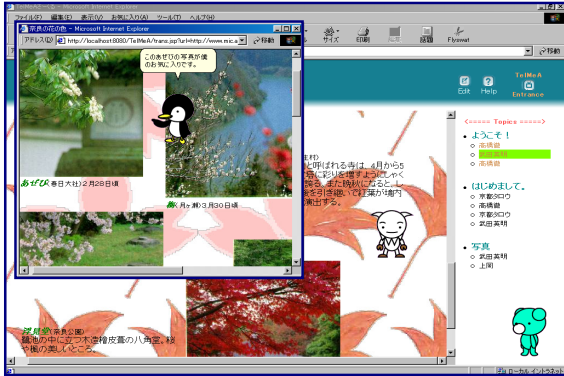
Figure 1. Three PM and multimedia "place" in TelMeA

2. RELATED WORKS

There are many languages for software agent systems. However, there are few languages for PM itself because most systems employ PM for real-time communication. PM for real-time communication are called avatars [5]. Users of avatars encounter each other and communicate in the avatars' virtual worlds, but their central communication channel is a simple text chat, or chat with quite simple behaviors like greeting gestures and facial emotions. Because users of avatars have little time to compose their representation, they cannot afford to use various physical modalities in real-time communication.

From the viewpoint of physical rich expression via PM, the machinery-choreographing technology in BodyChat [4] and BEAT [3] are interesting. These technologies add natural and social behaviors to PM automatically when a user inputs text sentences. BEAT has an action form described in XML, and it is possible to change its behavior patterns by modifying the action form. By means of such systems, users of avatars can engage in real-time chatting with multimodal behaviors. This action form helps the unconscious social behaviors of PM. However, many human behaviors are performed consciously in face-to-face conversation. Our script language is not only for representation, but also for analysis. We aim at a conscious, informative, and social "place" on the net, where we can analyze social communication, knowledge in conversations, and intentions of users from logs of embodied communities.

In addition to avatar systems, there are some mailer systems that employ PM (e.g., [13]). Users of such mailer systems compose writings that include marks for bodily behaviors and exchange utterances using their PM instead of text mail. Because mailer systems are asynchronous communication systems, users have time to consider the behaviors of PM. In such mailer systems, a receiver of an utterance may recognize a "place" between him or her and the PM, but there is no shared "place" between the sender and the receiver. There are instead two different "places," such as the "place" between the sender's media and the receiver and the "place" between the sender and the receiver's media.

An online community with PM forms a "place" between multiple PM and each user, and each "place" of each user overlaps with the PM. Therefore, users can share one "place" indirectly on the online community system. As a result, users can communicate while making good use of the context of the shared "place" on the online community system. The purpose of this research is to design a script language that describes utterances via PM. For this script language, we need to make the best use of this shared "place" context.

3. EXAMPLE OF AN EMBODIED COMMUNITY

In this Section, we construct an image of an online community system that has the shared "place" via multiple PM through an explanation of our implemented system, named TelMeA [11].

3.1 Description of TelMeA

We designed TelMeA as a web application system. The server-side system of TelMeA is built in Java and the client-side system embedded in the web pages of TelMeA is built in JavaScript.

Anyone can visit the web site of TelMeA via his/her common web browser and can participate in several TelMeA communities by registering his/her ID and personal PM from the web page.

Figure 1 shows a screenshot of a TelMeA community. This image includes three PM on two web pages. The bigger page is the main web page of TelMeA. This page consists of three frames: a control frame, a conversation list frame, and a central frame. Users can control actions by their PM on the control frame and select the conversations they want to see on the conversation list frame. The central frame shows a web page of the community. Conversations via their PM are mainly made on this shared web page. Additionally, participants can open new browser windows and refer to web contents on web pages through their utterances. Therefore, the TelMeA's shared "place" of a conversation consists of the following media: PM; main web page; and other web pages referred to during the conversation.

3.2 Editing Utterances in ALAScript

When a participant clicks a title of conversation from the conversation list frame, all PM participating in the conversation appear. Then, the first of the PM starts to utter. On TelMeA, all utterances are written in a unique script language named ALAScript.

