The Base Research in the Intelligent Processing System of the Data for Physics Experiment

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***Abstract*- For the characteristics of the intelligent processing system of the data in Physics experiment, two basic problems have been put forward. The difference between the two problems was that the weights of the experimental data were not the same. The first one was equal weights. The second one was unequal weights. For the first one the elimination method had been pointed. The datum would be eliminated if it was out of the scope in two times standard deviation near the average. The effective number of the experimental data could be statistics again after the careless error had been eliminated. For the second one the effective data method had been pointed out. The different differential algorithm had been used in the intelligent system for the experiment in determination of sound speed with different numbers of the effective data. The results in the intelligent processing system were following to the rules of the signification figure and uncertainty. The developed intelligent system was suitable for all kinds of physical experiment data which are filled by any experimenter. The shown results were quick and accurate.**

Keywords- Intelligent Processing System; Physics Experiment; Statistics; Multimedia

I. INTRODUCTION

There are many teachers and scientists [1-4] focusing on the signification figure and uncertainty in experiment data processing. The signification figure could be obtained after measurement. The measured datum was an error. The best estimation was the average for many times of measurement. The difference between the data of the experiment and the best estimation was uncertainty. The uncertainty was a very good method for describing the experiment results [5-6]. Jiang et al had developed a series of intelligent systems to process the experiment data since 1995 by Multimedia ToolBook [7-9]. The intelligent processing system of data in Physics experiment had taken an important role in Physics experiment teaching.

Recently, the basic problems had been put forward for the equal weight data and the unequal weight data. For the problems, the elimination method for the large error or careless error and the effective data method had been researched in this paper.

II. ELIMINATION METHOD FOR THE LARGE ERROR OR CARELESS ERROR IN EQUAL WEIGHT DATA

Many data in Physics experiments were equal weight data. The large error (it is abbreviated as LE) or careless errors maybe occur that caused by the experimenter in seeing, reading, and writing. The LE maybe occur that caused by the environmental conditions such as the temperature. The LE was different from the system error and random error. The system error could be compensated by the method of adding or deducting the zero error. The random error could be evaluated by the statistics method. The LE may be very large and must be eliminated. The elimination method was science. For the equal weight data, the shown rule was according to the Gauss distribution. The average and the standard deviation were two important elements. The probability was 68.3% when a datum was in the scope in one time standard deviation near the average value. The probability was 95.5% when a datum was in the scope in two times standard deviation near the average value. The probability was 99.7% when a datum was in the scope in three times standard deviation near the average value. It was a better method in Physics experiment for eliminating the LE by two times standard deviation near the average value.

As an example for the equal weight experiment data, the experiment of measurement of the electromotive force for the dry battery is a representative experiment. The experiment was based on the compensation principal and got the electromotive force for the dry battery when two compensative lengths had been measured. The first length was the compensative length of the standard battery. The second length was the compensative length of the testing battery. The electromotive force of the standard battery is 1.0186V when the temperature is 20℃. The electromotive force is proportional to the compensative length. In the general case the student could get 10 values for the electromotive force of the testing battery shown in Figure 1. Sometimes one of values was LE. Sometimes the number of the values was less than 10.

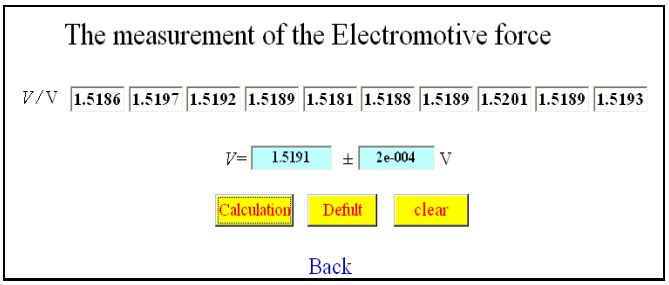

Fig. 1(a) The calculation result for 10 data

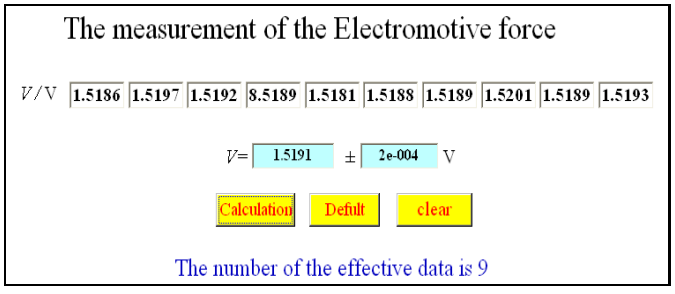

Fig. 1(b) The calculation result after eliminated for 9 data

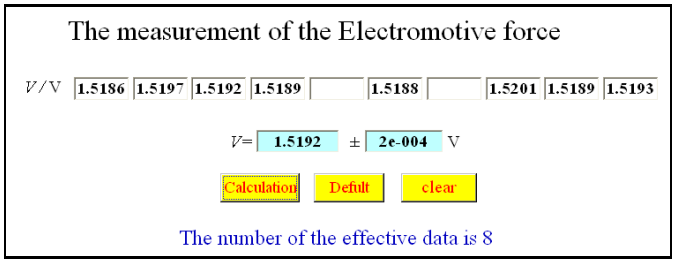

Fig. 1(c) The calculation result for equal weight data

The intelligent system had been developed in three stages and shown as Figure 2. The LE must be eliminated. When the LE had been eliminated the average value and the uncertainty of the experiment data were calculated.

