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Photograph to demonstrate the lightness constancy of a real scene

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ABSTRACT

A scene photograph does not give us the lightness constancy and we see in the photograph a different brightness distribution from the read scene. We modified photographs in their lightness by making a dark shadow part brighter and found which modification was proper to give the same brightness impression on the photograph as for the real scene. It was found that the photograph modified to match with a real experimental room in whiteness distribution along the vertical direction of the wall gave the best match in the overall impression of the brightness distribution to the real room.

1. INTRODUCTION

Whether a room is illuminated brightly or dimly a white paper in the room appears white independently from the illuminance level. The phenomenon is called the lightness constancy. Even in a room with one level of illuminance the luminance of a wall changes depending on the distance from the illumination light and at shadows of objects such as a shelf on the wall. But when one enters the room and looks at the wall the brightness impression of the wall at upper portion and the lower portion remains more or less same to him and that for the shadow of the shelf does not appear as dark as its luminance shows. This is also a phenomenon of the lightness constancy. There have been developed many theories to explain the lightness constancy as well as the color constancy and one of them is the RVSI theory, the recognized visual space of illumination theory, developed by Ikeda et al.[1, 2]. The theory emphasizes the recognition of a space and the adaptation to the illumination filling the space. Mooklai et al. confirmed the theory in the case of the lightness constancy[3]. When a subject looked at portions above and below of a shelf on the wall in a room from outside through a small hole without allowing him a space perception for the room the brightness simply reflected the luminance on the wall. But when he entered the room to allow him the space recognition the brightness was not so much different at above and below. The lightness constancy took place. By the same token the lightness constancy does not take place in a photograph for which we can not perceive a space. If we make an interior catalogue of a house by a photograph that reproduces luminance distribution of the room correctly the photograph does not

give clients a correct impression of the real room. It is needed to produce photographs that really give the same impression of brightness of interior to give satisfaction to clients. In this paper we developed a picture that gave the same brightness impression as for a real room by referring to the technique of modifying photograph presented previously[4] and confirmed the validity of the photograph as a catalogue.

2. APPARATUS AND EXPERIMENT

Figure 1 shows rationale to obtain a photograph Pw faithful to the subject's perception from a real scene of which luminance Y is available. Pp indicates a picture to physically reproduce Y of the real scene. W on the right flow indicates the amount of whiteness on the real wall measured by the elementary color naming method. Then we transfer W to L* by a formula $L^* = (W + 31.9)/1.4$, which was obtained previously[4] and modify Pp to give the L*, which is Pw or a photograph to have the same whiteness amount as a real scene. *Fig.*

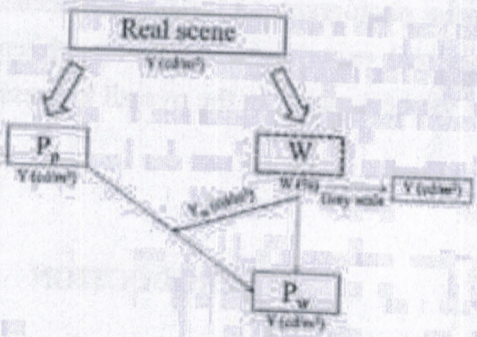

Fig. 1 A flow chart to modify a photograph to give the impression as for the real space.

An experimental room was of the size of 230 cm deep, 120 cm wide and 200 cm high. It was decorated by some objects to simulate a normal room. On the front wall a shelf was attached and its depth was changeable to either of 20, 30, and 40 cm. The room was illuminated by a white light of the daylight type at 80 lx on the shelf.

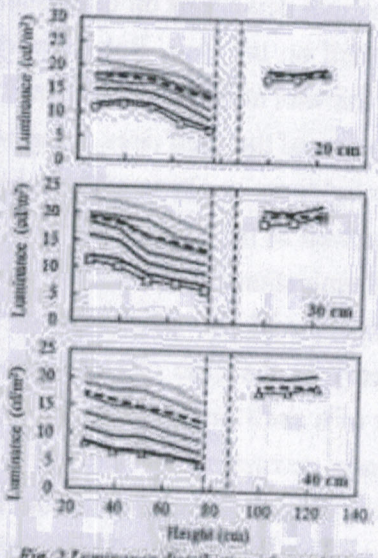

Fig. 2 Luminance distribution of a real room (a thick line with symbols), of a photograph to give the same whiteness impression as for the real room (a thick dotted line), and of photographs used in the present experiment.

