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A proposal for metadata to express students' "presence" in digital photos – Use in the determination of equality in groups of photos –*

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In this research, we target students' photos for school use. When using students' photos in a class newspaper, teachers have to treat students equally. Usually in this case, the teacher counts the number of times a student appears in the photos. However, by only using this method it is difficult to feature students equally, since there are various kinds of photos, such as individual photos, group photos, etc. Considering this particularity of school use of photos, we propose the concept of "presence," which expresses the impact of the face in a photo, by examining every subject in the photo, and measuring the students equally using the "presence" points of each subject. In this paper, we present a regression formula of "presence" using simple and objective items. Next, we present an experiment we conducted which measured perceptions of equality of student exposure in photos using the sum of "presence" points. The result of the experiment was the group of photos where "presence" points were within the predicted "range of equality" was judged to be fair.

Key words : presence, digital photo, metadata, equality, quantification theory type I, regression formula

1. INTRODUCTION

1.1. Background of research

The recent increase in popularity of digital cameras and the spread of inexpensive, large-volume recording media have made it possible for individual people to take and store photographs easily. The same is happening in schools as well--teachers are taking photographs of the students' activities for use in various locations such as class newspapers, albums, and school webpages. The downside of this is that the manual management of large numbers of digital photos and the selection of photos to be used is troublesome, so it is now necessary to have a photo management system that enables organization and retrieval (Mills *et al.* 2000). Against this social background, this research first focused on metadata to be added to photos, for use in a photo management system.

There are already many internationally standardized frameworks for metadata relating to digital photos. For instance, there is the Exif format that was standardized by JEITA to set out a description of metadata for digital photos, which specifies details such as the camera, parameters relating to the time of shooting, and even location information (Watanabe and Tsubaki 2003). There is also MPEG-7, which specifies a framework for describing multimedia contents, centered on movies and audio files (Shibata 2001). In addition, there are experiments in representing images by combining existing standards. For example, there is W3C Note that implements photo description and retrieval by using DRF and HTTP (Lafon and Bos 2002), and an approach that describes image metadata by combining the vocabularies of Dublin Core, FOAF, and RSS 1.0 to enable the provision and sharing of sophisticated image data (Kanzaki 2004). However, although such metadata can be used by various existing tools, because it is created to be versatile and expandable, it is necessary to supplement or extend the metadata in order to adapt it for a proprietary domain. In addition, descriptions of the contents of photos, such as the subjects portrayed in them, must be entered manually, and it can happen that the same contents are not described uniquely (Takahashi *et al.* 2002). In general, a method based on a standard that is versatile and expandable is used

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in such a case, with the addition of metadata that is suited to the intended field and objectives (Fukumoto and Akahori 2003). Moreover, regarding the metadata that is added in this way, Fukumoto *et al.* (2003) studied the degree of importance of each keyword in the metadata and stated that it is necessary to describe sensitive language for information such as the situational behavior of objects and the impressions and feelings evoked by images.

Based on this background, the objective of this research makes "the usage of photos in schools" as the intended field, and proposes essential metadata for image management that considers the specific characteristics of schools. We first study the metadata that is necessary for photo usage in schools.

1.2. Study of metadata necessary for use in photos, considering school characteristics

When considering the characteristics of photos in schools, we note that (a) many of the digital photos in schools are taken by students themselves, with the subjects being the class or school year to which those students belong. In addition, (b) teachers aim to treat students equally when using digital photos. In projects that the authors have participated in, when the teachers of elementary and junior high schools create blogs from visits and share photos and comments of scenes of student activities to show to parents and current students, once they have confirmed that articles relating to all of the participating students have been created, they publish all of the articles together (Umeda *et al.* 2004). Teachers are also careful to ensure that students appear equally within a fixed period in class newspapers, and use various devices to check that the date and name of all students featured in articles are registered (Nagai and Kimata 1980).