The first stage was interface design [7-9]. The objects in interface included the title, the variables, the fields that could be filled , the shown fields, the buttons, and the status field. The three buttons were said to be Clear, Default, and Calculation.

The second stage was statistics and elimination for button Calculation. When the experimenter filled the experiment data in the field that could be filled , the button of Calculation had been clicked. The system got the number *n* of the data and the average value was calculated. The difference between a datum and the average value could be obtained and the sum of the difference square could be got as well. The standard deviation was the square root of the sum divided by *n*. Since the *n* was small, the standard deviation was replaced by the unbiased estimate. The unbiased estimate was square root of the sum divided by *n*-1. The probability was 95.5% when a datum was in the scope of two times standard deviation near the average. The intelligent system was based on the probability and the elimination result was very good. The calculated result for the 10 values of the electromotive force for the dry battery was shown in Figure 1(a). When one of the 10 values was 8.5189 it is far greater than the normal values and it was a LE, the LE must have been eliminated. The average value and the uncertainty of the other 9 values of the electromotive force were shown in Figure 1(b). If the number of the experiment data is less than 10, the average value and the uncertainty of the effective data had been calculated , as shown in Figure 1(c).

The third stage the result was shown according to the rules of the signification figure and uncertainty. In Physics experiment the uncertainty took a digit and the digit was alignment for the last digit of signification figure. The uncertainty was only carried bit.

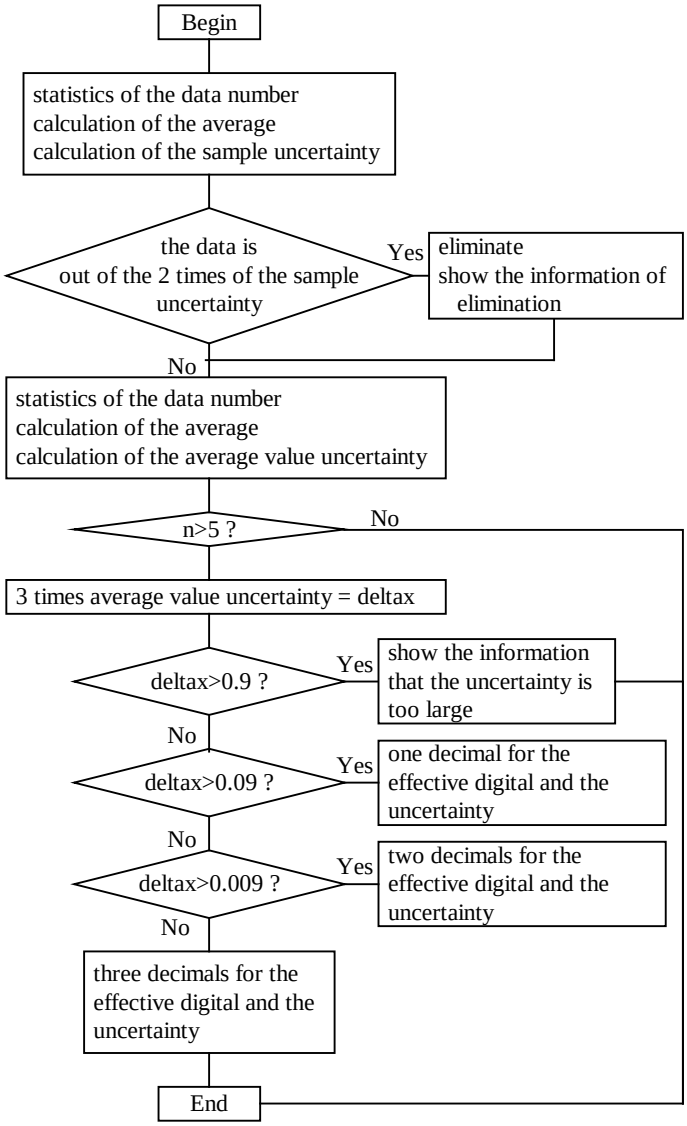

Fig. 2 The chart flow of the intelligent system

The signification figure was carried bit when the remainder was equal or larger than 0.5, while it was rounding down when the remainder was less than 0.5. The average value and the uncertainty based on the laws were shown in Figure 1(a), Figure 1(b), and Figure 1(c).