On TelMeA, we imclude Microsoft Agent [1, 8] as PM. Behaviors of Microsoft Agent are described via script code in JavaScript, but participants of TelMeA communities never compose utterances in Microsoft Agent's specific way. Instead, TelMeA prepares ALAScript and an editor of this script language. The client-side system of TelMeA includes an interpreter of ALAScript; this component interprets an ALAScript description into Microsoft Agent's specific grammar and a described character acts in accordance with the description.

Figure 2 shows an instance of ALAScript. With tagged annotation on the head, each line describes a uni-modal sentence of utterance. In this instance, a "penguin" PM approaches a "bear" PM and says "I found such a web page" with smiling animation. The "penguin" PM opens a web page located at "http://www.mis.atr.co.jp," refers to a picture on the page, and says, "This picture is nice, isn't it?" Thus, an utterance is composed by putting together various representations. PM of TelMeA can represent verbal representations with synthesized

```
<#actor> penguin
<#approach> bear
<#play> Smile
<#speak> I found such a web page.
<#open> http://www.mis.atr.co.jp
<#refer> img3@http://www.mis.atr.co.jp
<#speak> This picture is nice, isn't it?
```

Figure 2. Instance of ALAScript description

voice and text balloons, and physical representations with associated animations. PM can open a web page as well as move on a display to the location of other PM or an image on opened web page.

After a participant writes up an ALAScript description and confirms it, she/he submits this description to the server-side system. The system registers the submitted description as part of the dialogue on a database, and the description becomes available to other participants. In this way, participants communicate asynchronously on TelMeA, but share the context of the "place" that the participants' PM represented.

4. ATTRIBUTES OF EMBODIED CONVERSATIONAL MEDIA

To represent themselves, and to interact socially with a "place," participants of a PM mediated online community system continue to exchange a description for their PM. A sequence of such descriptions makes a conversation and develops their "place" on the community system. In this Section, we give the attributes of PM in the "place" and clarify guidelines of the script language specification for PM.

4.1 Bodily Multimodal Representation

People in the real world represent themselves by their bodily modalities such as voice, gesture, facial expression, pose, gaze, and finger pointing. With recent technology, PM can also have several verbal and nonverbal bodily modalities as functions. For example, PM can display text sentences with balloons and speak the sentence by synchronously using a text-to-speech technology with the balloon sentences. By means of CG animation or 3D modeling technology, PM can make gestures, facial expressions, poses, gazes, and finger pointing naturally.

4.2 Representation with Multimedia "Places"

The community environment can play/display multimedia content such as images, figures, movies, audio, applications, and their combinations like web pages. PM can introduce multimedia content into the multimedia environment and refer to them by finger pointing or by gaze. During a conversation, multiple PM move around in such an environment to encounter each other or to refer to their multimedia contents by turn.

These interactions among PM and multimedia contents form a "place" for conversation, where the directions of each PM and
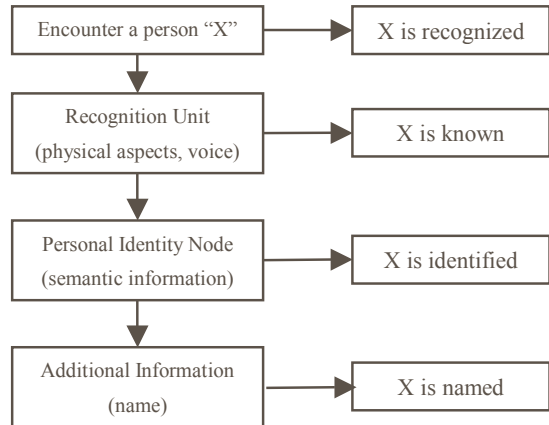

Figure 3. Model of the process for recognizing and naming a person

distances between PM have meanings as in face-to-face conversations. The "place" grows through the conversation.

4.3 Social Presence

The term social presence provides a logical explanation of the image of a "place" between PM and their users. Reeves & Nass [9] demonstrated that the interaction between humans and computers is social and is similarly formed as the one between humans. Takeuchi & Katagiri [12] suggested that it is possible for system designers to affect users' behaviors by inducing human interpersonal reactions. Moreover, we suggested that it is also possible for system designers to make good use of social relationships between users and their personal agents of a system and protect the system from users' unsocial/unexpected behaviors [10]. In each case, the personification of interface agents is an essential factor in enhancing interpersonal reactions.