In such situations, a method of counting the number of appearances is often used when ensuring equality. If it were possible to determine equality by simply counting the number of appearances, this could be implemented by means such as counting the names of subjects, which are already widely used in the metadata. With photos, however, a simple count of the number of times a person appears cannot be said to be fair. This is because a child A who is always at the center of photos and a child B who is always at the periphery of photos, by way of example, cannot be said to appear equally, even though they appear in the same number of photos. First of all, when a single photo is considered, a child who is shown at the center and a child who is shown at the periphery will be conspicuous to differing degrees. This difference also occurs between a photo that shows only one child and a photo that shows a number of children.

With this study, we propose not just a simple count of the number of times a subject appears in photos, but also the addition of an index of the "presence" of each subject in a photo as a new type of metadata, and use the sum of "presence" of each subject when considering equality. To that end, the objectives of this research are laid out below.

2. RESEARCH OBJECTIVES

In light of the above, we first define "presence" as "the degree to which a specific person within a photo is conspicuous, and the impact of that person." Since there is no mathematical model that expresses "presence," our first objective is to develop a regression formula to obtain that factor. Presence is generally a subjective determination, so our aim is to define "presence" from simple items, while bearing in mind that the people who input metadata are often inconsistent, which is one problem with the metadata format.

Our second objective is to add "presence" as part of the metadata attached to each subject in each photo, and study how to use that factor to determine equality. When dealing with photos in a school, equality can be defined as: "a bias-free measure of the degree of appearance of subjects (individual students) who belong to a specific group (such as class or school year) within a specific group of photos (with class newspapers that are issued throughout the year, this would be photos that appear in the class newspapers throughout one year, and with a graduation album this would be photos within that album)." In this research, this definition of "bias-free degree of appearance" is taken to be the "bias-free presence" of each subject, and we confirm that a group of photos that conforms to this factor can be perceived to be equal.

Note that the terms "presence" and "equality" that have appeared up to this point in this paper are as defined previously. In Section 3, we discuss our investigations into the procedure for creating a regression formula to express presence and in Section 4 we discuss confirmation as to whether presence can be used to determine equality in a group of photos.

3. CREATION OF REGRESSION FORMULA TO DETERMINE PRESENCE

We use the following procedure to obtain the regression formula to determine presence. First, we define items for obtaining the values of "presence" and the categories of those items, in the light of previous research. Then we perform experiments using photos of people to whom those items and categories apply, analyze them by quantification theory type I, and create a regression formula. Finally, we use the same procedure to perform new experiments to obtain presence points and compare those values with the predicted values obtained from the regression formula, in order to confirm the validity of the regression formula.

3.1. Investigation of items that define presence

3.1.1. Item determination

In this section, we investigate simple objective items for measuring presence. First of all, since previous research has made it clear that the physical size of photos affects evaluation of the impressions given by those photos (Onaka *et al.* 2003), we used the following criteria: (1) size of photo as one item. As research into a search system using image composition, we next performed searches using the relationship between spatial and relative locations of objects (Takahashi *et al.* 1990; Nishiyama and Matsushita 1996) and the distribution of objects and image composition within the domain area (Toshima and Hachimura 1999) as clues. Using those sources as a reference, we also included the following as items for this research (2) number of subjects, (3) area occupied by the face, and (4) spatial location of the subject's face. This use of the subjects' faces as a measurement item instead of the subjects' entire bodies was because it is considered that the presence of a person differs between a full-length photo and a photo in which the face is shown larger, so the assumption is that a face shows presence better. Note that photos in which faces were turned away or were partially overlapping could also be considered, but since such consideration would necessitate complicated classification, only photos in which the subjects were facing forwards were involved in this testing of the regression formula. However, such provisos can be considered to be included in criterion (3) the area occupied by the face and criterion (4) the spatial location of the face.

Other than the above items, it is considered that "presence" is also affected by the subject's pose or color of clothing in reality. With color in particular, there has been research into sensitive retrieval by using hue information, and it is known that retrieval by colored patterns and sensitive language also has an effect on mental imagery (Kimoto 1999). However, it is difficult to specify people's poses and clothing color objectively and uniquely, so this is outside the scope of this study. According to research conducted by J.M. Mandler into what parts of a complicated picture are remembered, a meaningful item at the center of the picture is retained better than superficial details. It has been concluded, by way of example, that in a picture that shows a street scene, the fact that it contains a vehicle or the spatial locational relationship between that vehicle and a pedestrian is important as the topic of the picture, rather than a detailed depiction of that vehicle (Takahashi *et al.* 1988). For that reason, we consider it possible to define presence without considering pose or clothing colors, and attempted to create a regression formula from the above four items.

