Design of the android robot head for stage performances

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Abstract: In this paper, we propose an android robot head for stage performances. As you know, an android robot is one of humanoid robots but more like human. It has human like joint structures and artificial skin, so the android robot is the nearest creature to human appearance. To date, there are several android robots are developed but most of them are made for research purpose or exhibitions. We had our attention to commercial values of android robot, especially in the acting field. EveR-3, our android robot, already had commercial plays in the theater and through these; we could learn what requisite points for robot as an actor are. The new 9 D.O.F head is developed for stage performances. The D.O.F is reduced for using larger motors can make exaggerated expressions, because exaggerated expressions are more important than detail, complex expression on the stages. L.E.D lights are installed in the both cheeks to emphasize emotion expression by color exchanging like make-up. From these trials, new head is more suitable for stage performances.

Keywords: Android, robot, head, emotion, stage, performance

I. INTRODUCTION

For a long time, the main issues of robotic researches have been applications in the industrial fields, but now, the advancement of robot technology can expand applying of robots to variable fields. One of new field what we focus is the arts, in detail, area of the stage performances. Though the applications of robots to arts have been nonmainstream, some attempts have been trying continuously. TAREK M. SOBH made robot musicians to play real instruments [1]. It is very realizable application of robot on the stage, but it was more likely to automation. Some researches tried to investigate relationship between autonomous robots and intelligent environment [2] [3]. The main concerns of these researches are about interaction with human, environment and robots. Cynthia Breazeal made cyber flower and intelligent theater to study interactive effects between robot performer and audiences [4]. These works are very meaningful to know interaction of human with robots in the arts, but our interest is more likely to the commercial performances. We made Android robot EveR-3 for stage performances which has silicon skin covered face, humanoid body and movable lower body. Our first android robot EveR-1 was made for exhibitions [5] as a secretary but we find other possibility as an actor, so our recent hardware EveR-3 was made for stage performances. We already had several commercial performances and through these, we could find what requisite points for robot as an actor

were. The first point is beauty, the second is durability and the third is exaggerated expressions. Finally, we make new 9 D.O.F head which has reduced but large motors, L.E.D lights beneath the skin. This head has less expression but it can express more clearly and with L.E.D lights, it can emphasize expressions.

II. Hardware design

1. Design of the android face

In the part of making face, our goal is to make beautiful face but "beautiful" is very subjective. To solve this problem, we survey many comments of audiences who enjoyed our performances and find some important factors of beautiful face. One is the size of face. Most people consider small face as beautiful face than large one, so we should reduce the size of head. The other factor is age. The young face seems to be more beautiful than old face. From these considerations, we try to make smaller, younger face than exist one.

There are no models to our face. We designed our model by 3-D program (Cinema 4D) (Fig.1), because it is easier to make beautiful character by imagination than using a real model and our goal is commercial performance, so portrait right is very important problem. With 3-D design, we can have beautiful face freely and no problem of portrait right even if it is unreal character. After design, we made mold for real skin. The mold is made by RP (RAPID PROTOTYPING). The silicon

complex is used as skin because it is the nearest material to human skin. With 3D design and mold, we can duplicate and modification our face easily.

Fig.1 Face and 3D image

2. Mechanical part

The mechanical parts are divided an inner frame and a motor frame. The inner frame is designed by 3D CAD program (3D MAX) and its shape is based on face image (Fig.2). We use strings to pull and push the skin to make emotions. The routes of strings guided by Kevlar tubes and they are located at inner frame and the inner frame roles as connector between skin and motor frame. The inner frame is made of urethane to have strength of structure. The motor frame has 9 RC servo motors (Hs85mg, HiTec). It is bigger size than our existing hardware EveR-1's, so it can make bigger movement of skin to express exaggerated expressions. The locations of motors are decided by FACS [6] [7], but we should reduce the number of motors, because small size head, large motors and simplifying structure for durability. The D.O.F is one of important factors for durability. If there are many motors in the head, it's hard to maintain and the possibility of disorder is becoming highly. From these reasons, we choose 9 essential points and they are shown in table 1. These purposes of design brought less number of expressions, so we used L.E.D lights to emphasize the expressions to solve this problem.

