Development and psychological evaluation of Multimodal Presentation Markup Language for Humanoid Robots

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***Abstract*— Research in robotics is growing and many robots are being produced. Robots are remarkable media because they can help humans and they can act in the real world. So, it is important to make the control of robots as easy as possible. For this reason we have developed the script language for humanoid robots called MPML for Humanoid Robots or MPML-HR which is simple enough to allow everyone to make multimodal presentation contents using the humanoid robot. Further, we evaluated the humanoid robot's presentation ability to find the difference in audience impression between the humanoid robot and the 2-D character agent. Psychological evaluation was used to compare the impression of the humanoid robot's presentation with the 2-D character agent's presentation. Two methods were used for psychological evaluation and the efficiency of the humanoid robot's presentation was verified.**

***Index Terms*— Multimodal presentation, Humanoid robot, Script language, SD method**

I. Introduction

The multimodal contents that unifies plural modalities like vision and audition are increasing in media and interface. We have developed Multimodal Presentation Markup Language MPML [2], [3], [4] which is a medium level scripting language allowing many non-specialists to easily write multimodal presentations with life-like character agents.

While current MPML allows only 2-D agent presentation, we have extended MPML to make multimodal presentation content with humanoid robots. The presentation by the humanoid robot gives a different impression from that of the character agent; it is much more life-like because, for example, it can move in real space and look around at the audience. It is important to develop the software allowing users to easily control robots because there is no medium level scripting language for humanoid robots such as MPML. We report the development of MPML-HR and its implementation on the humanoid robot ASIMO in section II.

Next, we evaluated the MPML-HR. One method of evaluation is to measure the user-friendliness of the language or the function of the language. In addition it is important to measure the impression of the presentation by the humanoid robot. So, we used a psychological method in the evaluation of the MPML-HR. The previous version of MPML was able to make a multimodal presentation using a 2-D character agent. There are many multimodal contents using 2-D character agents. But there has been no psychological evaluation to compare the impression given by the humanoid robot presentation with the 2-D agent presentation. We decided to compare the impression of the humanoid robot presentation to the 2-D character agent presentaion in order to evaluate each impression and to find the difference in impression between the humanoid robot and the 2-D character agent. The SD method and the direct comparison are used in psychological evaluation. If a humanoid robot can give a more positive impression than a 2-D character agent, then presentation will become an active domain for humanoid robots. We report this in section III.

II. MPML-HR

A. MPML

MPML-HR has been developed to extend MPML to humanoid robots. MPML-HR stands for Multimodal Presentation Markup Language for Humanoid Robots. MPML is a scripting language that allows many non-specialists to easily write multimodal presentation with Microsoft Agent [8] which is a 2-D character agent. MPML is a medium level description language that does not depend on particular browsers or agent systems. There are other versions of MPML, such as MPML-VR [5] that can control a 3D character in 3D virtual space, and MPML-mobile [6] running on mobile phones. MPML has many character control functions: position, movements, gestures and the emotion of the agent. MPML is understandable and easy to use in making multimodal presentations because it is based on XML (Extensible Markup Language).

B. MPML-HR

In this section, MPML-HR tags are explained. The 5 tags $< \mathbf{play} >$, $< \mathbf{move} >$, $< \mathbf{point} >$, $< \mathbf{speak} >$ and $< \mathbf{emotion} >$ are the main tags for controlling the robots.

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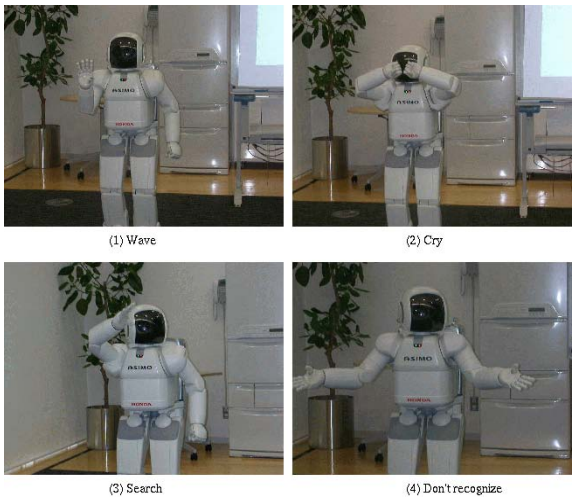