3.1.2. Category determination

After the investigation of Section 3.1.1, we investigated the various categories of the four items (1) to (4). In the creation of categories, we aimed to restrict the number to about three categories for each item, to simplify the process as far as possible.

First of all, (1) the size of photo was divided into three categories of image size that are often used in webpages: 640x480 pixels, 320 × 240 pixels, and 160x120 pixels.

Next, for the remaining items (2) to (4), two of the authors looked at 100 photos of people to decide on each item. Concentrating first on just item (2), which is the number of people in each photo, we decided that the subjects in photos that contain ten or more subjects are so tightly packed, the area of each face is so small it can be assumed that there is substantially no difference in presence between those subjects. With photos with fewer people, however, we were unable to judge where best to divide the photos according to the number of people in each. We tested this with 57 university students, as described below. We first prepared 120 photos of a total of 11 types, ranging from photos in which between one to ten people are portrayed to photos in which 15 people are portrayed, as examples of photos of ten or more people. Each student was shown 32 of these

photos selected at random and was asked to assign them to categories: "individual photos," "group photos," and "party photos." As a result, we found that a significantly large number of people judged photos containing one or two people to be "individual photos" and, similarly, that a significantly large number of people judged photos containing three to ten people to be "group photos" and photos containing 15 people to be "party photos" ($p<.05$). That is why we created three categories for the number of people in photos. However, since there is such a wide range of three to ten people in group photos, we compared photos with three to seven people (called group 1) and photos with eight to ten people (called group 2) and found that significantly more of the participants responded that photos belonging in group 2 are party photos, than those that responded that photos in group 1 ($p<.05$) are party photos. We therefore divided the photos into four categories: individual photos with one or two people, group 1 photos with three to seven people, group 2 photos with eight to ten people, and party photos with more than ten people.

Finally, we tried dividing each of category (3) the area occupied by the subject's face and category (4) the location of the face into three categories: large, medium, and small; and center, periphery, and periphery; respectively. However, it became clear during the process of dividing 100 photos into categories relating to the number of people in each photo and subjectively judging and classifying the presence of each subject, that there was some ambiguity concerning the center category, particularly when the number of people in the photo increased. That is why we set only two categories for each of category (3) the area occupied by the subject's face and category (4) the location of the face. From the 100 photos, we categorized a face as "large" when the area of a rectangle that surrounds the face is more than 1/24 of the entire area of the photo, and as "small" when the area is less than that. For category (4) the location of the face, we divided each photo into two divisions vertically and four divisions horizontally and categorized the location of a face as "center" if at least half of the face was within the two divisions in the middle of the lower side, or "periphery" if the face was outside those divisions.

An example of the items and categories for subjects in a certain photo is shown in Fig. 1.

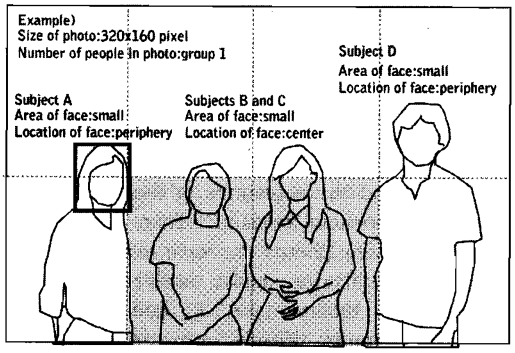

Fig. 1. Example of items and categories for each subject

3.2. *Creation of regression formula to determine presence*

3.2.1. *Summary of experiment*

Participants: 97 university students.

Materials: As described in Section 3.1, these were 48 digital photos comprising subjects that correspond to a total of 48 ($3\times4\times2\times2$) different combinations of the following:

1. Size of photo (640×480, 320×240, 160×120)
2. Number of people in photo (individual, group 1, group 2, party)
3. Area occupied by subject's face (large, small)
4. Location of subject's face (center, periphery)

However, since item (1) relates to the same photo at different resolutions, we actually prepared 16 original photos (one photo from each of $4\times2\times2$ categories). The 16 photos were deliberately chosen to show subjects at substantially the same size in the same photos.