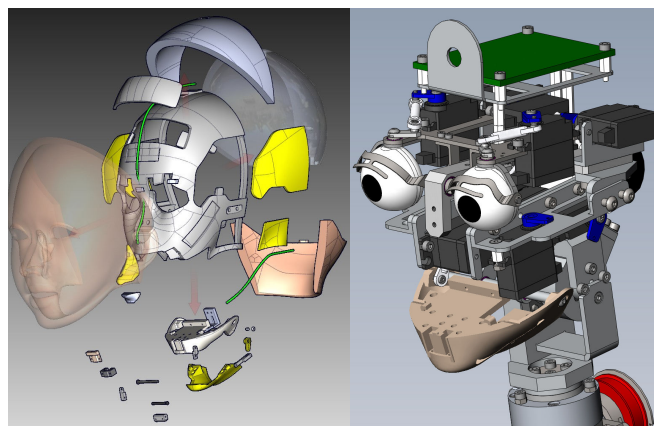| Action	D.O.F
Eyelid open-close	2
Eye raise-down	1
Eye rotation	2
Chin open-close	1
Lip corner stretch-press	2
Lip stretch-press	1

Table.1 D.O.F for actions

Fig. 2 Inner frame and motor frame

3. L.E.D lights

The L.E.D lights are used to emphasize emotion expression (fig.3). People often use color of skin to emphasize emotions unconsciously. When people feel shame their face become red, for example, and fear make the color of skin white. To change all colors of skin is not easy, so we choose both cheeks as the L.E.D point, because cheeks are highlight points of the face. The L.E.D lights are designed which can express all colors by combing three basic colors (red, blue, green). These L.E.D lights are made as panels and they are attached under the silicon skin. These are connected to main controller to synchronize with emotions. Though we made our efforts to use effectively, we faced one big problem. The L.E.D modules works well without skin, but when it is attached beneath the skin, it can make only red color. We can find the color of skin and penetration ratio disturbs the color of L.E.Ds. As a result, we can express only red color and our next goal is to solve this problem.
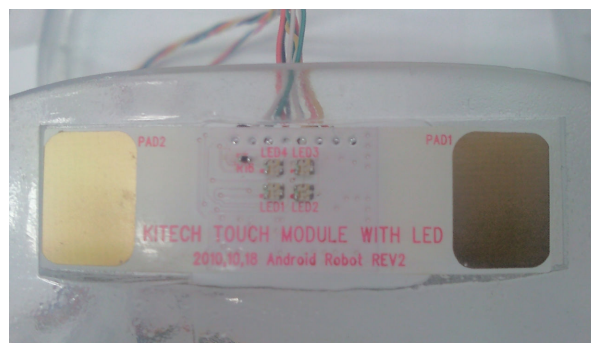

Fig. 3 L.E.D light module

III.   Experiment and result

The experiment took to check 3 aims. The first is whether it can make 7 expressions (pleasure, smile, surprise, fear, pain, wink, and sorrow) or not, the second is the comparison with exaggerated expression and existing expression and the third is how L.E.D effects when it is used with expression. We attached new head to our hardware, android robot EveR-3, and make mentioned expressions. Suggested seven expressions are working well. We can also the exaggerated expressions are more clear and easy to recognize than existing ones. Of course, it is very subjective to judge the mount how much exaggerated, so we need to make kinds of standards of judgment. The comparison of two models is shown fig. 4. We also compared same expression with L.E.D and without L.E.D. All seven expressions are tested and we can verify that L.E.D lights can emphasize the emotion expression (fig. 5).

Fig. 4 The effect of exaggerated expression (surprise)

Fig.5 The L.E.D effect in same expression (smile)

IV.   CONCLUSION

The 9 D.O.F android head which is made for stage performances is presented. In the stage, important factors are beauty, durability and exaggerated expressions. To satisfy these factors, we reduce D.O.F of head to make small head, use large motors and raise durability by simplifying. The problem of less expression is caused, by reducing D.O.F, so we use bigger motors to make exaggerated expression and L.E.D lights to emphasize expressions. After several experiments, we can confirm our goals and find our future works which are L.E.D problems with skin and some kinds of expression standard to judge.

Acknowledgement

References

[1] TAREX M. SOBH and BEI WANG (2003), Experimental Robot Musicians. Journal of Intelligent and Robotic Systems 38: 197-212
[2] Mari Velonaki and David Rye (2010), Human-Robot Interaction in a Media Art Environment. HRI Workshop 16-20
[3] Kwang-Hyun Park, Kyoung Jin Kim, Sang-Rok Oh and Il Hong Suh A Miniature Robot Musical Using Roboid Studio. HRI Workshop 47-48
[4] Cynthea Breazeal, Andrew Brooks, Jesse Gray, Matt Hancher, Cory Kidd, John McBean, Dan Stiehl, Joshua Strickon (2003), Interactive Robot Theater. IROS2003.
[5] Taegeun Lee, Moosung Choi, Taeju Kim, Kwangung Yang (2006), Development of an Android Robot: K-1004, CASS2006.
[6] P. Ekman and W. Friesen (1978), "Facial Action Coding System (FACS). A technique for the measurement of facial action," Palo Alto, CA: Consulting.
[7] Tingfan Wu, Nicholas J. Butko, Paul Ruvulo, Marian S. Bartlett, Javier R. Movellan (2009), Learning to Make Facial Expressions. IEEE 8TH international conference on development and learning.