Fig. 1. The examples of "play" actions

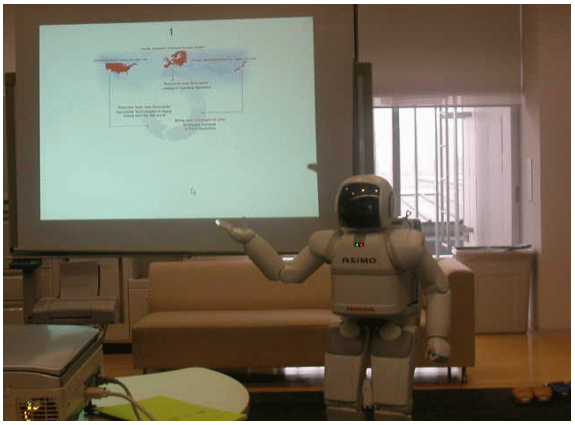

Fig. 2. The pointing action

①**Play tag**
The $<$ **play** $>$ tag invokes a specified action. Each agent has some pre-defined actions. The action is specified by {act=" "}. ASIMO has many pre-defined actions such as "wave", "cry", "search", "don't recognize", etc. MPML commands are converted to ASIMO API commands using a mapping table. One can produce his/her presentation contents easily by using the $<$ **play** $>$ tag, because he/she only describes this tag to invoke a specified action, and does not need to be concerned with the detailed control of the action. Figure 1 shows the examples of the ASIMO's actions.

②**Move tag**
The $<$ **move** $>$ tag indicates the movement of the humanoid robot to a specific position. The position is specified by {x=" "} and {y=" "}, where the (x,y) position is x[m] or y[m] far from the origin. MPML-HR uses absolute coordinates and ASIMO API uses relative coordinates.

③**Speak tag**
The humanoid robot speaks the text sentence surrounded by the $<$ **speak** $>$ tag using a speech synthesizer, which is prepared apart from ASIMO.

④**Emotion tag**
The $<$ **speak** $>$ tag and the $<$ **move** $>$ tag can be surrounded by the $<$ **emotion** $>$ tag. The pitch and tempo of synthesized speech are altered by this tag according to the emotion. In addition, some appropriate gestures are introduced before or after the speech, if suitable, to express the emotion. In MPML Ver.2.0e, the speed of the movement is changed by this tag; however, in MPML-HR, this functionality is excluded. The emotion is specified by {types=" "}. Based on the OCC model[7], the most comprehensive emotion model, 22 types of emotion such as 'happy-for', 'worried', 'anger', etc. are prepared in the current implementation. The parameters of the speech synthesizer like tempo pitch and speed are pre-defined for each emotion.

⑤**Point tag**
The $<$ **point** $>$ is a new tag introduced in MPML-HR. In a 2-D character agent, the agent can point to a position on the screen by moving to that point. Here the $<$ **move** $>$ tag is used to point to a specified position on the screen. The humanoid robot, however, he can't move to the position on the screen. To point to the specified position on the screen, the humanoid robot points to the screen with his hand, a stick or a laser pointer as in human behavior. To solve to this problem, the $<$ **point** $>$ is added to MPML-HR. The $<$ **point** $>$ is used with the attribute of {x=" " y=" "}. The robot can point to the (x,y) position on the screen using this tag. In the current prototype implementation, the robot points to the screen not with a laser pointer or a stick, but with his left or right hand. The robot can point to 1 of 6 areas on the screen. If the point operation is executed, the robot moves to one side (right side or left side) of the screen, and then points to the high area, middle area, or low area with his hand. If the target point is on the right half of the screen, the robot moves to the right side and points with his left hand. If the contrary, he moves to the left side and points with his right hand. This system also supports the robot moving to an arbitrary position by the $<$ **move** $>$ tag.