Procedure: We performed an experiment in which each participant used a laptop computer to view digital photos displayed on a website. Each participant was shown the above 48 digital photos at random and was asked to look for a specific person in each photo, then respond whether the presence of that person was at one of five levels: 1. "When I looked carefully at the photo, I eventually found the subject," 2. "I see the subject in the photo, but don't perceive a particularly strong presence," 3. "I feel that the subject's presence is strong, but is not particularly obvious," 4. "The subject is easy to see," or 5. "The subject is the focus of the photo and is extremely obvious." Note that only people who were facing forward were designated, and the same people were designated for all the participants in the same variety of photos.

We investigated the presence of subjects falling within the items and categories determined as described above, and created a regression formula.

3.2.2. *Results*

We scored the five levels of "presence" responses obtained for the 48 different subjects as described in Section 3.2.1 as 1 to 5, then used the quantification theory type I method to create a regression formula to determine presence. Since this quantification theory type I is characterized by multiple regression analysis, it is an analysis method that is used when objective variables are quantitative variables and explanatory variables are qualitative variables. In this case, the objective variables are the presence points (from 1 to 5) and the explanatory variables are: (1) size of photo (three categories), (2) number of people in photo (four categories), (3) area of face (two categories), and (4) location of face (two categories). Since an ordinal scale can also be used as an interval scale for presence points, it was treated as an interval scale in this study.

As the result of using a stepwise method (with F value 2) to analyze these variables, the seven variables shown in Table 1 were selected, with a level of significance of 1%. In other words, the regression formula for obtaining a presence y is as follows:

$$y = -0.092x_{12} - 0.487x_{13} + 1.109x_{21} - 0.28x_{23} - 0.896x_{24} + 0.41x_{31} + 0.443x_{41} + 2.894$$

(adjusted R square = 0.461, standard deviation of estimates = 0.879)

Note that since (2) the number of people in the photo and (3) the area occupied by each face are thought to display a considerable correlation among the variables, it is possible that multicollinearity could occur in the regression formula. To test that, we obtained the Variance Inflation Factor (VIF) for each item, but we did not see large values of VIF (Table 1). From this formula, we determined that a subject categorized as "size of photo: 640×480, number of people in photo: individual, area of face: large, location of face: center" had the largest presence (y = 4.856), whereas a subject categorized as "size of photo: 160×120, number of people in photo: party, area of face: small, location of face: periphery" had the smallest presence (y = 1.511). This conforms with the result that can be assumed from combining the categories. From the above, it is considered that multicollinearity does not occur.

Looking at the range of each item in Table 1, it is clear that "number of people in photo" > "size of photo" > "location of face" > "area of face," so the factor that has the largest effect on presence is the number of people in a photo.

Table 1. Results of quantification I data

Constant	Category	Partial regression coefficient	VIF	Range
X1: Size of photo	640×480	0		0.487
	320×240	-0.092	1.3	
	160×120	-0.487	1.3	
X2: Number of people in photo	Individual	1.109	1.5	2.005
	Group 1	0		
	Group 2	-0.280	1.5	
	Party	-0.896	1.5	
X3: Area of face	Large	0.410	1.0	0.410
	Small	0		
X4: Area of face	Center	0.443	1.0	0.443
	Periphery	0		
Constant		2.894		

3.3. *Study of validity of regression formula*

Since items and categories were determined in a top-down manner during the creation of the regression formula, we performed an experiment to confirm that presence can indeed be measured by this regression formula. We showed newly prepared photos to university students, then created a regression formula and asked about presence using the same procedure as above. We took the new mean values of presence we obtained as measured values, and investigated the correlation with predicted values obtained from the regression formula.

Participants: 57 university students, different from those of the study described in Section 3.2.

Materials: 120 photos of people, different from those of the study described in Section 3.2. From the consideration that the number of people in each photo has the greatest effect on the regression formula, these 120 photos were selected as described below.