Therefore, PM are not media that simply express their users. PM also enhance social relationships between PM and participants in online community systems. The above research suggests the possibility of designing an online community system where each participant has a strong relationship with his/her own PM and forms social relationships with other participants via their PM.

Whether a participant of the system is aware of the existence of other participants behind other PM or not, the social presences of PM have an effect on the context of their conversation; PM reduce the chance of offhand unsocial reactions turning into unintended wasteful "flaming" arguments, and each participant may behave socially in the "place" as a natural consequence.

4.4 Basis of Community Awareness

Because of the social presences and unique aspects of PM, participants of the community system can be easily identified by each other. Figure 3 is a model of the process for recognizing and naming a person, which was studied by Young et al. [14]. The important point of the model is that the process is strictly sequential: a person cannot access information related to other people unless familiar aspects can be found, and she or he does not access additional information on them, such as names, unless

she or he can access their semantic information, such as their biographies, interests, personalities, episodes, and so on.

This model says that the physical aspect is important for identifying people. By applying this model to text-based asynchronous conversations like Newsgroups or BBS (Bulletin Board System), users cannot get enough information to identify people because the participants' names and texts are provided without their physical aspects. Suppose a newcomer to the community cannot get to know other participants well. The newcomer might be able to understand each contribution's message, but would probably encounter difficulty in identifying a participant as the contributor of previous messages. This difficulty prevents participants, especially newcomers, from recognizing other participant's personalities and relationships in the group, the meta-structures in conversations, and, as a result, hinders the participation of newcomers in ongoing conversations. (Detailed experimental results are written in [11].)

Conversely, if messages are provided with physical aspects like PM, visitors can identify and recognize other participants more naturally. Therefore, participants can understand utterances of others when provided with a background to each human environment of online communities. As a result, participants, especially newcomers, feel free to join a conversation and the conversation develops more smoothly.

4.5 Summary of Attributes of PM

Users of PM can represent bodily multimodal representations, including verbal and nonverbal physical representation. Moreover, the multimedia and multiple PM environment of PMake shared "places" among participants. The PM of participants can represent the context of the shared "place". As a result, the representations nurture the conversation and the context of the "place".

Personified aspects of PM enhance the social nature of interrelationships between humans and PM. In turn, the social relationships between participants and their PM enhance the social behavior of the participants and reduce their unsocial reactions in the "place". Moreover, social behaviors of personified PM enhance the social presence of PM. The social presence leads to the community's awareness of human environments and enhances smooth communication in the "place".

5. PROPOSAL FOR A NEW SCRIPT LANGUAGE FOR PM

5.1 Requirements for Script Languages for PM

Most script languages used to describe the behaviors of interface agents are designed to control the functions of a whole agent comprehensively. That is, they are languages for developers of agent systems. On the other hand, script languages for PM are languages for users. From the viewpoint of users, these languages for PM should be designed so that users can describe as many various social and informative representations as possible. Additionally, it is desirable that script languages for PM be designed to describe the entire context of the representations in order to analyze each utterance and conversation. Consequently, specifications of script languages for PM must not only allow users to represent all of the representations mentioned in the

previous section using these languages, but also all the representations of these languages to be analyzed from the viewpoint mentioned in the previous section.

5.2 Evaluation of ALAScript

From the above viewpoint, we evaluate ALAScript, a script language for TelMeA (see Section 3.).

5.2.1 Identifier and Social Presence

ALAScript has several kinds of tag annotations. The <#actor> tag is the identifier for PM. Because each PM of TelMeA has a unique personified aspect, PM enhance community awareness of the human environment. However, all PM participate in a displayed conversation from the beginning until the end. Therefore, the presence of each PM simply means participation in a conversation, not participation in the current situation. In other words, participants of PM cannot use the presence of PM in terms of indicating their intentions. Instead, the presence may be confused with the context of the "place".

5.2.2 Bodily Multimodal Representation

The <#speak> and <#think> tags indicate verbal representation, that is, the text sentence of a speech balloon with/without synthesized voice. The <#play> tag means physical representation with animation such as gesture, facial expression, face movement, and finger pointing. These tags express bodily multimodal expressions efficiently. However, there may be different meanings in a single animated behavior for several contexts, causing the intention of the utterance to be ambiguous for analysis.