A more detailed pointing action is performed as follows.

1) Move to one side of the screen (right side or left side)
2) Turn his body 20 degrees to the screen.
3) Raise the right or left hand, and point to the high, middle or low area of the screen

C. System configuration

Figure 3 shows the system configuration of MPML-HR. We used the humanoid robot ASIMO as the presenter.

The ASIMO control server controls the humanoid robot ASIMO via wireless connection. ASIMO's speech is synthesized at the ASIMO voice server. The speech is able to be outputted from ASIMO and is also able to be outputted from the speaker connected with the ASIMO voice server.

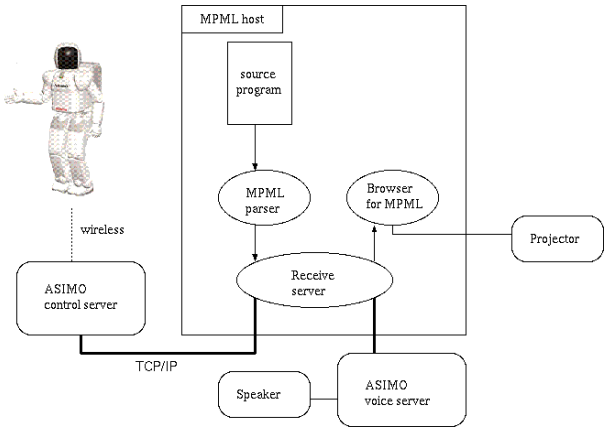

Fig. 3. System configuration of MPML-HR

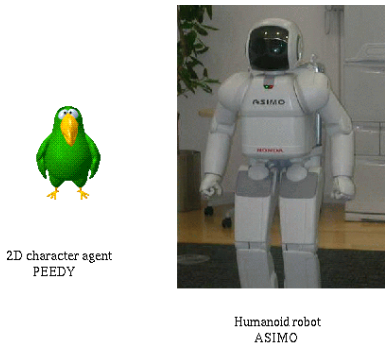

Fig. 4. 2-D agent Peedy and humanoid robot ASIMO

MPML-HR is executed on the MPML host. The MPML host is connected to the ASIMO control server and the ASIMO voice server via TCP/IP network. The commands are sent via TCP/IP network.

The MPML script files are loaded on the MPML parser, then the control commands such as display commands and ASIMO control commands are sent from the MPML parser to the receive server. If the receive server receives display commands, it sends these commands to the special browser, and if it receives control commands for the humanoid robot, it sends these commands to the ASIMO control server. Further if it receives speech commands, it sends these commands include text and emotion to the ASIMO voice server. ASIMO voice server synthesizes the emotional speech based on text and emotion. The receive server can translate MPML commands to the ASIMO commands using the mapping table for ASIMO control server.

III. Evaluation

In this section we describe the psychological evaluation. We think that it is important to measure the impression given by the humanoid robot's presentation.

There are several reports on the psychological evaluation of robots. Nakata proposed generation of familiar behavior for a killer whale model robot, and evaluated it using SD method[11]. Ogata evaluated an autonomous robot with an emotional model using SD method[12]. The evaluation was performed using 5 adjective pairs. Kanda evaluated the impression given by the robot using 28 adjective pairs[9]. And Kanda evaluated not only the static aspect but also the dynamic aspect[10].

Based on previous work we think that it is appropriate to use SD methods to evaluate the impression given by the humanoid robot's presentation. We evaluated this impression by comparing the humanoid robot's presentation with the 2-D character agent's presentation. There are many multimodal components involved in presentations using 2-D character agents. We believe that the robots can fill the role of 2-D character agents in multimodal presentations because robots have several modalities and the robots give positive impressions beyond that of 2-D character agents, i.e., robots can move in real space. There are no psychological evaluations to compare the impression given by a robot's presentation with the impression given by 2-D character agent's presentation. To extend the active domain of robot's, it is important to compare the robot and the 2-D character agent and finding the difference in the impression between the humanoid robot and the 2-D character agent. We can make better presentations using humanoid robots by find the disadvantages of the humanoid robot's presentation through psychological evaluation and improving on it.

