5D−7 Feeling Communication System using Facial Expression Analysis/Synthesis basec on Individual Model

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1 Introduction

It is said that Japanese people are poor at expressing their feelings, especially in international communications comprehensible to other nationalities. Therefore, when the people from other countries try to understand a Japanese person's feelings from their facial expressions, inadequate recognition of feelings often interferes with mutual understanding during international communication.

In our research, we have developed a system which enables the cultivation of mutual understanding by the combination of video communication system and our "feeling" communication system. The feeling communication system enables users to convey feelings more accurately by modeling individual differences of facial expression as "Individual Models". Through the use of "Individual Models", this communication system extracts and transmits the meaning of a user's facial expression to other users. A suitable facial expression (one that conveys the user's true meaning) is then synthesized and presented on an individual basis to other users, thus helping user's to bridge cultural barriers.

2 Feeling Communication System

Fig.2.1 shows an example of "feeling" communication using individual models. It is assumed that user A who is reserved in her expression is communicating with user B who absorbes more strongly expressed feeling (in this case, we will label this "moderate" expression).

1. Although now user A's actual feeling is "Very Happy", her expression looks as if her feeling were "Little Happy". This facial expression ("Little Happy") can be captured by video camera.
2. Her "Little Happy" expression is generalized using user A's analytical individual model. Eventually, user A's actual feeling ("Very Happy") is determined. Then, the information of the feeling is transmitted to user B on the synthesis side.
3. User A's feeling ("Very Happy") is converted to a general expression and personalized using user B's synthetic individual model. Finally, an equivalent expression through which user B can understand user A's actual feeling (a little exaggerated in comparison to the original expression) is synthesized.
4. Thus, user B can understand user A's actual feeling ("Very Happy") by seeing the displayed facial image.

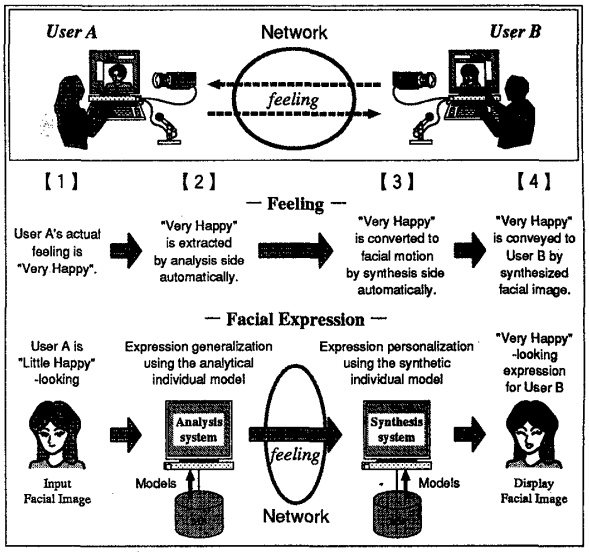

Fig.2.1 – Feeling Communication.

3 Expression Models

Facial expression model on the analysis side is defined as the expression pattern which characterize the 2-D motion, including the motion distance α_i and the motion direction θ_i, at the feature points on the face. The expression pattern E_{analy} is expressed as the following equation:

$$E_{analy} = \left[\alpha_1^{j\theta_1} \cdots \alpha_{26}^{j\theta_{26}}\right]^T = [a_1 + jb_1 \cdots a_{26} + jb_{26}]^T \quad (3.1)$$

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4 Individual Models

The analytical individual model is defined as a 2-D matrix which shows the difference between the general person's motion vector and the individual motion vector of feature points. The relation between the general expression pattern E_{gen} and the individual expression pattern $E_{indiv,analy}$ is defined using the analytical individual model M_{analy} as the following equation:

$$E_{gen} = M_{analy} \cdot E_{indiv,analy} \tag{4.1}$$

Then, the analytical individual model M_{analy} is expressed as the following equation:

$$M_{analy} = \begin{bmatrix} m_{1,1} & \cdots & m_{1,26} \\ \vdots & \ddots & \vdots \\ m_{26,1} & \cdots & m_{26,26} \end{bmatrix} \tag{4.2}$$

$$m_{i,i} = \lambda_{i,i} e^{j\omega_{i,i}} \tag{4.3}$$

Similarly, the synthetic individual model on the synthesis side is calculated from the following relation:

$$E_{indiv,synth} = M_{synth} \cdot E_{gen} \tag{4.4}$$

5 Evaluation of the Analysis side

In order to verify the accuracy of the analysis side, we evaluated the analytical individual model about "happiness", "anger", "sadness" and "surprise" on 14 students and evaluated three degrees such as "little", "normal" and "very" about each feeling. We calculated the feeling recognition ratio (FRR) defined as the equation (5.1) and then compared and evaluated in the following three cases.

case 1 The analytical individual model is not used.

case 2 The analytical individual model is used.

$$FRR = \frac{N_{success}}{N_{analysis}} \times 100\ [\%] \tag{5.1}$$

$N_{success}$: The number of the expresions analyzed correctly.

$N_{analysis}$: The total number of the analyzed expressions.

	Little	Normal	Very
Happiness	7.143	7.143	14.286
Anger	-	71.429	92.857
Sadness	-	21.429	7.143
Surprise	64.286	64.286	78.571

Table.5.1 – case 1 : FRRs [%]

	Little	Normal	Very
Happiness	97.619	100.000	95.238
Anger	-	100.000	100.000
Sadness	-	100.000	100.000
Surprise	97.619	100.000	100.000

Table.5.2 – case 2 : FRRs [%]

As shown in **Table.5.1**, in case 1, the FRRs were insufficient and unstable. On the other hand, the FRRs of all feeling in case 2 were sufficient compared with case 1 as shown in **Table.5.2**. Thus, in our feeling communication system, the analytical individual model is very effective to extract accurate feelings from individuals.

6 Example of Synthetic Facial Image

Fig.6.1 indicates a expression image for "happy" feeling.

Fig.6.1 – Facial Image: "Happiness".

7 Conclusion

In this research, concept of our feeling communication system, evaluation of the analysis side and generation of the synthetic individual model are described. Now we are implementing the synthetic individual model and verify the effectiveness of our feeling communication system.

References

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