5.2.3 Context of the "Place"

The <#open> tag means opening a designated web content designated by a URL. The <#move>, <#approach>, and <#refer> tags mean the movement of PM to a designated point, to other PM, and to web content, respectively. These tags use and increase the contexts in the "place." At the same time, these tags enhance the sense of shared "place" among the participants.

5.2.4 Summary of ALAScript

ALAScript can represent various expressions including social presence and the sense of "place" with a small number of tag annotations. Except for representation of social existence, ALAScript has adequate ability to describe the utterances in a PM mediated community system. From the viewpoint of dialogue analysis, however, descriptions in ALAScript are in regards to user intention.

5.3 Proposal of PMScript

For the purpose of informative and social representation for PM, as well as for PM's analytical capability, we designed a new script language named PMScript. In this script, as for ALAScript, one PMScript description represents one utterance.

Figure 4 shows the structure tree of PMScript. As the figure shows, the content of PMScript consists of two elements, i.e., CAST element and SCRIPT element.
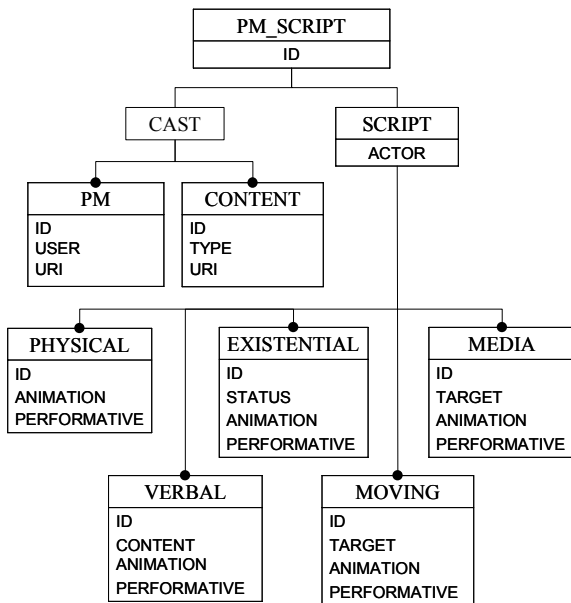
4

```
            ┌─────────────────┐
            │   PM_SCRIPT     │
            ├─────────────────┤
            │       ID        │
            └─────────────────┘
         ┌──────────┬──────────┐
    ┌─────────┐          ┌─────────────┐
    │  CAST   │          │   SCRIPT    │
    └─────────┘          ├─────────────┤
                         │   ACTOR     │
                         └─────────────┘
    ┌─────────┬──────────────┐
┌─────────┐      ┌─────────────┐
│   PM    │      │  CONTENT    │
├─────────┤      ├─────────────┤
│  ID     │      │  ID         │
│  USER   │      │  TYPE       │
│  URI    │      │  URI        │
└─────────┘      └─────────────┘
```

Figure 4. Structure tree of PMScript

5.3.1 CAST element

The CAST element presents a list of PM and multimedia contents that are involved in the Script element. PM of the list are presented in the PM element and multimedia contents of the list are presented in the CONTENT elements.

The CAST element has only one attribute, that is, the ID attribute. The ID attribute is an identifier of elements. Most elements in PMScript have this attribute, and it simply shows the identifier, so we will omit the explanation of the ID attribute hereafter.

5.3.2 PM element and CONTENT element

The PM element presents PM of a participant in this script, and the CONTENT element presents multimodal content as well. The PM element and CONTENT element each have three attributes: ID, USER, and URI attributes for the PM element, and ID, TYPE, and URI attributes for the CONTENT element. The USER attribute of the PM element presents the user of the PM. The TYPE element of the CONTENT element presents the MIME content type of this content. The URI attribute of both elements presents the URI (Uniform Resource Identifier) of this PM/content.

5.3.3 SCRIPT Element

The SCRIPT element has only one attribute, The ACTOR attribute. The utterer PM of the script is designated by this ACTOR attribute in the SCRIPT element. The SCRIPT element presents the context of the utterance as a combination of its sub-elements, i.e., VERBAL, PHYSICAL, MOVING, EXISTENTIAL, and MEDIA elements. Each element has ID attribute respectively and a system use values of the ID attributes when the system processes PMScript We explain details of each elements below.