Furthermore, we used the direct comparison as well as SD methods because it is important to compare robots and 2-D character agents. The clear result, which is better seen in presentation format, appears in the direct comparison method rather than an SD method. Ten important factors of the presentation were chosen and their direct comparison is shown in Table V.

It is important to give the information to audiences and to have these audiences clearly understand the presentations. To achieve this purpose, the presenter needs to get the audience to concentrate on the presentation. To accomplish this it is necessary for the presenter to make the presentation interesting. The "image" of the presentation is measured by an SD method, so that the positive impression makes the audience want to concentrate on the presentation.

The two agents which are the presenters of the presentation for psychological evaluation are shown in Figure 4. The 2-D agent is Peedy, a Microsoft Agent. The humanoid robot is ASIMO. The look of Peedy is different from ASIMO.

A. Experimental setup

We used the two methods of psychological evaluation: the SD method (Semantic Differential method) and comparison of the two presentations directly on 10 points. The SD method was proposed by Osgood and is used to measure the impressions, for example, the image of a company, merchandise, and so on. It is also used to measure of the image of robots. The method of comparing the presentation directly was used to measure the relative advantage of the presentations on each of

the ten points.

The subject group consists of 20 members. The age of the subjects ranges approximately from thirty to fifty and all are male. All subjects had seen ASIMO previously, but some subjects had not seen Peedy. The subjects were all engineers, and they were accustomed to ASIMO and character agents.

The evaluation was based on the presentation of weather information. Everyone is used to seeing weather information, so the subject content had little effect on the presentation. This is why we choose weather information for the presentation content. Both presentation contents were made by MPML-HR. The speech text and the speech synthesizer in both presentations was the same. The motions of the presentations were a little different because the presenter was different. But the frequency of motions was the same.

The time for the 2-D agent's presentation and the humanoid robot's presentation was approximately 5 minutes. The subjects were divided into 2 groups for the evaluation. The grouping method was random: group A was 12 subjects, group B was 8 subjects. In group A the subjects were shown the Peedy presentation at first, and the ASIMO's presentation last. In group B the order of the presentations was reversed, the ASIMO presentation was first, followed by the Peedy presentation. The evaluation procedure was as follows. First, the subjects were shown the first presentation. Second, we had the subjects write the SD method. Third, the second presentation was shown to the subjects. Fourth, we had the subjects write the SD method. Fifth, we had the subjects write their responses to the to the direct comparing questions on the 10 items. So as not to forget the impression, we had the subjects write their responses immediately after the presentations.

B. Results of SD method

Twenty-eight pairs of adjective sets are used for the SD method. These adjective pairs are shown in Table IV. The evaluation uses 7 scales for each adjective pairs. For example, a good-bad pair is ... highly good, very good, not bad, neither, not good, very bad ,and highly bad. In the analysis step, these responses are expressed by scores. One is the most negative adjective (ex. highly bad) and 7 is the most positive adjective (ex. highly good).

Factor analysis was performed on the SD method ratings for the 28 adjective pairs. Based on the difference in eigenvalues, we adopted a solution that consists of 4 factors. Table I shows the varimax normalized factor pattern.

Factor 1 is named "unti-sociability" because absoluteness of loadings is high in the "frank" and "favorite" adjective sets. This is "unti-sociability" so factor loadings are negative. Factor 2 is named "unti-evaluation" because absoluteness of loadings are high in "good", "full" and "complex" adjective sets. This is "unti-evaluation" so that factor loadings are negative. Factor 3 is named "potency" bacause factor loadings of "rapid" and "intelligent" are high. Factor 4 is named "familiarlity" because factor loadings of "humanlike", "pleasant" and "likable" are high.

