Evaluating Video Playing Application for Elderly People at Home by Facial Expression Sensing Service

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ABSTRACT

We have been developing "Facial expression sensing service" for emotional analysis and quantitative evaluation of care based on subtle facial movements and conducted a preliminary experiment about its practicality. In this research, focusing both obtaining facial expression data and searching for an efficient care method, to elderly people can activate themselves and relieve their stress, we have developed "Video player service" that can easily play videos and automatically collect facial expression data. After developing the service, we have asked people who engage in elderly care to try it and obtained feedback. As a result, we received favorable comments for the usefulness of the service, and we were able to get facial expression data for four people.

CCS CONCEPTS

• **Human-centered computing** → **Visualization systems and tools**; • **Applied computing** → *Health care information systems.*

KEYWORDS

Scientific long-term care, Reminiscence therapy, Facial expression analysis, Care effect

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1 INTRODUCTION

Japan is facing a super-aged society. The number of elderly people who need care is increasing, which leads to a chronic lack of care resources. Under this circumstance, the Japan Government has declared the practice of "scientific long-term care" as a national policy[3]. It aims at optimal use of care resources by corroborating the effect of the care by scientific evidence. To achieve scientific long-term care, it is essential to evaluate the effect of the care objectively and quantitatively.

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We have been researching and developing "*Facial expression sensing service*" [4]. This service focuses on facial expressions as an objective indicator of the care effects, and to capture subtle changes of facial expression. Also, we have attempted an experiment of this service to obtain data of facial expression changes of elderly people who are receiving care and discussed whether the service can acquire useful data for estimating the emotions of the object person. However, at present, our experiment is only preliminary by using videos and data of the other past experiments.

To examine facial expression data in more detail, we have to collect face images of the people who are receiving care. To obtain accurate data, we have to collect stable face images. Then it is considered unsuitable to try to capture the face during the care of moving the body dynamically like bodily exercise. Besides, it is unclear whether care recipients behave as usual under the condition of being pointed by a camera to take facial photos. However, hiding the camera is a bad idea considering privacy issues. Therefore, we have to let care recipients be immersed in the care and weaken the existence of a camera. To collect facial data smoothly, we have to consider a care method that can overcome such constraints naturally.

In this study, to meet the above-mentioned conditions, to obtain facial expression data efficiently, and to be enjoyable for care recipients, we have decided to let them view videos on a computer or a tablet device. Then we have developed a dedicated "*Video player service*". With this service, the care recipient can easily play videos set by the caregiver in advance. In addition, face images can be automatically collected while the care recipient is watching videos.

In this research, we have developed Video player service. Also, we have asked people who are involved in elderly care to try the created service and to make feedback on the usability and usefulness of the service. As a result, we received favorable comments for the usefulness of the service. Also, we were able to get facial expression data for four people.

2 PRELIMINARIES

2.1 The current situation around scientific long-term care

As we described in Chapter 1, to evaluate the effect of care quantitatively and objectively is important for scientific long-term care. However, the evaluation methods of care tend to depend on a subjective scale, like observations and questionnaires.

Therefore, it is difficult to use the obtained data as scientific evidence. Moreover, these assessment methods compel a heavy burden on care evaluators, care recipients, or both.

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Besides, since scientific care is premised on using large-scale data, efficient data collection is required. In the past, to measure care effects objectively, an experiment that measured the changes in the facial expressions of object people undergoing care have been conducted[10]. In this experiment, facial features such as the height of eyebrows and the opening of eyes are measured from images based on the method called "facial expression analysis" of P. Ekman et al[2] and so on. However, they measured the features from the recorded video manually. Also, in the report, they have been concluded that "...Currently, we have not generalized this study successfully because of the limited number of cases. ... To establish an objective evaluation method, We have to collect and analyze both the data of the objective people and the caregiver more."

From the above, to realize practicing scientific long-term care, it is important to develop a computer-assisted service that enables us to automatically collect data that contributes to the quantitative assessment of care.