5.3.4 PHYSICAL Element

The PHYSICAL element presents a representation of a physical modality by animation, such as gestures, facial expressions, and poses. The PHYSICAL element has two attributes other than ID attribute, i.e., ANIMATION and PERFORMATIVE. The ANIMATION attribute indicates the entity of the animation, which shows a sequence of physical movement of PM. On the other hand, the PERFORMATIVE attribute presents the user's intention what the user intend to carry by performing this physical representation. For instance, when a "smile" animation is selected in a utterance, the PERFORMATIVE attribute indicates this "smile" animation means whether the intention of acceptation or sarcasm.

5.3.5 VERBAL Element

The VERBAL element presents linguistic representation such as balloon text and synthesized voice via PM. The VERBAL element has three attributes other than ID attribute, i.e., CONTENT, ANIMATION, and PERFORMATIVE. The CONTENT attribute presents the linguistic sentences for this representation, and the ANIMATION attribute presents physical representation incidental on this verbal representation such as lip-movement when PM utters. The ANIMATION attribute also indicates the type of verbal representation, just like a distinction of <#speech> and <#thought> in ALAScript. For example, the terms of "speech," "thought," "whisper," "sing," and "write" may be suitable for the ANIMATION attribute. The PERFORMATIVE attribute presents the user's intention of this verbal representation.

5.3.6 MOVING Element

The MOVING element presents representation through the movement of the PM on the display. The MOVING element has three attributes other than ID attribute, i.e., TARGET, ANIMATION, and PERFORMATIVE. The TARGET attribute presents the move point of the PM, which is designated as an ID attribute of a PM element or a CONTENT element or value indicating coordinates on the display. The ANIMATION attribute presents physical representation incidental on verbal representation such as a representation of steps. The ANIMATION attribute also indicates movement speed. The PERFORMATIVE attribute presents the user's intention of this movement.

5.3.7 EXISTENTIAL Element

The EXISTENTIAL element presents changing a state of a PM, such as size of PM, appearance of PM, or the state whether the PM is displayed or not. The EXISTENTIAL element, for example, may makes the PM bigger, reclothe the PM, or disappear the PM. The EXISTENTIAL element has three attributes other than ID, i.e., STATE, ANIMATION, and PERFORMATIVE. The STATE attribute presents a state of PM after this representation performed. The ANIMATION attribute presents physical representation incidental on the state changing from the current to the goal. The PERFORMATIVE attribute presents the user's intention of this state changing.

5.3.8 MEDIA Element

The MEDIA element presents representation with multimedia contents. The MEDIA element has three attributes other than ID attribute, i.e., TARGET, ANIMATION, and PERFORMATIVE. The TARGET attribute presents the target of a multimedia

```
<ECM_SCRIPT>
<CAST>
    <CONTENT  ID="em_0" TYPE="embodied_media"
        USER="Toru Takahashi"
        URI="http://telmea.aist-nara.ac.jp/char/goat.acs" />
    < CONTENT ID="em_1" TYPE="embodied_media"
        USER="Hideaki Takeda"
        URI="http://telmea.aist-nara.ac.jp/char/penguin.acs" />
    < CONTENT ID="html_0" TYPE="text/html"
        TYPE="text/html"
        URI="http://ai-www.aist-nara.ac.jp/" />
</CAST>
<SCRIPT ACTOR="em_0">
    <MOBILE  ID="exp_0" TARGET="em_1"
        ANIMATION="Look"
        PERFORMATIVE="ACCOST" />
    <PHYSICAL  ID="exp_1" ANIMATION="Smile"
        PERFORMATIVE="FAVOR" />
    <VERBAL  ID="exp_2" TYPE="SPEACH"
        CONTENT="I found such a web page" />
    <MEDIA  ID="exp_3" TARGET="html_0"
        ANIMATION="Look"
        PERFORMATIVE="EXHIBIT" />
    <MOBILE  ID="exp_4" TARGET="img_2@html_0"
        ANIMATION="GESTURE"
        PERFORMATIVE="REFER" />
    <VERBAL  ID="exp_5" TYPE="SPEACH"
        CONTENT="This picture is nice, isn't it?" />
    <VERBAL  ID="exp_6" TYPE="SPEACH"
        CONTENT="Anyway, I'll get off this conversation." />
    <VERBAL  ID="exp_7" TYPE="SPEACH"
        CONTENT="See you! " />
    <EXISTENTIAL  ID="exp_8" ANIMATION="Hide"
        PERFORMATIVE="Quit" />
</SCRIPT>
</ECM_SCRIPT>
```