	Factor 1	2	3	4	Commu-nality
Brave	0.872	-0.052	0.235	0.178	0.850
Pleasant	-0.65	-0.399	0.444	0.122	0.801
Frank	-0.658	-0.424	-0.053	0.414	0.784
Likable	-0.646	-0.223	0.590	0.220	0.863
Favorite	-0.644	-0.436	0.121	0.357	0.747
Pretty	-0.574	-0.364	0.103	0.487	0.710
Warm	-0.565	-0.418	0.014	0.444	0.692
Accessible	-0.542	-0.153	-0.028	-0.055	0.322
Friendly	-0.451	-0.083	0.342	0.124	0.343
Agitated	0.379	-0.017	-0.095	-0.002	0.153
Safe	-0.333	-0.039	-0.049	0.121	0.130
Good	-0.464	-0.694	0.272	0.084	0.779
Full	-0.161	-0.683	0.375	0.174	0.664
Complex	-0.159	-0.655	0.257	0.003	0.521
Interesting	-0.223	-0.643	0.262	0.131	0.550
Active	0.151	-0.643	-0.124	0.357	0.579
Altruistic	-0.445	-0.625	-0.138	0.243	0.667
Sharp	-0.315	-0.343	0.341	0.184	0.367
Rapid	-0.005	0.113	0.816	0.037	0.681
Quick	-0.005	-0.197	0.673	0.211	0.537
Intelligent	0.011	-0.249	0.642	0.262	0.543
Distinct	0.004	-0.226	0.315	0.091	0.157
Light	-0.068	0.027	0.346	0.728	0.355
Cheerful	-0.135	-0.202	0.114	0.659	0.506
Humanlike	-0.508	-0.225	0.106	0.616	0.699
Showy	0.089	-0.075	0.249	0.499	0.325
Kind	-0.333	-0.206	0.074	0.476	0.386
Exciting	0.010	-0.312	0.351	0.361	0.351

TABLE I

VARIMAX NORMALIZED FACTOR PATTERN

	Group	A(P-A)		B(A-P)	
	Presenter	Peedy	ASIMO	Peedy	ASIMO
	Num. of sub.	12	12	8	8
Mean of the factor scores	Sociability	0.010	0.364	-0.431	-0.265
	Evaluation	-0.334(*4)	0.145(*4)	-0.001	0.283
	Potency	-0.493(*2)	0.370(*2)	-0.223(*4)	0.409(*4)
	Familiarity	0.064	-0.182	0.093	0.085
S.D. of the factor scores	Sociability	0.959	0.890	1.165	0.943
	Evaluation	0.762	0.967	0.933	1.271
	Potency	0.954	0.548	0.732	1.120
	Familiarity	1.049	0.900	0.984	0.725

TABLE II

COMPRISON OF SUBJECT'S IMPRESSION IN OBSERVING CONDITIONS

Standardized factor scores are calculated to analyze the data. Standardized factor score means that the factor score is standardized to where mean equals 0 and standard deviation equals 1.

Table II and table III shows the summaries of the standardized factor scores. Table II shows the Peedy and ASIMO standardized scores separately from group A and group B. Table III shows Peedy and ASIMO standardized scores together with group A and group B. Standard deviations are also shown in Tables II and III. Factor 1 is named "unti-sociability" and factor 2 is named "unti-evaluation", but the standardized scores of "sociability" and "evaluation" are shown in Tables II and III. These scores are multiplied by -1. The priorities as checked by t-test are also shown in the tables. From (*1) to (*5) shows the priority of criterion in 1%, 2%, 10%, 20%, 40%.

Table IV shows the mean and standard deviation of Peedy and ASIMO scores for each adjective pair.