2.2 Facial expression sensing service

We have been researching and developing "Facial expression sensing service" focusing "scientific long-term care". This service focuses on facial expressions as an objective indicator of the care effects, and to capture subtle changes of facial expression. This service measures movements of facial parts as "feature values" to quantify the care effect.

One of the ways of estimating facial expressions from face images is to use a cognitive API constructed using machine learning. However, the existing API is for general purpose. Therefore, for example, when the facial expression changes of a care recipient are weakened by functional and/or cognitive impairment, the API may be impossible to capture the subtle changes. Also, the emotion analysis of existing APIs is a black box. Therefore, caregivers cannot trace why and how the results from API are output. As a result, we may face difficulty when we are going to use the data from API as the evidence for the effect of care.

Facial expression sensing service extracts the coordinates of characteristic parts of the face (= *feature points*) such as eyebrows, eyes, and mouth from the face image. Then, the service measures the length connecting two feature points as a *feature value* and records as time-series data. By tracking the change of these values, we can measure the degree of facial expression change from facial movement. As a result, even when the object person shows only subtle facial expression change, the service will be able to measure and record them without overlooking. We aim to contribute to explicable emotion analysis and quantitative evaluation of care by examining the degree of facial expression change as clear numerical values and inferring the emotional changes associated with the movement of facial expression.

2.3 Reminiscence therapy

"Reminiscence therapy" is one of non-drug therapy for dementia. It aims at the object person's psychological stability by offering him/her a time to take a look back one's past experience and responding empathically and receptively. It is used to control the progression of dementia and prevent depression of elderly people[1].

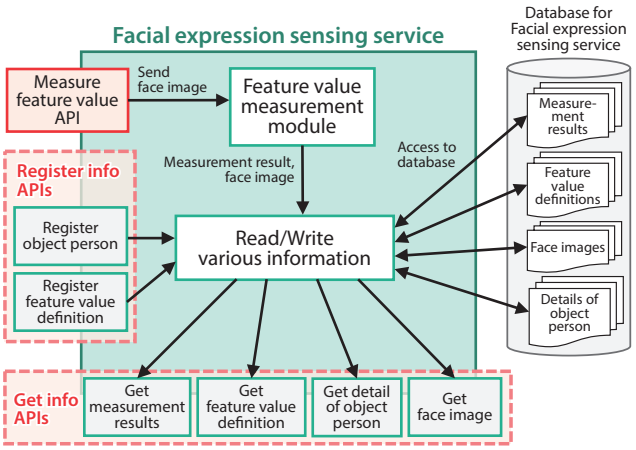

Figure 1: Conceptual diagram of Facial expression sensing service

In some cases, old images and music which make an object person feels nostalgic are used supplementarily so that the object person can recall one's memory easily[13]. There is also a report of reminiscence therapy with using YouTube (video sharing service)[8].

3 SUMMARY AND IMPLEMENTATION OF SERVICES

In this chapter, we explain the implementation of Facial expression sensing service stated in Chapter 2.2 and the summary and implementation of Video player service we mentioned in Chapter 1.

We have implemented each service as a web service so that users can use them from a web browser.

3.1 Summary of Facial expression sensing service

Facial expression sensing service provides various functions as APIs so that external applications can access them via the Internet. The service has a dedicated external database to store the information about object people and the measurement results of the feature values, and so on. Figure 1 shows a conceptual diagram of the service.

To measure facial feature values, users must specify the combination of feature points and define the feature values in advance. This service has various APIs to register various kinds of information, and by sending a request to them, users can register and store the data in the database. For the measurement, the service receives face images from measure feature value API and calculates the feature values based on the created definitions. The measurement data is recorded in the database with face images. Users can retrieve various data stored in the database by using the get information APIs.

Object people information registered in Facial expression sensing service is used to specify the person when measuring feature values. In addition, this object people information will also be used by external services that provide care with this service to specify the person who receives the care.