We first prepared approximately 200 photos showing the activities of university students. To examine item (2) the number of people in each photo in detail, we classified these 200 photos into 11 types from single-person shots up to photos of ten people, and also larger groups. Although the number of people in each photo in group 1 and group 2 of the first study was within a wide range from three people to ten people, we selected and studied each photo within this category individually. In this study, we decided to use all of eight different varieties of photos within those two categories, ranging from three people to ten people. After taking this policy into consideration, we were left with 120 photos as a result of excluding photos such as those in which there is a bias in the number of photos for each category of the number of people depicted, photos in which one or two people are shown large, and photos in

which crowds of people are shown small. Within these 120 photos, we ended up with photos containing people that corresponded to 32 of the 48 different combinations of the categories of items (1) to (4).

Procedure: The environment and procedure were the same as those for the study of the creation of the regression formula. Each participant was presented with 32 photos selected at random from among the 120 photos. One person in the photo was designated for each photo, and the participants were asked to select one of the five levels of Section 3.2.1 on a multiple-choice form. Note that the designated person was always someone facing forward.

Results: When we took the mean values of the five levels of presence of the subjects in each category as measured values and obtained the correlation coefficients for predicted values obtained from the regression formula, we obtained r=.884. The results of non-correlation verification were significant ($F(1, 30)$=107.28 p<.01). The explanatory ratio was 78.1%, showing that there is a strong correlation between the two variables (Fig. 2). This demonstrated the validity of the regression formula; in other words, it suggested that this regression formula represents presence.

From the above, we were able to assign "presence" metadata for each subject in a photo, from (1) the size of photo, (2) the number of people in the photo, (3) the area of the subject's face, and (4) the location of the face.

4. USE OF PRESENCE TO DETERMINE EQUALITY IN GROUP OF PHOTOS

In this section, we use the presence metadata of Section 3 to investigate whether the equality of a group of photos can be determined. When considering how to use photos and how to define equality in a school's class newspaper or album, the following conditions apply:

- In principle, the subjects appearing in the group of photos belong to a group. (With students, that means they belong to a class or school year.)
- Each of the people belonging to the group appears at least once in the group of photos. (There is no case in which a specific student does not appear.)

Based on these conditions, we performed an experiment as described below.

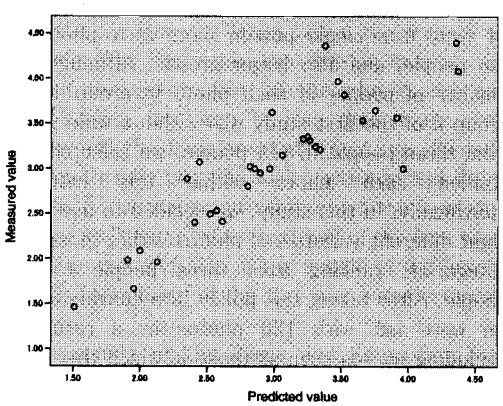

Fig. 2. Correlation between measured and predicted values

4.1. Study into determining equality

Using photos featuring university students, we created two different groups of photos and conducted an experiment to judge the equality of subjects appearing in each of these groups.

4.1.1. Creation of groups of photos

From the conditions given above, we first selected 16 students who belong to the same circle at university, as subjects appearing in a group of photos, and prepared 40 photos showing scenes of that circle's activities in the past. We adjusted the resolution to 320 × 240. No one outside of the group of 16 people was shown in the 40 photos. From these 40 photos, we selected 16 photos for each of two groups: one in which "there is no bias in the sum of presence of each of the 16 subjects" and another in which "each of the 16 people appears at least one, but there is bias in the respective sums of presence." We then labeled the first group as photo group a and the second group as photo group b.

It should be noted that "there is no bias in the sums of presence" is considered as follows. If we consider the strictest definition of bias-free sum of presence, that would mean that the sums of presence of all of the 16 people match exactly. However, it is not feasible to have such a perfect match. We therefore set a range and consider that the sums of presence of the members are equal if they all fall within that range. This range is called the "equality range" below.