	Presenter	Peedy	ASIMO
	Num. of sub.	20	20
Mean of the factor scores	Sociability	-0.112(*5)	0.112(*5)
	Evaluation	-0.203(*3)	0.203(*3)
	Potency	-0.385(*1)	0.385(*1)
	Familiarity	0.075	-0.075
S.D. of the factor scores	Sociability	1.078	0.962
	Evaluation	0.851	1.100
	Potency	0.882	0.869
	Familiarity	1.024	0.845

TABLE III

COMPRISON OF SUBJECT'S IMPRESSION IN PEEDY OR ASIMO

ASIMO has higher scores than Peedy in both group A and group B in "sociability", "evaluation" and "potency" as shown in Table II. This means that ASIMO gives a more positive impression than Peedy. ASIMO has almost the same scores as Peedy in "familiarlity". In "familiarlity" the "light" and "cheerful" adjective sets have high factor loadings. Peedy is a light and cheerful character and this character appears as motion. Since Peedy has good scores in these 2 adjective sets, Peedy has almost the same scores as ASIMO. As shown in Table IV, Peedy has almost the same scores as ASIMO in the "light" and "cheerful" adjective sets.

We established the hypothesis for this psychological evaluation as follows. The humanoid robot gives a stronger impression than the 2-D character agent in displaying movement because the humanoid robot moves in the real space. This strong impression causes increased audience concentration resulting in considerable information delivered in the presentation. Experimental results show that on the whole ASIMO gives a more positive impression than Peedy. The score on the "interesting" adjective set shows the prior result of 0.01% criterion in Table IV. We think that the humanoid robot is more interesting to the audiences than the 2-D agent and draws them into the world of presentations. The interest of the audiences in the humanoid robot's presentation is the same as our expectation.

C. Result of directly comparison

Table V shows the results of directly comparison. Five measures are used on the questionnaire. If Peedy is evaluated better, the assigned value is -2 or -1. If ASIMO is evaluated better, the assigned value is 2 or 1. Priorities are not shown by chi-square test. On the item "comprehension", the second presenter got higher scores than the first presenter as shown in Table V. The presentation contents were the same, so that the audiences appear to have a deeper understanding at a second presentation. On the item "Pointing", Peedy got a higher score than ASIMO. ASIMO can't point to a specific coordinate on the screen, only to an approximately region. But Peedy can point to a specific coordinate on the screen by movement. For these reasons, Peedy received a higher score on the item "pointing".

ASIMO got higher scores than Peedy on all items except "Comprehension" and "Pointing". This shows that ASIMO

Adjective Pairs		Peedy	ASIMO	Priority
Brave	Cowardly	4.05(0.973)	4.00(0.837)	N.D.
Pleasant	Unpleasant	3.85(1.236)	4.65(1.108)	N.D.
Frank	Rigid	4.00(1.265)	4.30(1.187)	5%
Likable	Dislikeable	3.75(1.178)	4.60(0.860)	2%
Favorite	Unfavorite	3.95(1.322)	4.40(1.200)	N.D.
Pretty	Ugly	4.40(1.200)	4.80(0.812)	N.D.
Warm	Cold	3.90(1.338)	4.30(1.345)	N.D.
Accessible	Inaccessible	4.30(1.345)	4.25(1.090)	N.D.
Friendly	Unfriendly	4.05(1.564)	4.30(1.229)	N.D.
Agitated	Calm	3.55(0.865)	3.50(1.118)	N.D.
Safe	Dangerous	5.10(1.136)	4.45(0.865)	5%
Good	Bad	3.80(1.208)	4.50(1.285)	5%
Full	Empty	3.20(1.208)	3.90(1.044)	1%
Complex	Simple	2.95(1.203)	3.65(1.236)	2%
Interesting	Boring	3.35(1.352)	4.50(1.118)	0.01%
Active	Passive	4.10(0.768)	4.00(1.183)	N.D.
Altruistic	Selfish	3.90(0.995)	4.15(1.062)	N.D.
Sharp	Blunt	2.80(1.077)	3.35(1.062)	10%
Rapid	Slow	2.80(1.536)	3.75(1.410)	5%
Quick	Slow	2.40(1.200)	3.40(1.281)	1%
Intelligent	Unintelligent	3.55(1.161)	4.15(1.276)	N.D.
Distinct	Vague	3.85(1.526)	3.80(1.166)	N.D.
Light	Dark	4.35(1.062)	4.40(1.241)	N.D.
Cheerful	Lonely	4.30(1.054)	4.35(1.152)	N.D.
Humanlike	Mechanical	3.35(1.492)	3.40(1.393)	N.D.
Showy	Quiet	4.00(1.183)	4.20(0.980)	N.D.
Kind	Cruel	4.85(0.792)	4.75(0.994)	N.D.
Exciting	Dull	3.60(1.281)	4.20(1.364)	N.D.

