Interval Scoring Method on Vehicle Seat Comfort Evaluation

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Abstract This paper provided an evaluation method to analyze the comfort interval of automobile seats. According to the theory and analytical procedure of interval parameter structure, based on the human pressure data and valuation results of a large number of automobile seat comfort subjective evaluation tests, the uncertain mathematical relations between objective data of automobile seat comfort test and subjective evaluation scores could be established. This mathematical relation was called interval relationship. The author established the seat evaluation database with a large number of test results, and developed an evaluation method of seat comfort interval with the application of the mathematical model. The Result of the analysis on the feasibility and effectiveness of the evaluation method proved that it could provide more reliable seat comfort evaluation results. The seat design engineer could use this method to replace the complex manual seat evaluation process. Meanwhile, the comfort score provided theoretical guidance for automobile seat design and improvement.

1. Preface1

The automobile industry had been developing for over a hundred years, and its performance had been breaking through its limits. But no matter how the car develops, the car was always servant, and the evaluation of the car is essentially subjective. Car seat comfort evaluationwas also a typical one. China's car seat factory attached great importance to the introduction of foreign advanced seat production of manufacturing technology, processing equipment and production materials, and even completely imitate its shape, but the car seat design concept of inadequate research related research was also very limited.

Based on the above requirements, this paper presents a method for evaluating the comfort of car seats in line with the physical characteristics of Chinese people. First of all, according to the Chinese seat comfort subjective evaluation test to obtain a large number of subjective evaluation data and seat pressure data, and then through the classification and screening to form a representative representative of the subjective evaluation database. Then, the subjective evaluation of the data for numerical analysis, through the mathematical method of objective, that is, the formation of seat comfort function. Finally, the human body pressure data, seat sample data and evaluation scoring data in the database were integrated into a seat

comfort evaluation method according to their association function, and then the software was formed. Through this software, seat manufacturers could quickly get the seat comfort score, thus saving the foreign hirers to assess the division time and cost, to ensure that the score was in accordance with the Chinese people's physical characteristics and driving habits of the comprehensive derived.

2. Seat comfort test method and subjective evaluation score

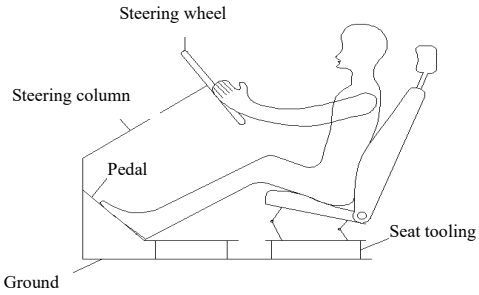

Fig.1 The posture of the experimenter

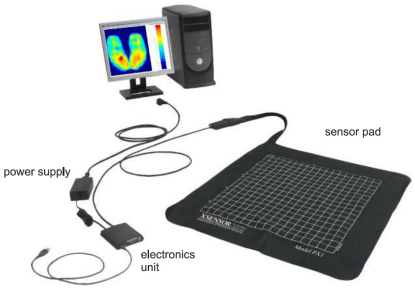

Fig.2 x-sensor pressure distribution test system

The seat comfort test bench contained a driving simulator. Among them, the main test equipment was x-sensor pressure distribution test system, as shown in Figure 2. It could test the body and the seat interface pressure distribution and pressure data. Evaluation of the left hand grip steering wheel 9 o'clock position, the right hand grip the steering wheel 3 o'clock position, the palm of your hand a little tight, the thumb naturally. The feet were placed on the clutch 4 pedal (the force effect could also be equivalent to the left foot position of the automatic truck) and the accelerator pedal.

The test evaluation form was mainly filled by the subjects, including the information of the subjects, the main content of which was the subjective evaluation results of the subjects. Back scoring: from the back to the lower back to the front of the thigh, a total of points for the 1-9 area. As shown in Figure 3. The experimenter asked the main feeling of comfort in these areas and gave a comprehensive score. Buttocks score: the same feeling 10-15 area, as shown in Figure 3. The experimenter was asked to primarily feel the comfort of these areas and give a comprehensive score.

3. Evaluation index of body pressure distribution

Seat comfort evaluation of the objective data was mainly pressure cushion and back pad measured pressure cloud. Summary of the common characteristics of the cloud been found, the greater the maximum pressure of the hard cushion. However, for the same material of the seat, due to the difference in surface shape, making the number of pressure sensors were different, the average pressure was also different. This also reflected the complex relationship between seat shape and human stress. This point seat design engineers are generally recognized[11].

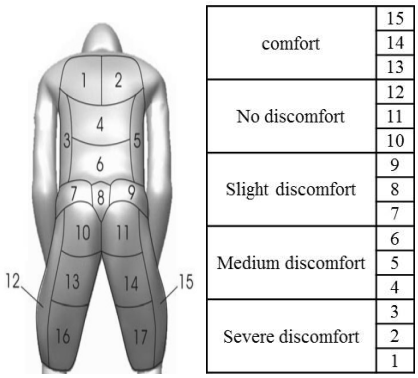

Fig.3 Scoring rules

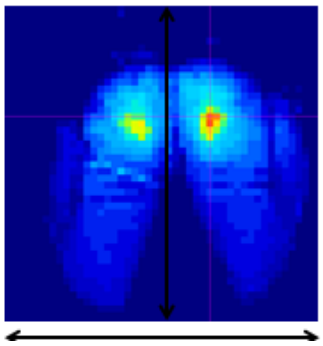

Fig.4 Hip pressure distribution

In addition, from Figure 4, it could be seen that even the same person buttocks or back pressure was not completely symmetrical. A peak was randomly generated during the measurement. But throughout the experiment, a measured seat scoring and an evaluation of the pressure data association could be basically consistent. Using this consistency, we try to let the evaluator sit down and stay in the experiment for some time to collect data. Experiments showed that this aspect was better to ensure the consistency of the relationship between the pressure distribution and the shape of the seat. So the seat comfort test time required the experimenter to take more than 5 minutes to ensure data accuracy. Back data with the same.