In this experiment, we determined the equality range as follows. We first set the mean value of the sums of presence of all the subjects as a reference point. Next, from consideration of 16 photos in which each of the 16 constituent members of the group for this experiment

appeared at least once, we set the difference between the person with the largest sum of presence and the person with the smallest sum of presence to be smaller than the presence that would be equivalent for an individual photo. Since the mean value of presence of a subject in an individual photo was 4.337, the equality range of this study was taken to be: "the mean value of the sum of presence of each subject ± half the mean value of presence in one individual photo (= 2.169)".

For both groups of photos, we arranged all the photos in groups of four on sheets of A4 paper, and printed them using a color printer. In other words, we made a four-page spread, with four photos on each page. We added a neutral caption under each photo. The sum of presence and the number of appearances of each subject in both groups of photos are listed in Table 2.

Table 2. Sum of presence and number of appearances of each subject in photo groups a and b

Person No.	Sum of presence	Number of appearances	Person No.	Sum of presence	Number of appearances
Photo group a					
1	5.60	2	9	8.49	3
2	6.59	2	10	5.72	2
A 3	6.18	2	11	7.80	3
B 4	7.39	3	12	8.12	3
5	6.67	2	13	7.29	2
6	7.39	3	C 14	9.08	2
7	6.67	2	D 15	6.18	2
8	5.90	2	16	6.23	2
Mean value of sumes of presence				6.96	
4.79<	Equality range			< 9.12	
Photo group b					
1	6.89	2	9	14.58	5
E 2	14.75	5	10	19.67	6
3	7.30	2	H 11	6.87	2
4	7.92	3	12	9.65	3
F 5	19.85	5	13	7.69	2
G 6	2.32	1	14	7.56	2
7	4.84	2	15	2.8	1
8	21.26	6	16	1.91	1
Mean value of sumes of presence				9.74	
7.57<	Equality range			< 11.91	

4.1.2. *Summary of experiment*

Participants: 17 university students, different from those of the experiment described in Section 3. Eight of these students themselves belonged to the group of 16 students shown in the photos, and the other nine were not in that group of 16 but knew all of the members of that group well. We divided the participants into two groups because

Table 3. Photos in which Subjects A to D and Subjects E to H appeared in photo groups a and b, and values of presence in those photos

	Photo No.→	1	2	3	4	6	9	12	16	Presence sum
	Participant No.↓	Individual	G1	G1	G2	Individual	G2	Party	G2	
Photo group a	(A)3		Large, center		Small, Periphery					6.18
			3.65		2.52					
	(B)4						Small, Periphery	Small, Periphery	Small, center	7.39
							2.52	1.91	2.97	
	(C)14	Large, center				Large, Periphery				9.08
		4.76				4.32				
	(D)15			Small, center	Large, center					6.18
				3.25	2.93					

For example, Subject A appeared in photos 2 and 4 of photo group a.
- For photo 2, (1) the number of people in the photo placed it in group 1, (3) the area occupied by the face of Subject A was large, and (4) the location of the face was at the center.
- For photo 4, (1) the number of people in the photo placed it in group 2, (3) the area occupied by the face of Subject A was small, and (4) the location of the face was at the periphery.

	Photo No.→	1	2	3	4	5	6	7	8	11	13	16	Presence sum
	Participant No.↓	G1	G1	Individual	Individual	G1	G2	Party	G1	Individual	G1	G1	
Photo group b	(E)2						Large, Periphery	Small, Periphery	Large, Periphery		Large, Periphery	Large, Periphery	14.75
							3.21	1.91	3.21		3.21	3.21	
	(F)5	Large, Periphery		Large, center	Large, center			Small, center		Large, center			19.85
		3.21		4.76	4.76			2.35		4.76			
	(G)6							Large, Periphery					2.32
								2.316					
	(H)11					Large, center			Large, Periphery				6.87
						3.66			3.21				

Note: (1) photo size: 320 x 240 , (2) number of people in photo (individual: individual photo; G1:group 1; G2: group 2; Party: party photo)
Upper level: (3) the area occupied by the face (large or small) and (4) the location of the face (center or periphery)
Note: Data omitted for subjects other than Subjects A to H and for photos other than those in which Subjects A to H appeared.

we considered the possibility that there might be differences in the perception of equality depending on whether or not the participants appeared in the photos.