TABLE IV

EVALUATED ADJECTIVE PAIRS AND RESULT OF PEEDY OR ASIMO

is more interesting to the audiences, when using the SD method of evaluating the presentation. Further, ASIMO got higher scores on "Concentration" and "Interest" in direct comparison. This means that the concentration of the audiences increases with an interesting presentation. We think that as the presentation is made more interesting more content is conveyed to the audience.

ASIMO got higher score on the item "Humanlike". ASIMO can move in the real space and looks human. We think that "Humanlike" is one reason for increased interest.

In these psychological evaluations, the subjects were all male and engineers, and there exists bias in these subjects. But it is important to compare the impression given by the humanoid robot's presentation with the 2-D character agent's presentation. The results clearly show that the humanoid robot gives a more positive impression than the 2-D character agent. This tendency also should be shown in an evaluation using non-biased subjects.

It has been verified in these evaluations that the robots can fill the role of the 2-D character agent in presentations. We think that presentation is a new active domain for robots. And robots also may play the role of 2-D character agents in multimodal contents other than presentations.

IV. SUMMARY

In this paper, we report the development of Multimodal Presentation Markup Language for Humanoid Robots MPML-HR, and the psychological evaluation of humanoid robot presentations. MPML is a script language for making multimodal presentation content based on XML. MPML is easy enough so

Group	Group A(P-A)	Group B(A-P)	all
Num. of sub.	12	8	20
Comprehension	0.17(1.067)	-0.13(1.053)	0.05(1.071)
concentration	0.42(1.320)	1.13(0.599)	0.70(1.145)
Interest	0.58(1.115)	1.00(0.500)	0.75(0.942)
Tempo	0.67(1.106)	0.38(1.111)	0.55(1.117)
Impression	0.67(1.312)	0.63(0.857)	0.65(1.152)
Emotional expression	0.50(0.866)	0.25(1.199)	0.40(1.020)
Motion	0.83(0.687)	0.88(0.599)	0.85(0.654)
Pointing	-0.58(1.037)	-0.50(1.414)	-0.55(1.203)
Humanlike	0.67(0.850)	1.13(0.781)	0.85(0.853)
On the whole	0.83(0.986)	0.63(0.992)	0.75(0.994)

TABLE V

RESULT OF EVALUATION FOR 10 ITEMS

that everyone can make presentation content. MPML is used to make presentation contents with 2-D agents as the presenter. We extended this language and ease of use to humanoid robots with MPML-HR. MPML-HR is a new version of MPML. It is compatible with MPML so that the source programs for MPML can be compiled by MPML-HR. The humanoid robot's presentation can be made from MPML source programs. The aim of MPML is to make multimodal presentation content, but MPML-HR is used not only to make multimodal presentation content but also to control the action of the robots because MPML-HR provides for easy control of the robots. Before development of MPML-HR, in many cases complicated special programs were needed to control robot action.

To verify the efficacy of the humanoid robot's presentation, and to find the difference in the impression between the humanoid robot and the 2-D character agent, we evaluated both agents using a psychological method. SD method and directly comparison were used for psychological evaluation, and this evaluation was used to compare the humanoid robot's presentation with the 2-D agent's presentation. The humanoid robot gives positive impressions particularly in "interest" to the audiences at the presentation. The concentration of the audiences increases with this increased interest. The audiences received more information by concentrating on the presentation. The humanoid robot gives a more positive impression than the 2-D agent in a presentation. This means that the humanoid robot can make better presentations than the 2-D character agent. We think that presentation is a new active domain for the humanoid robot.