To confirm the photograph Pw given by the whiteness measurement perceptually close to the real room we employed a pair comparison technique. Circles, squares, and triangles in Fig. 2 show the luminance at 8 points on the front wall at different height shown on the abscissa for the cases of shelf depth 20 cm, 30 cm, and 40 cm, respectively. Two vertical dotted lines indicate the width of the shelf seen from the subject's eyes. A thick dotted curve shows the luminance that was transferred from the amount of witness measured for this room[3], which corresponds to Pw in Fig. 1.

Six photographs of the front scene of the room were prepared to give different luminance distribution around Pw by using the level tool of Photoshop CS5.1 and

by trial and error. The results are shown by thick solid lines and we called them the photograph number 1, 2, , , 6 from the bottom. The picture number 4 was closest to Pw.

In the experiment a subject was asked to sit in the room facing the front wall and was presented six photographs one by one in a randomized order. He was asked to look at the photograph and the real room freely and compare the brightness distribution along vertical direction of the wall. He was asked to respond "darker" if the lower part of the shelf is darker in the photograph compared to the real room in the comparison of the distribution, or "brighter" if the part is brighter. He should always consider the distribution of the wall brightness along the vertical direction in making the judge. The observation was repeated for ten times for each photograph. Two subjects participated in the experiment.

3. RESULT AND DISCUSSION

Results are shown in Fig. 3 for the subject CP and KT. The abscissa shows the photograph number and the ordinate the percentage of "brighter" response. Circles are for 20 cm depth of shelf, squares for 30 cm, and triangles for 40 cm. Then we took the average of the two subjects for each shelf and showed them in Fig. 4 by using the same symbols for shelf depth as in Fig. 3. The photograph number corresponding to 50 % of brighter response can be read out from the curves to be 3.7 for 20 cm, 4.3 for 30 cm, and 3.3 for 4o cm. They are not too far from number 4 which was Pw obtained by the whiteness measurement.

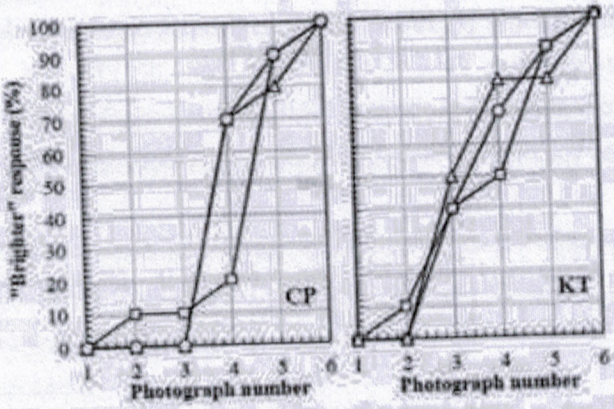

Fig. 3 Percentage of "brighter" response for different photographs. Subjects, CP and KT.

Figure 5 shows two photographs, one on the left to show the same luminance distribution on the front wall of the experimental room and the other on the right to show the photograph to give the same perception of the brightness distribution as for the real room. The right photograph should serve a better photograph to be shown to clients when they like to know the real impression of the interior. The result of present experiment was supported the reducing of luminance at the shadow part in the picture to match with brightness impression in the real scene.

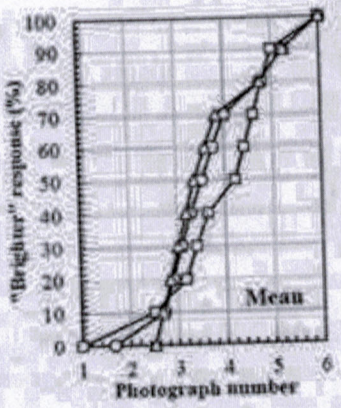

Fig. 4 Average result from two subjects.

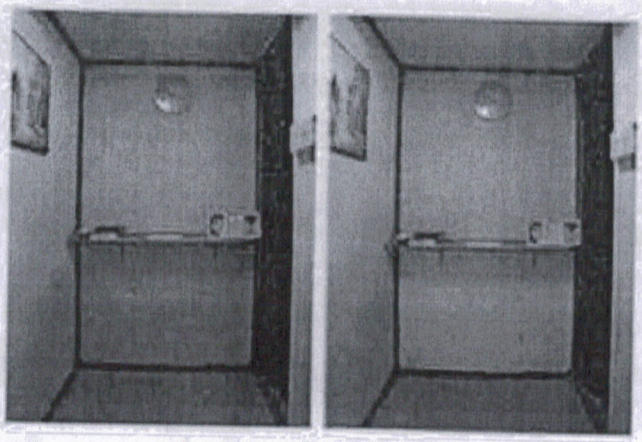

Fig. 5 A Photograph representing a real room in the luminance distribution (left) and that representing the perception as for the real room (right).

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