Figure 5. Instance of PMScript

content to operate such as letter string, image, movies, web pages, and so on. This value of the TARGET attribute is designated as an ID attribute of the CONTENT element. The ANIMATION attribute presents physical representation incidental on verbal representation and operation for the multimedia content. The PERFORMATIVE attribute presents the user's intention of this operation.

5.4 Design of an Editor for PMScript

The structure of PMScript becomes more complex than the structure of ALAScript. However, an community system with PM should not make a user aware of the structure of the language. By designing a good GUI for an editor, we can enable a user to edit the description of complexly structured language without knowledge about it.

We introduce a PERFORMATIVE attribute into PMScript. The purpose of this introduction is to clarify the intentions of utterers when they compose the script. For instance, we suppose users select their behavior not from the representation of animations but from the PERFORMATIVE, that is, the intention of this behavior. The same behavior often has different meanings in various contexts. Therefore, even when people can understand the meaning of a behavior in the context of a conversation "place,"

Figure 6. Editor for PMScript

the system cannot analyze the meaning. However, if the PERFORMATIVE of the behavior is designated, a participant can understand not only each behavior, but also the context of the "place" from the sequence of the PERFORMATIVE.

Figure 5 shows an instance of PMScript. This instance is nearly the same as that of the instance of ALAScript in Figure 2. Comparied with the instance of ALAScript, the instance of PMScript is much more informative. However, composing ALAScript is probably easier than composing PMScript because the GUI of the editor is improved.

Figure 6 shows a screenshot of our editor for PMScript, which is under construction. When a user wants to make his/her PM speak, for example, the user simply selects the word "speak" on the left-hand side of the window and inputs a sentence into the text area that appears in the center space. When a user wants to make his/her PM smile, the user simply selects the word "animation" on the left-hand side and selects a behavior's name associated with its PERFORMATIVE from the menu list that appears. Smiling behavior has various meanings depending on context, i.e., friendship, having fun, quizzical smile, and derisive smile. Since users select behaviors based on the meaning of the behaviors, the system can use the intentions of the users in analysis. Therefore, the PERFORMATIVE attribute has effects on both the user interface and system analysis.

6. CONCLUSION

In this paper, we propose a script language for ECA that can function as the personal conversational media on asynchronous community systems. Personified Media (PM) is an environment that provides social "place" for online communities by using multiple embodied conversational agents. We analyzed our existing system called TelMeA and identified four aspects to realize script languages for PM, i.e., bodily multimodal representation, representation with "place", social presence, and community awareness. We designed a script language for PM called PMScript, which has two basic elements, i.e., CAST and SCRIPT. The former represents agents and other multimedia contents including web pages. The latter realizes utterances by various multimodal methods, i.e., verbal, physical, MOVING, existential, and media. PMScript is currently provided by XML syntax. In short, an utterance by PMScript is a tagged sentence. We also provide an editor for PMScript to make it easy for users to compose utterances with PMScript.

The benefits of PMScript are that it (1) provides a standard protocol that enables different agent-based community systems, and (2) provides a good structure of utterances in order to reuse them. Future works around PMScript is implementation of adequate PM that can represent wide spread expression in PMScript. Because PM are media for representation in online community, the ECA for PM do not need for ability expressing completely human representation. Therefore, current scriptable ECA system such as MS Agent can be used as PM in TelMeA, but its ability of representation is limited, for example, it cannot move on screen with speaking. We have to approve both design of PMScript and ECAs as PM. We are currently working to adapt our new community system using PM to be able to understand and process PMScript, and we are going to propose to the agent research community that the specification of PMScript be used as the standard in order to stimulate further discussion.

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