V. FUTURE WORK

One of our future goals is to equip the robot with pointing ability. Now the 2-D agent can point to specific coordinates on the screen , but the humanoid robot can't point as precisely as the 2-D agent. This is a weak point in the humanoid robot's presentation. Pointing with a laser pointer is one way to overcome this deficiency because the screen is pointed to by a laser pointer in human presentations. And pointing in a similar manner as the 2-D agent in the humanoid robot's presentation is another way of introducing pointing action. The presentation using 2-D agent and real spatial humanoid robot is very attractive because the strong point of each agent is emphasized in the presentation.

The subjects in the psychological evaluation were all engineers and all know ASIMO very well. There was a bias in the subjects. And we use two agents, Peedy and ASIMO in this psychological evaluation. Peedy is like bird whose look is different from ASIMO like human. Because of this we want to evaluate in a fairer environment by gathering many types of subjects, male, female, young, adult, engineer, non-engineer, and so on and using 2D and real spatial agents whose look is same.

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REFERENCES

[1] H. Prendinger and M. Ishizuka (eds.) : "Life-like Characters-Tools, Affective Functions, and Applications, Springer-Verlag, 2004."

[2] MPML Home Page: http://www.miv.t.u-tokyo.ac.jp/MPML/mpml.html

[3] H. Prendinger, S. Descomps and M. Ishizuka: "MPML: A Markup Language for Controlling the Behavior of Life-like Characters," Jour. of Visual Languages and Computing, Vol.15, No.2, pp.183-203, 2004.

[4] Y. Zong, H. Dohi and M. Ishizuka: "Multimodal Presentation Markup Language MPML with Emotion Expression Functions Attached", Proc. 2000 Int'l Symp. on Multimedia Software Engineering (IEEE Computer Soc.), pp.359-365, 2000.

[5] N. Okazaki, S. Aya, S. Saeyor, and M. Ishizuka: "A Multimodal Presentation Markup Language MML-VR for a 3D Virtual Space," Workshop Proc. (CD-ROM) on Virtual Conversational Characters: Applications, Methods, and Research Challenges (in conjunction with HF2002 and OZCHI2002), 4 pages, 2002.

[6] Santi Saeyor, Koki Uchiyama, Mitsuru Ishizuka, "Multimodal Presentation Markup Language on Mobile Phones"", AAMAS Worksohp Proc. (W10) - Embodied Conversational Characters as Individuals, (in conjunction with Second Int'l Joint Conference on Autonomous Agents and Multiagent Systems (AAMAS-03)), Melbourne, Australia, pp.68-71, (2003.7)

[7] Ortony A., Clore G.L., Collins A. "The Cognitive Structure of Emotions", Cambridge University Press, 1988.

[8] Microsoft Agent Home Page: http://www.microsoft.com/msagent/

[9] Takayuki Kanda, Hiroshi Ishiguro, and Toru Ishida, "Psychological analysis on human-robot interaction", IEEE International Conference on Robotics and Automation (ICRA 2001), pp.4166-4173, 2001.

[10] Takayuki Kanda, Hiroshi Ishiguro, Tetsuo Ono, Michita Imai and Ryohei Nakatsu, " Development and Evaluation of an Interactive Humanoid Robot@ "Robovie"", IEEE International Conference on Robotics and Automation (ICRA 2002), pp.1848-1855, 2002.

[11] Toru Nakata, Tomomasa Sato, Taketoshi Mori and Hiroshi Mizoguchi, "Generating Familiarity by Robot Behavior toward a Human Being", Journal of Robotics Society of Japan, Vol.15, No.7, pp.1068-1074, 1997.

[12] Tetsuya Ogata and Shigeki Sugano, "Experimental Evaluation of the Emotional Communication between Robots and Humans", Journal of the Institute of Systems, Control and Information Engineers, Vol.13, No.12, pp.566-574, 2000.