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Evaluation of Camera APP Interface Element Layout Based on Interface Aesthetics Model

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ABSTRACT

With the popularity of large screen smartphones, more and more mobile apps have emerged in the market. However, there are few studies on the comprehensive aesthetics of camera app interfaces. Therefore, this paper proposes a method for evaluating the aesthetics of camera app interfaces by selecting appropriate aesthetics measures, introducing the hierarchical analysis method and an algorithm for quantifying measures. In this paper, we also selected existing camera interfaces to validate the method, and the results showed the effectiveness of the method for evaluating the aesthetics of camera app interfaces.

Keywords: App interface, Aesthetics evaluation, Aesthetic measures, AHP

INTRODUCTION

The interface includes software interface and hardware interface. The software interface (user interface,UI) discussed in this paper mainly refers to the interface which can make people communicate with computers, and the interface design can improve the user's efficiency while improving the interface aesthetics by designing and layout the elements in the interface (Lai, 2010).

Ngo et al. (2002) proposed 13 indicators to evaluate the aesthetics of interfaces from different dimensions. By using these aesthetics indicators, the qualitative indicators of interface aesthetics can be quantified and the scientific nature of interface aesthetics evaluation can be improved (Lai, 2010).

SELECTION OF EVALUATION MEASURES

Taking into account the functional differences of camera APP interfaces, through user interviews and designer guidance, this study selected six specific aesthetic measures as evaluation measures to quantify.

Measure of Simplicity

Simplicity refers to the degree of alignment between elements (Ngo, 2003).

$$\mathrm{SMM} = \frac{3}{n_v + n_h + n} \in [0, 1]. \tag{1}$$

Here nv and nh are the number of different x and y coordinates; n set as the total number of rectangles.

Measure of Sequence

A sense of sequence is a necessary requirement for any interface design.

$$\mathrm{SQM} = 1 - \frac{\sum_{j=\mathrm{LR,\ LL,\ UR,\ UL}} |q_j - v_j|}{8} \in [0, 1]. \tag{2}$$

Among them, {q LR, q LL, q UR, q UL} = {1,2,3,4}.

$$v_j = \begin{cases} 4\ w_j = \text{Maximum} \\ 3\ w_j = \text{the 2nd biggest} \\ 2\ w_j = \text{the 3rd biggest} \\ 1\ w_j = \text{the minimum} \end{cases} \quad j = \mathrm{LR,\ LL,\ UR,\ UL}. \tag{3}$$

$$w_j = q_j \sum_{i}^{n_j} a_{ij}. \tag{4}$$

$$w_j = \{w_{LR},\ w_{LL},\ w_{UR}, w_{UL}\}. \tag{5}$$

The LR, LL, UR, UL are the four quadrants, nj set as the number of rectangle in j part and aij set as the size of rectangle i in part j (Sun and Xue, 2021).

Measure of Symmetry

For measuring the symmetry of the interface (Ngo, 2003).

$$\mathrm{SYM} = 1 - \frac{|\mathrm{SYM}_{\mathrm{vertical}}| + |\mathrm{SYM}_{\mathrm{horizontal}}| + |\mathrm{SYM}_{\mathrm{radial}}|}{3} \in [0, 1]. \tag{6}$$

$$\mathrm{SYM}_{\mathrm{vertical}} = \frac{\begin{array}{c} |X'_{UL} - X'_{UR}| + |X'_{LL} - X'_{LR}| + |Y'_{UL} - Y'_{UR}| + |Y'_{LL} - Y'_{LR}| + \\ |H'_{UL} - H'_{UR}| + |H'_{LL} - H'_{LR}| + |B'_{UL} - B'_{UR}| + |B'_{LL} - B'_{LR}| + \\ |\theta'_{UL} - \theta'_{UR}| + |\theta'_{LL} - \theta'_{LR}| + |R'_{UL} - R'_{UR}| + |R'_{LL} - R'_{LR}| \end{array}}{12}. \tag{7}$$