Materials: Printouts of photo groups a and b, together with a questionnaire, prepared as described in Section 4.1. The questions asked were: (a) Do you think that the degree of appearance of the 16 people belonging to this group is equal over the entire group of photos? (b) One specific person is designated from within the 16 people--do you think that that person is shown equally in comparison with the other people in the group? And (c) How do you rate that person's presence? For questions (a) and (b), which deal with equality, the participants were asked to rate them on a four-point scale: 1. Equal, 2. Roughly equal, 3. Fairly unequal, and 4. Unequal. For question (c) concerning presence, they were asked to rate them by the same five levels as those given in Section 3.2.1 when we created the regression formula. The designated people were four people from each of the two groups, called Subjects A to H. The numbers of the photos in which each of Subjects A to H appear and the presence points of each subject are listed in Table 3. In photo group a, Subjects A and D each appear twice and their sums of presence are about the same; Subject C appears twice, with an equality range that is fairly high; and Subject B has about the same sum of presence as Subjects A and D, but appears three times, although only in party and group photos. In photo group b, Subjects E and F each appear five times and have excessive presences, Subject G appears once and has a minimal presence, and Subject H appears twice and is one of the subjects of photo group b whose presence is close to the central value.

Procedure: The participants were first shown photo group a and were asked to respond to the questionnaire. They were allowed to go over the group of photos as many times as they wanted. They were then shown photo group b in a similar manner.

4.2. *Results*

4.2.1. *Whether or not each participant was included*

When we compared the responses of a group in which the participants themselves were subjects of the photos and a group in which they knew the subjects, no significant difference was seen concerning any of the items, as described below. Therefore, the results given below are described for both groups together (N= 17).

4.2.2. *Presence of specific people*

We asked about presence for specific persons A to H. In contrast to the experiment of Section 3 in which presence was judged within single photos, the presence of a specific person was judged within a number of photos in the experiment of Section 4.

When we analyzed variance in photo group a, taking a dependent variable as a mean value of presence, the effect of the group was significant ($F(3, 42) = 19.7$, $p<.01$), and the result of multiple comparisons showed that C > A = D > B ($p<.01$) (Table 4). This result substantially matched the sequence of sums of presence. Although the sums of presence of Subjects A, D, and B did not vary much, the reason the presence of B was determined to be low was considered to be because B's presence was small despite appearing in three photos. In photo group b, too, the effect of the group was significant ($F(3, 42) = 206.26$, $p<.01$), and the result of multiple comparisons showed that E = F > H > G ($p<.01$) (Table 4), which substantially matched the sequence of sums of presence.

4.2.3. *Equality of specific persons*

Concerning the equalities of specific persons, we found that the equalities of Subjects A to D in photo group a was perceived to be "roughly equal" (Table 5). Even variance analysis of the mean values for Subjects A to D did not produce a significant difference ($F(3, 42) = 1.78$, *n.s.*). On the other hand, we found that the equalities of Subjects E to H were determined to be from "fairly unequal" to "unequal" (Table 5).

Table 4. Results of asking about presence of Subjects A to H in photo groups a and b
(Mean score: 1. Weak presence <--> 5. Strong presence)

	Photo group a				Photo group b			
	A	B	C	D	E	F	G	H
M	2.82	2.00	3.76	2.94	4.65	4.94	1.18	3.12
SD	0.88	0.71	0.44	0.75	0.61	0.24	0.39	0.60

Table 5. Results of asking about equality of Subjects A to H in photo groups a and b
(Mean score: 1: Equal <--> 4: Unequal)

	Photo group a				Photo group b			
	A	B	C	D	E	F	G	H
M	1.82	2.29	1.94	1.94	3.71	4.00	3.94	3.00
SD	0.81	0.92	0.75	0.56	0.47	0.00	0.24	0.61

4.2.4. *Equality of entire group of photos*

When we averaged responses concerning equality for the entire group of photos, we found that photo group a was thought to be "roughly equal," whereas photo group b was thought to be "unequal" (Table 6).