Personal stature and weight were different. Seat comfort experiment found that the body's body weight and body weight was directly related. After the data processing and data analysis, this difference should also be reflected. Experiments show that, regardless of which type of body index (BMI) of the experimenter of the degree of pressure changes and scoring results are more closely related. However, the shape of the different indicators of the experimental changes in this situation was still different. Therefore, different methods of evaluation should be designed according to different shape indicators. According to the international BMI algorithm, we divided the experimenter into three categories: thin: less than BMI <18.5; normal: BMI = [18.5-24.99]; fat: BMI> 25.

4. Database establishment

We summarized the pressure cloud data and subjective scoring results of all seat evaluators and form the database. According to the evaluation of the seat of the past for the evaluation of these seats in the past, we screen out all the evaluation results of large differences in the cloud and scoring. In this way, the rest of the data was more reliable scoring and pressure corresponding to the statistical results. And then in accordance with the shape of different indicators of experimental subjects, and in accordance with the level of high and low order to sort the data.

This database was mainly used to provide seat developers with reference to the development of seat data. More importantly, we can use these experimental data to find important aspects of seat comfort evaluation, and accordingly form a seat comfort evaluation method.

5. Seat comfort interval evaluation method

We were divided into three groups according to the BMI standard of the human body, respectively, to establish the evaluation method. It was important to note that although the three groups of data are different but the method is the same.

In the same group of people, all the pressure cloud diagram, whether it was the number of pressure points or pressure values are different. So it was necessary to use the normalization method in the evaluation of unified data specifications.

In the evaluation, we used the interval method to measure the data interval, that was, considering the uncertainty of the test process, and then modified the evaluation results. The data processing as follows:

Step 1: Normalization.

The data measured by x-sensor is the pressure data measured by the pressure sensor at each point. Set the number of pressure points that are not zero. These data were converted to the ratio of the pressure value to

the maximum pressure value

$$pp_i = p_i / p_{\max} \quad (1)$$

The ratio was divided into 10 segments from 0.1 to 1, and the number of pressure points in ten segments [0.0-0.1, 0.1-0.2, ..., 0.9-1] was counted. And then divide these values by the number of sensors with a pressure value, which was converted to the ratio of the total number of pressures

$$mm_k = m_k / m_{\max} \quad (2)$$

Step 2: form the basic evaluation index curve.

The proportion of the points in the respective pressured intervals corresponds to the formation of a two-dimensional fold line. The spline curve fitting method was used to fit into a two-dimensional function curve approximating this line, which was the basic evaluation index curve function.

Step 3: the establishment of evaluation criteria curve library.

The seat rating was in the range of 1 to 10, and the reference seats that have been evaluated comfortably according to the traditional method are sorted by 1-10. And then according to the human body BMI algorithm of the body of the three categories to select the experimental staff seat, and measured pressure cloud. Finally, through the above steps and the second step to established the basic evaluation index curve could be formed under different scores of the evaluation standard curve library.

Step 4: Basic scoring

The measured seat was to be routed according to BMI. The computer according to the first step and the second step to form a test curve, which then compared with the 10 scores of the basic evaluation index curve consistency,

$$r(f_k(x), f(x)) = \frac{Cov(f_k(x), f(x))}{\sqrt{Var[f_k(x)]Var[f(x)]}} \quad (3)$$

Where Cov was the covariance of two functions and Var was the variance of the two functions. The smaller the r value, the better the consistency. Therefore, the curve with which the score of the basic evaluation index curve consistency, the seat of the basic scoring was the score.

Step 5: Interval Correction

As the reference seat score was 1-10 integer points, the measured seat evaluation curve and the standard curve was different. This difference was the basis for the seat comfort score correction. Based on the basic evaluation standard curve as the center line, with 0.25 for the interval radius band, the establishment of interval function. Check whether the overall curve of the test curve in this curve, the evaluation score to be fixed on the basis of scoring. Correction principle: interval radius of each increase of 0.025, minus 0.1 points, the lower limit of 0.5. Interval radius of each reduction of 0.025 plus 0.1 points, the upper limit of -0.5. The corrected score was the initial comfort score of the seat under test.

According to the above body BMI standard selection method. Three kinds of body selection of a person, in accordance with the above steps 4 and 5 scoring, took the average points. This score was the final comfort score of the measured seat.

6. Conclusion

This paper presented a method of evaluation of seat comfort interval, which solved the problem of large change of pressure data in different evaluation scores of different human body (BMI) types by means of normalization. But also in the traditional scoring at the same time, the introduction of the interval parameter correction function, making scoring more scientific. According to the method developed the corresponding software, the actual application found that the use of Chinese characters to describe the comfort more intuitive. The software could also record the actual application process and important data, as shown in Figure 5. Through the actual use of the software to further proved that the seat comfort interval evaluation method had a good engineering application value.

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