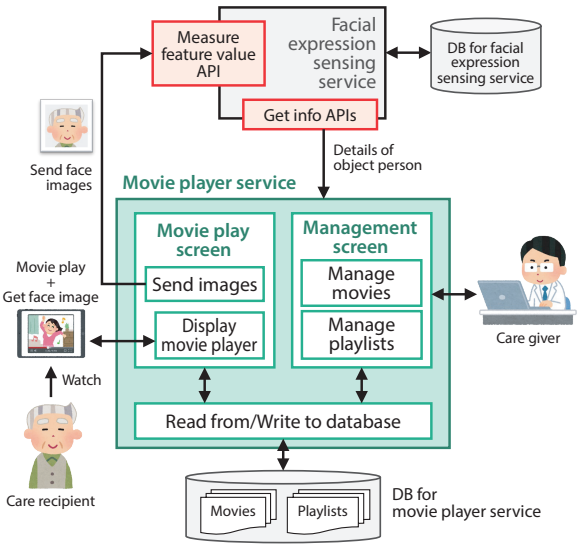

Figure 2: Conceptual diagram of Video player service

This service itself is an API and has no user interface. Therefore, we have created a separate Web application for managing the API, which wraps functions of the service and can be used from a browser with a graphical interface.

3.2 Summary of Video player service

The purpose of Video player service is to relieve object people's stress and make them feel better through watching videos. Developing this service, we referred to the concept of reminiscence therapy described in Chapter 2.3. Figure 2 shows the conceptual diagram of Video player service. The usage of this service is divided into the caregiver's side and the care recipient's side.

First, caregivers have to register videos which they want to show care recipients. When selecting videos, it is assumed that caregivers will refer to the preferences of the target care recipient. The preferences are, for example, investigated by listening directly or using a questionnaire to the care recipient or his/her family. This service uses the video-sharing service "YouTube" as the video source. After registering videos, caregivers put together multiple videos and make a playlist, and link to the care recipient who is taken care of them. This service uses the information of care recipients registered in Facial expression sensing service. When making playlists process is completed, a URL link to play videos is created for each care recipient. Caregivers have to present it to their care recipients so that they can access it.

The care recipient accesses the video player page from the link presented by the caregiver. Then, the video play start screen is displayed, and the list of playlists prepared by the caregiver is showed. Selecting one of them, the service will start playing the playlist. With playing videos, the service gets face images of the care recipient who is watching videos at fixed time intervals, and sends them to Facial expression sensing service, and measures the feature values. Besides, we have prepared no-sensing mode in which the service only plays videos and does not take face images.