$$\mathrm{SYM}_{\mathrm{horizontal}} = \frac{\begin{array}{c}\left|X'_{UL} - X'_{LL}\right| + \left|X'_{UR} - X'_{LR}\right| + \left|Y'_{UL} - X'_{LL}\right| + \left|Y'_{UR} - Y'_{LR}\right| + \\ \left|H'_{UL} - H'_{LL}\right| + \left|H'_{UR} - H'_{LR}\right| + \left|B'_{UL} - B'_{LL}\right| + \left|B'_{UR} - B'_{LR}\right| + \\ \left|\theta'_{UL} - \theta'_{LL}\right| + \left|\theta'_{UR} - \theta'_{LR}\right| + \left|R'_{UL} - R'_{LL}\right| + \left|R'_{UR} - R'_{LR}\right|\end{array}}{12}. \tag{8}$$

$$\mathrm{SYM}_{\mathrm{radial}} = \frac{\begin{array}{c}\left|X'_{UL} - X'_{LR}\right| + \left|X'_{UR} - X'_{LL}\right| + \left|Y'_{UL} - Y'_{LR}\right| + \left|Y'_{UR} - Y'_{LL}\right| + \\ \left|H'_{UL} - H'_{LR}\right| + \left|H'_{UR} - H'_{LL}\right| + \left|B'_{UL} - B'_{LR}\right| + \left|B'_{UR} - B'_{LL}\right| + \\ \left|\theta'_{UL} - \theta'_{LR}\right| + \left|\theta'_{UR} - \theta'_{LL}\right| + \left|R'_{UL} - R'_{LR}\right| + \left|R'_{UR} - R'_{LL}\right|\end{array}}{12}. \tag{9}$$

X'_j, Y'_j, H'_j, B'_j, θ'_j, R'_j can be obtained by normalization.

$$X_j = \sum_i^{n_j} \left|x_{ij} - x_c\right|. \tag{10}$$

$$Y_j = \sum_i^{n_j} \left|y_{ij} - y\right|. \tag{11}$$

$$H_j = \sum_i^{n_j} h_{ij}. \tag{12}$$

$$B_j = \sum_i^{n_j} b_{ij}. \tag{13}$$

$$\theta_j = \sum_i^{n_j} \left|\frac{y_{ij} - y_c}{x_{ij} - x_c}\right|. \tag{14}$$

$$R_j = \sum_i^{n_j} \sqrt{(x_{ij} - x_c)^2 + (y_{ij} - y_c)^2}. \tag{15}$$

(xij, yij) and (xc, yc) indicate the center coordinate of rectangle i in part j and interface, respectively; hij and bij represent the length and width of the rectangle.

Measure of Density

A degree of tightness in the interface (Ngo, 2003).

$$DM = 1 - 2\left|0.5 - \frac{\sum_i^n a_i}{a_{\mathrm{frame}}}\right| \in [0, 1]. \tag{16}$$

Among them, ai and aframe are the area of the rectangle and the interface.

Measure of Balance

It refers to the sense of stability (Ngo, 2003).

$$BM = 1 - \frac{\left|BM_{vertical}\right| + \left|BM_{horizontal}\right|}{2} \in [0,1]. \tag{17}$$

$$BM_{vertical} = \frac{w_L - w_R}{\max(|w_L|, |w_R|)}. \tag{18}$$

$$BM_{horizontal} = \frac{w_T - w_B}{\max(|w_T|, |w_B|)}. \tag{19}$$

$$w_j = \sum_{i}^{n_j} a_{ij} d_{ij} \quad j = T, D, L, R. \tag{20}$$

T, D, L and R are up, down, left and right; dij set as the distance from the rectangle midline to the app midline (Xie et al., 2021).

Measure of Regularity

Regularity refers to the degree of consistency between interface elements (Ngo, 2003).

$$RM = \frac{\left|RM_{alignment}\right| + \left|RM_{spacing}\right|}{2} \in [0,1]. \tag{21}$$

$$RM_{alignment} = \begin{cases} 1 & \text{if } n = 1 \\ 1 - \frac{n_v + n_h}{2n} & \text{otherwise} \end{cases}. \tag{22}$$

$$RM_{spacing} = \begin{cases} 1 & \text{if } n = 1 \\ 1 - \frac{n_s - 1}{2(n-1)} & \text{otherwise} \end{cases}. \tag{23}$$

Nv, nh and n have the same meaning as above; ns represents the number of different intervals between the different x and y coordinates of rectangles.

METHODOLOGY AND RESULTS

The test selects the top 6 camera APPs in APP store as the sample, abstracts the functional partition as the smallest rectangle, draws it with the rectangle tool in Photoshop, and reads the width and height as well as the X and Y coordinates of each element in the interface as raw data input as shown in Table 1.

