Animatronics for control of countenance muscles in face using Moving-Units

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Figure 1: *Facial Muscle Model Animatronics*

1 Introduction

If we can see the muscles under the human skin, it will be an interesting and wonderful experience. For, they are inside our body and invisible to our eyes.
Up to now, the muscles could be seen only in books or models. Moreover, for the moving muscles, we had to be satisfied with seeing them in 3D computer graphics.
For this reason, this work was made to express the movement of countenance muscles in the face over the neck and other subsidiary muscles with a robot for their observation in actual 3D.

2 Exposition

In a precedent study (which is in the examination process), the Moving-Unit (hereafter, MU) was researched and proposed as a basic unit by multiple actuators to control the mechanical muscle structure.
There are 26 MUs in total, of which 20 MUs are used to express the 58 AUs(Action-Units) of FACS**. Moreover, the animatronics of face model has been actually produced to verify the applicability of MU.
On the basis of precedent study, the skull was supposed as of Koreans, and the skin thickness was also referred to the average tissue thickness of Koreans. The modeling was made with clay in the method of the facial reconstruction, which is used in the forensic medicine. After then, it was produced with the silicon rubber to express the shape and texture of actual muscles as close as possible.
To control 11 MUs, 15 actuators(servo motors) were employed. With this, more than 36 of 58 AUs in FACS could be expressed. Let alone 6 basic countenances like Happiness, Sadness, Anger, Disgust, Surprise, and Fear, other innumerable countenances could be expressed by mutual combining of 15 actuators.
CPU was ATMEGA128 of ATMEL, and the memory was Prochips 24LC32 eeprom. As the programming language, RoboBasic was used for the production.

Table 1: *A Summary of Moving-Unit & Relation of Action-Units*

MU-ID	Description	AU in Charge
A	Action of Lid	**5**, **7**, 41, 42, 43, 44, 45, 46
BI, **BO**	Action of Brow	**1**, **2**, **4**
C	Action of Upper Lip	**10**
D	Action of Chin	16, **17**
E	Eye turn left & right	61, 62, 65, 66
F	Eyes up & down	63, 64
G	Lip Corner Puller	**6**, 11, **12**
H	Lip Corner Depressor	**15**
I	Nose Wrinkler	**9**
J	Action of Jaw	**25**, **26**, **27**, 31
K	Action of Cheek	13, 33, 34, 35
L	Dimpler	14
M	Action of Nostril	38, 39
N	Jaw Thrust & sideways	29, 30
O	Lip Bite	32
P	Action of Ear	
Q	Neck Tightener	21
R	Action of Tongue	19, 36, 37
S	Action of Trunk	
T	Action of Arm or Forefoot	
U	Leg or Hind Leg	
V	Option	
W	Option	
X	Option	
Y	Head turn left & right	51, 52
Z	Head tilt left & right, up & down	53, 54, 55, 56, 57, 58
Example of mixing MU		
D+**G**	Lip stretcher	**20**
C+**D**+**G**+**H**	Action of Lip	8, 18, 22, **23**, **24**, 28

3 Conclusion

This study is expected to help the production of robots not only for entertainment but for education, medicine, sports, and other purposes.

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