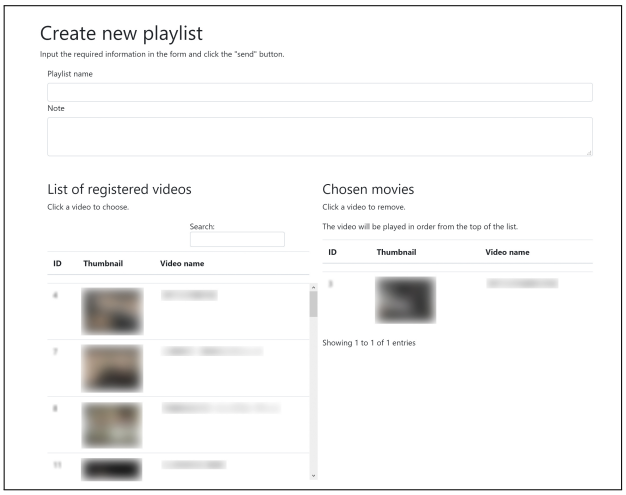

Figure 3: Video player service, playlist create screen

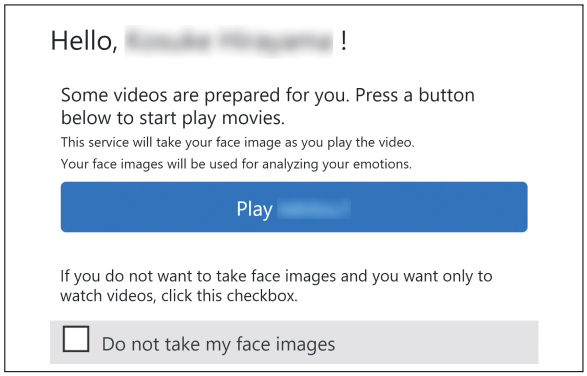

Figure 4: Video player service, movie play start screen

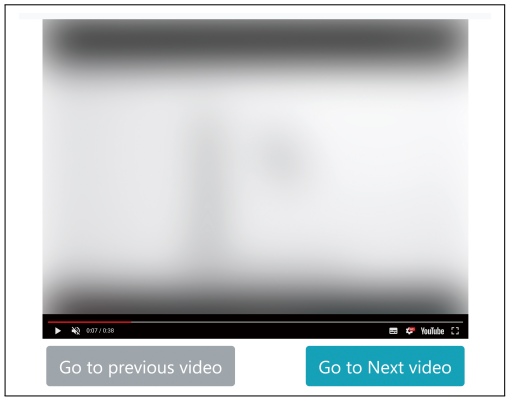

Figure 5: Video player service, movie player screen

As mentioned above, since we have implemented this service as a Web service, users can use this service anywhere if a Web browser and a Web camera (when measuring feature values) are

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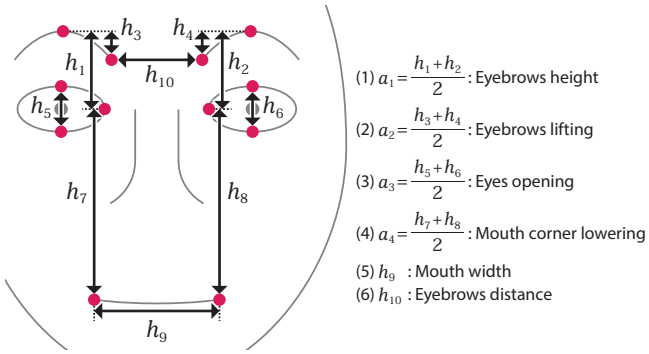

Figure 6: Used feature values for the experiment

available. Therefore, care recipients can access the service and play the playlist created by the caregiver even at home, and we can acquire the feature values.

3.3 implementation

We have used the following technologies to implement the API of Facial expression sensing service.

- Development languages: Python3
- Libraries and tools: Django, OpenCV, dlib[6], Celery, Redis, PostgreSQL
- External database: MySQL

We have used the following technologies to implement the management application of Facial expression sensing service and Video player service.

- Development languages: Java 1.8, HTML, JavaScript
- Libraries and tools: Apache Tomcat, Gradle, Spring Boot, jQuery, Bootstrap, Plotly, DataTables
- External database: MySQL

Figure 3 shows the playlist create screen, Figure 4 shows the movie play start screen, and Figure 5 shows the movie player screen. We designed the screens used by care recipients (Fig. 4, Fig. 5) with an easy-to-understand user interface in consideration of the case where an elderly person who is not very familiar with digital devices. On the movie player screen, embedded player of YouTube[1] is used to play videos defined in the playlist. A care recipient can change a playing video by clicking the bottom "Go to the previous video" and "Go to the next video" buttons.

4 EVALUATION EXPERIMENT

4.1 Purpose of the experiment

By asking other people to use implemented Video player service and collecting feedback, we have validated the usefulness of the service and checked an area for improvement. In addition, we have collected facial expression data (=feature values) during the experiment and briefly examined them.

[1]https://developers.google.com/youtube/iframe_api_reference

Table 1: Detail of the qestionnaire

Q1	Please write your name.
Q2	Do you think you could operate the service without confusion?
Q3	Do you think you could play videos without any problems?
Q4	Do you think you could make playlists smoothly?
Q5	Do you think the system's usability (feeling to use,simplicity of screen, etc.) was good?
Q6	Do you think this service will be useful for elderly care?
Q7	Please write the reason why you thought so in Q6.
Q8	Do you think any caregiver can handle this service?
Q9	Do you think any care recipient can use this service without any problems?
Q10	Did you encounter troubles when using the service?
Q11	(If you answered "Yes" to Q10) Please report the detail of the troubles.
Q12	Do you think the manual we sent was easy to understand?
Q13	If you have any other feedback, requests, suggestions for improvement, comments, etc., please write.