A Comprehensive Evaluation Method for Layout Aesthetics Based on AHP

Hierarchical analysis was used to allow designers to assign values to six aesthetic indicators by comparing them two by two to determine the relative importance of the indicators (Lai, 2010). The consistency of the judgment matrix was also checked, and if it is reasonable, the weights were standardized and brought into the equation (24) for calculation (Zheng et al., 2009).

Table 1. Interface App 6 camera.

Name	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6
Original image						
Processed image						

Table 2. Specific parameters of each element in the camera interface 1

C	SMM	SQM	SM	DM	BM	RM
SMM	1	5	2	3	1	3
SQM	1/5	1	1/3	1/3	1/5	1/2
SM	1/2	3	1	1	1/2	4
DM	1/3	3	1	1	1/5	2
BM	1	5	2	5	1	7
RM	1/3	2	1/4	1/2	1/7	1

Then the order of each interface is obtained by comparison, and then the existing interface design can be optimized according to the data.

The maximum eigenvalue of matrix C is obtained by Matlab software: L max = 6.2200, and the weight vector is [0.2724, 0.047, 0.1564, 0.1119, 0.3491, 0.0632]. Then the RI = (0, 0.58, 0.96, 1.12, 1.24) is obtained CRRI = 0.0355 < 0.1, verify that the consistency of the above matrix is in accordance with the criteria.

The Evaluation of the Aesthetics Measure of Each Camera APP

According to equations (1) to (23), the six aesthetic indexes of each app are calculated separately, and the weight values obtained from the hierarchical analysis above are brought into the equation (24) to obtain the comprehensive interface aesthetic of each program. The corresponding data are obtained as shown in Table 2.

$$D = \sum_{i}^{n} D_i \cdot w_i \,. \tag{24}$$

With the results shown in Table 3, we can see that in all six interfaces, camera 1 has the highest score and camera 3 has the last score, for many reasons.

Table 3. Calculated values for each aesthetic index of the camera App interface.

Number	SMM	SQM	SM	DM	BM	RM	Comprehensive aesthetics
1	0.06	0.5	0.32	0.15	0.89	0.32	0.4369
2	0.14	0	0.89	0.07	0.40	0.17	0.3343
3	0.07	0.25	0.80	0.12	0.37	0.17	0.3077
4	0.06	0	0.76	0.14	0.51	0.28	0.3486
5	0.06	0	0.76	0.14	0.57	0.36	0.3728
6	0.07	0.5	0.83	0.11	0.59	0.26	0.4059

Table 4. Comparison of the aesthetic measures of the NO.3 interface before and after optimization.

Number	Interface	SMM	SQM	SM	DM	BM	RM	Comprehensive aesthetics
No.3 before optimization		0.07	0.25	0.8	0.12	0.37	0.17	0.31
No.3 after optimization		0.07	0.25	0.8	0.66	0.71	0.31	0.5

As shown in Tab 1, the function key of camera 1 is basically symmetrical in the left and right direction, the distribution is uniform, the function key is mainly concentrated in the lower part, and the interface appears to be relatively stable and balanced. The function key of camera 3 in the middle position breaks the symmetry relation between the left and right, and the function key of the right half of the interface is obviously more than that of the left half, which forms the obvious effect of right weight and left light visually.

Improved Programmes

The design of the interface of camera 3 was redesigned to obtain the interface shown in Table 4, and the same method as above was used to test the design results. According to Equation (24), the final comprehensive aesthetic of the interface of camera 3 is: D = 0.5044>0.3077. From the calculated values, it can be seen that the overall aesthetic score of the design solution has been improved to some extent, so the method can guide the improvement of the design solution to some extent.

DISCUSSION AND CONCLUSION

In this study, six aesthetic evaluation values were extracted and quantified according to the characteristics of mobile camera applications; and the weights of each index were obtained by AHP method to establish a set of models for evaluating the comprehensive aesthetics of mobile camera interfaces. By calculating and comparing the comprehensive aesthetic values of the interfaces of the six apps and optimizing the interfaces, it is verified that the method can scientifically guide the improvement of the interface design scheme. However, there are still shortcomings in this research work: when dealing with camera APP interfaces, elements of different shapes are uniformly treated as rectangles, so the influence of shapes on interface aesthetics is not taken into account. In order to better help designers and users select and optimize interface design solutions, further research will be conducted in future studies by taking the shapes of elements into account.

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