III. EFFECTIVE NUMBER METHOD IN UNEQUAL WEIGHT DATA

For example, the experiment for determination of sound speed, the experimental data were related to the order. The experiment for measurement sound speed could be traced back to the age of Galileo and the result was not precise due to the technical constraint. With the development of radio technology, in particular, the development of sensor technology, the sound speed was measured by the multiplication of the time cycle and the frequency. The precision of sound speed had been improved greatly. The sound speed was 331.45m/s at 20℃. The experiment for determination of sound speed was based on the stand wave. The distance between the two adjacent loops was half wavelength for the intensity of the stand wave. The sound speed could be got by the wavelength of the stand wave multiplying the frequency of the ultrasonic wave.

The data could not be exchanged and they were unequal weight data shown in Figure 3. The number statistics method was different from the equal weight data. The effective number was the number of first non data occurred minus one. In the experiment for determination, different differential algorithm had been applied.

When the effective number was less than 6, the intelligent system showed the information "The effective number is too little, fill all the experiment data, please".

When the effective number was 6 or 7, the wavelength of stand wave would be calculated in the intelligent system. The previous 6 data would be recorded in arrays x[i], (i=1, 2, …, 6).

$$\text{wavelength}=(x[6]-x[3]+x[5]-x[2]+x[4]-x[1])/4.5 \quad (1)$$

When the effective number was 8 or 9, the wavelength of stand wave would be calculated in the intelligent system. The previous 8 data would be recorded in arrays x[i], (i=1, 2, …, 8).

$$\text{wavelength}=(x[8]-x[4]+x[7]-x[3]+x[6]-x[2]+x[5]-x[1])/8 \quad (2)$$

When the effective number was 10, the wavelength of stand wave would be calculated in the intelligent system. The total 10 data would be recorded in arrays x[i], (i=1, 2, …, 10).

$$\text{wavelength}=(x[10]-x[5]+x[9]-x[4]+x[8]-x[3]+x[7]-x[2]+x[6]-x[1])/12.5 \quad (3)$$

The calculation result of the sound speed was shown in Figure 3. The result had two parts. The first one is based on the position of the loop of the stand wave. The sound speed and the uncertainty had shown in the line "Calculation" of the Figure 3(a). The second one is based on the theoretical formula of the sound speed

$$v = 331.45\sqrt{T/273.15} \quad (4)$$

The unit is m/s and the T is temperature of Kelvin scale. The calculation result was shown in the line "Theory" of the Figure 3(a).

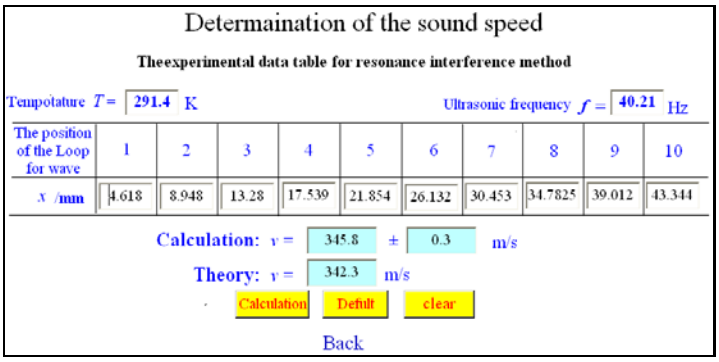

Fig. 3(a) The calculation result for 10 data

If one or more of the datum was not filled by experimenter it was shown in Figure 3(b). The intelligent system could calculate the result and the information of "The number of the effective data is 7" was shown in status field of the Figure 3(b). The precise of the result was shown in the line "Calculation" of the Figure 3(b). The result is average value and the uncertainty of the sound speed. The calculated result from the Formula (4) was shown the line "Theory" of the Figure 3(b).

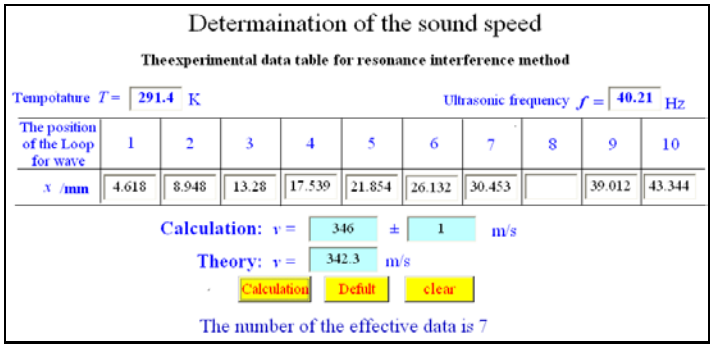

Fig. 3(b) The calculation result for unequal weight data

IV. CONCLUSION

For the equal weight data, the calculation result for 10 data was shown in Figure 1(a). When the 4th datum was a LE, the datum was eliminated and the effective number was 9 shown in Figure 1(b). If the experimenter did not fill the 5th and 7th data, the intelligent system calculated 8 data because the data was equal weight data.

For the unequal weight data, the calculation result for 10 data was shown in Figure 3(a). If the experimenter did not fill the 8th data, the intelligent system judged the effective number was 7, and the calculated result by Equation (1) was shown in Figure 3(b).

The developed intelligent system suited to all kinds of physical experiment data and suited to all kinds of filled data by any experimenter. The shown results of the signification figure and the uncertainty were quick and accurate.

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