Table 2: Result of the questionnaire

	Agree	Somewhat agree	Somewhat disagree	Disagree
Q2	**2**	-	-	-
Q3	**2**	-	-	-
Q4	-	**1**	-	**1**
Q5	-	**1**	**1**	-
Q6	**1**	**1**	-	-
Q8	-	**1**	-	**1**
Q9	-	**1**	**1**	-
Q12	-	**2**	-	-

	Yes	No
Q10 (whether encountered troubles)	**1**	**2**

4.2 Summary of experiment

The experiment was conducted with the cooperation of three people, and they used Video player service. Of the participants, two are medical personnel engaged in nursing care for the elderly, and one is a researcher. We asked each participant to perform a sequence of operations of the service, creating playlists, and playing movies themselves or showing movies to other people, referring to the manual sent in advance. Besides, take face images of the person watching the video, and measure feature values every about 3 seconds using Facial expression sensing service. We have measured 6 feature values, which are shown in Figure 6. In this experiment, it was difficult to acquire data from the actual care recipient due to privacy restrictions. Then we asked participants to show videos to a person close to them.

After having used the service for a certain period, we asked the participants to answer the questionnaire shown in Table 1 to get feedback. Q2 to Q6, Q8, Q9, and Q12 were evaluated in 4 levels: "Disagree," "Somewhat disagree," "Somewhat agree," and "Agree." We use SQuaRE[5], an international standard for software quality, as a reference to create this questionnaire.

After collecting the feature value data of the person watching videos, we examined them briefly.

The experiment has been approved by the Research Ethics Committee of Kobe University Graduate School of System Informatics (No. R01-02).

5 EXPERIMENT RESULTS

5.1 Result of questionnaire

Table 2 shows the results of the questionnaire.

In Q2 to Q5 which are questions about usability, there were many "Agree" and "Somewhat agree" answers, but also "Somewhat disagree" in Q2 and Q5, and "Disagree" in Q4. Regarding this, we got the feedback that "caregiver's operations such as registering videos are complicated, and I felt it is difficult for people who are not familiar with PC to complete these tasks." The usefulness of the service in Q6 was generally well-received, and the following opinions were obtained in the following Q7 (excerpt from the original text, partly modified).

- I thought it would be good to be able to provide videos according to the interests of the person so that seasonal events and one's hobbies could be reflected. When I showed movies to my mother, she enjoyed watching videos of scenery, dance, etc.
- By using this service, it could be possible to show the care recipient's favorite video at any time.
- I think that providing video contents according to the interests of the elderly is a new perspective in elderly care. Since it is possible to ensure individuality and create a video program according to the purpose, I think it is effective for reminiscence methods, recreation programs, and also reducing the care burden of the family of dementia patients.

Q8 and Q9 are questions from the viewpoint of whether anyone can use this service. There is no "Agree", while "Somewhat disagree" or "Disagree" were noticeable. From Q12, we proved that the manual obtained some evaluation. In Q10, we asked reports on troubles during use, and got a report from one person, which is "I cannot confirm whether the camera function is working well from a remote location."

5.2 Discussion about the result of questionnaire

Through the questionnaire, we have received good feedbacks that Video player service will be useful. In particular, they highly evaluated regarding the service can create playlists according to individual interests and care purposes. What contributed to this evaluation might be the advantage of using a video sharing service with huge video resources for care. Also, since Q3 was "Agree" with all 3 participants, we have found that the service had worked without causing serious trouble in the overall operations from creating playlists to play videos.

On the other hand, there were some complaints about the operability of service. In particular, most of them were comments and feedback regarding the complexity of the user interface on the caregiver side. Taking this result, We realized the necessity to brush up the service operability on the premise that people with various PC skills will operate this service not only on the care recipient side but also on the caregiver side.