From this, we determined that the 16 subjects in photo group a were judged to appear more-or-less equally, whereas the subjects in photo group b were judged to appear unequally.

4.3. *Discussion*

In this section, we use the sum of presence to investigate whether or not the equality of a group of photos can be determined. First of all, there was no difference when participants themselves appeared in the photos. Although we initially expected that there would be a possibility of variations in evaluations of presence and equality when participants were in the photos, no significant difference was found for any of the items. From this we found that the sum of presence can be used as a fixed baseline to ensure objectivity when teachers select photos.

From the results concerning the presence and equality of specific persons and the results concerning equality for the entire group of photos, we found that the group of photos as a whole was judged to be "roughly equal," although some differences were found in the presences of Subjects A to D in photo group a. With photo group b, on the other hand, we found that both excessive appearances and insufficient appearances were judged to be unequal, and the entire group of photos was also perceived to be unequal.

The above results suggested that equality can be determined by using the sums of presence of subjects to select photos that lie within the equality range.

In the future, it will be necessary to study baselines for determining equality. The present study used only simple sums of presence, but with this method, the presence with respect to photos becomes greater as the number of subjects in photos increases. In photo group a, although Subjects A and D who appeared twice each and Subject B who appeared three times had sums of presence that were not greatly different, the presence of Subject B in the group of photos was determined to be significantly lower. This result supports our assertion that equality cannot be guaranteed by simply counting the numbers of appearances, and also shows that a determination of equality by just simple sums of presence is also insufficient. This shows that some means of normalizing the sums of presence for each photo is necessary, in order to create a practical system based on determinations of equality.

Table 6. Results of asking about equality of entire photo groups a and b
(Mean score: 1: Equal <--> 4: Unequal)

	Photo group a	Photo group b
M	1.82	4.00
SD	0.64	0.00

5. CONCLUSIONS AND TOPICS FOR FURTHER STUDY

The conclusions of this research are as follows: We created a regression formula that expresses the subjective evaluation of "presence" from four objective items: (1) size of photo, (2) number of people in the photo, (3) area occupied by the subject's face, and (4) spatial location of the subject's face. The use of sums of presence calculated from this regression formula suggested it is possible to determine the equality of members who are depicted in a number of photos. We consider that these results will be of service as a new type of metadata for managing digital photos on site at schools.

The following are suggested as future topics of research: First of all, we would like to re-investigate categories relating to the creation of presence metadata. It is clear from this paper that it is possible to create a regression formula for expressing "presence" from 48 different items of qualitative data determined in a top-down fashion. As a future method for investigation, we consider it will be possible to create a more elaborate regression formula for presence by using these four items as quantitative data, without converting them into qualitative data. For example, it could be possible to obtain the area or location of a face as quantitative data by obtaining the coordinates of a rectangle surrounding the face, then calculating the proportion of the entire photo occupied by the face or the distance from the center of the photo to that face. We would also like to study whether or not factors such as the directions of faces or overlapping of faces can be included in the items relating to the areas occupied by faces and the locations of those faces, which were not included in the considerations for this study.

Next, we consider that further study is necessary into the usage of presence in

determining equality. We would like to study how to set an equality range for an entire group of photos, in addition to investigating determination baselines as discussed in Section 4.3. In addition, the present study related to experiments in the usage of a group of photos to investigate the equality of 16 people from 40 photos showing ordinary activities, which is an extreme example for a group of photos. In the future, we would like to conduct experiments concerning equality determination in which a new group of photos is created by increasing the number of photos or by preparing photos that are specifically designed for the experiments.

As another topic relating to the two mentioned above, the work involved in inputting metadata becomes greater when there are more than a certain number of people in photos, such as group or party photos. As was shown in Section 3.2.2, since the number of people in a photo has the largest effect on the presence regression formula, we would like to try to lighten the load of metadata input by some means such as batch processing of presence when the number of people is greater than a certain level.

In conclusion, presence metadata was used only for determining equality in this research, but we would also like to study applications for such metadata outside of equality, such as estimating personal relationships within specific groupings or determining degrees of distinction between people.

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