We have got another feedback that "I think it would be good to prepare some examples that will make object people happy by age group, gender, occupation, and so on." From this, we recognized that it is important for the experiment efficiency to prepare documents to assist to select videos, looking ahead to expand the experiment in the future. Of course, it would be difficult to present contents that are acceptable to everyone, because each person has different favorite things. However, We still would like to indicate some guides and make selecting movies smoothly. Regarding this, we received various opinions from the participants of this experiment. A participant who had the experience to show videos to elderly people before this experiment provided the following findings.

- The news, TV commercials, popular songs, etc. of the period when the object person was young or made a home seems effective when watching the video with him/her.
- Monotonuse images of landscapes can't draw much attention.
- I have tried to show elderly comic chats or song talks. However, it seems that videos contain fast-paced conversation makes them confused.
- Magic trice gave a good impression surprisingly. Many people watched magic videos earnestly.

In addition, I got the following comments from the other participant.

> If the object person is who have a mild to moderate degree of dementia, an approach of reminiscence therapy is effective. But when it comes to dealing with those who have severe dementia, this approach often becomes invalid because they forget their old memories. In that case, I think it would be good to use simple images, like baby and animal, moving landscape from car windows, or sparkling images such as fireworks.

To improve the quality of the service entirely, we would like to create a guide to select contents using such knowledge as references, in parallel with the improvement of service implementation.

5.3 Obtained facial data and discussion

In this experiment, we measured the feature values of five people, which are three participants and, with the cooperation of the father and mother of a participant, additional two people. We obtained four person's data successfully through measuring five people. The service has failed to get face images and measure the feature values for remaining one person. Figure 7 shows a part of the obtained features of one of the object people. The horizontal axis shows the elapsed time from the start of playing video, and the vertical axis shows the feature value. The black dotted line is the average value. Figure 8 is an image showing the feature points that were extracted from the face image and were used to measure the feature values. Here feature value means the ratio of length based on the distance

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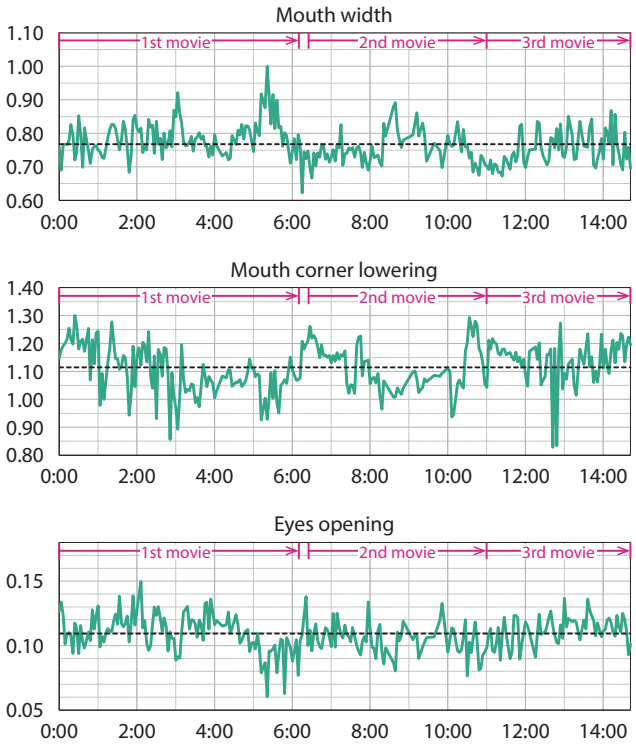

Figure 7: A part of the obtained features

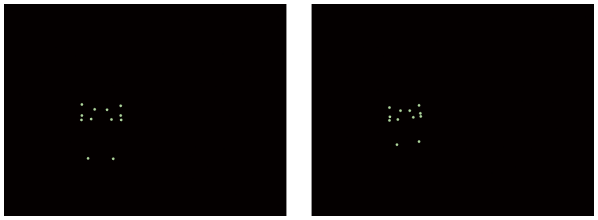

Figure 8: A part of feature points extraction result

connecting the centers of both eyes. When making a graph, we excluded obvious outliers that came from failures of face detection.

Changes in "Mouth width" and "Mouth corner lowering" seem to be relatively good hints to consider whether an object person enjoys watching a video. When we checked face images when "Mouth width" was high and mouth corners were raised (= when "Mouth corner lowering" was low), we could see smiling faces. By the way, even in reference [2] regarding the facial expression analysis that was stated in Chapter 2.1, the characteristic expression of happiness is defined as "edges of the lip are pulled backward and slightly raised" and "cheeks are lifted". In addition, "Eyes opening" could be evidence to judge whether they feel fun since the cheeks should rise when laughing, then a bottom eyelid should be raised accordingly, and as a result, the opening of eyes should be narrowed. Furthermore, it might be possible to consider whether they concentrate on videos when "Eyes opening" stays low for a long time. However, if it is too low, the video might be boring and they feel sleepy.

In this experiment, she watched three videos, and the contents were Manzai (Japanese stand-up comedy), dance, and scenery in order from the first. Among them, in the feature values in Fig. 7, the above-mentioned signs of happiness were mostly seen in the latter half of the first video. Therefore, we can analyze that she might like to watch Manzai videos.

As above, by examining the obtained feature values in detail, we may analyze care recipients' emotions based on numerical data rather than vague and subjective observations. In addition, by examining the obtained feature values in detail, it might be possible to guess what content a care recipient likes.

As in this experiment, when users use the service in their home, the quality of obtained face images depends on the environment around them (room lighting and brightness, camera performance, etc.). This time there were no problems caused by room environment, but we have realized that it is necessary to present some recommended environment because the environment for taking images could affect the reliability of feature values measurement. Also, in this experiment, we have faced a case of failed to get face images and the feature values. In consideration of the reported trouble mentioned in Q10 of 5.1, when the service does not work normally, we need to indicate clearly to the user about the trouble.

6 RELATED WORK

Various techniques have ever been devised for computer technology intervention in elderly care or dementia care. For example, there is a research that shows images such as paintings and photographs to patients with dementia using a tablet device and measures the effect[12]. To offer some stimulation to patients, the images were selected not likely to trigger for reminiscing about a specific time period or event. They have investigated the care effects by providing questionnaires and interviews with people with dementia and their caregivers. As part of that, the art-viewing app used in care asked about the user's mood and collected data before and after the care.

As a research to evaluate care effects from facial expressions, we cite "Face Emotion Tracker" which is one of the previous studies of our research group[9]. In this research, Microsoft Face API is used to analyze emotions while a person with dementia was receiving care. The researchers adopted a computer-based method as a care method, and people with dementia talked with a virtual agent[11]. As a result, various facial expression signs were able to be captured. However, for people with weakened facial expression changes caused by weakening facial muscles or euphoria, the emotion of the person became hard to analyze.

Besides, as a study to evaluate care quality, there is a research that focuses on how caregivers give care[7]. Caregivers performed care with wearing a head-mounted camera to their head and the distance and angle of the caregiver's face toward the cared person are measured from captured images. Then, based on the difference in the data between experts and amateurs, they extract care postures that are peculiar to experts. The aim of this is to enable caregivers to know their care skill from feedback and to improve their quality of care. From the viewpoint of care evaluation, this research have in common with this research and the related research mentioned above, but the focus is not on creating a new care methods but rather on improving the quality of existing care methods.

7 CONCLUSION

In this paper, we have developed Video player service that can efficiently obtain facial expression data and provide care that care recipients can enjoy, and conduct an evaluation experiment with people who engaged in care for the elderly people.

As a result of the experiment, we have been able to obtain a good evaluation regarding the usefulness of the service. In addition, we have been confirmed that facial data could be acquired and briefly examined.

As future works, we would like to improve the usability of the service and add functions with a view to expanding the scale of experiments. In the future, we would like to experiment with elderly people who are actual care recipients and analyzing facial expression data.

ACKNOWLEDGMENTS

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