Association for Information Systems
AIS Electronic Library (AISeL)

WHICEB 2017 Proceedings

Wuhan International Conference on e-Business

Summer 5-26-2017

An Intelligent Weighing System based on Editable Formula and Alterable Resolution

Ruijun Zhang
School of Management, Wuhan University of Science and Technology, Wuhan,430081, China

Ting Hu
School of Management, Wuhan University of Science and Technology, Wuhan,430081, China

Simin Yin
School of Management, Wuhan University of Science and Technology, Wuhan,430081, China

Kui Fu
School of Management, Wuhan University of Science and Technology, Wuhan,430081, China

An Intelligent Weighing System based on Editable Formula and Alterable Resolution

Ruijun Zhang[1], *Simin Yin*[1], *Ting Hu*[1], *Kui Fu*[1]
[1]School of Management, Wuhan University of Science and Technology, Wuhan,430081, China

Abstract：This paper is to design an intelligent weighing system to solve the problems in enterprises, such as incompatibility with hardware and software environment in different enterprise scenarios, the fixed interface layout and the dilemma that a single-way computational formulas can not fit the workflow of complementation of weighing system flexibly. A self-defining formula method is proposed to meet different demands from variable enterprises, which is solved by infix expression algorithm. The interface layout is screen self-adaptation by using an alterable resolution algorithm. The result of the experimental study reveals that the intelligent weighing system is more flexible in self-adaptation of environment than the traditional weighing system.

Keywords: Intelligent weighing system, Editable formula, Variable resolution edit, Infix expression

1. INTRODUCTION

Weighing system is not only a single system to provide weight data, but also an integral part of industrial control system and business management system, promoting the automation of industrial production and modernization of management. As the source of enterprise basic data, weighing system plays an important role in enterprise's ERP and logistics management. It can be widely applicable to many industries such as logistics management, highway, iron and steel, bridge, chemical engineering, compression refute collector and so on. However, some available weighing systems are not compatible with the different software and hardware environment due to single-way function, un-editable formula and fixed system mode. To solve the issues, some scholars have carried on researches on intelligent weighing system. For example, Qian Ting-ting designed a kind of automatic weighing system based on single chip [1], Niedzwiecki M studied on High-Precision FIR-Model-Based Dynamic Weighing System[2]. Yet the function of the system is not flexible and alterable. As for Li Yongwei's weighing system of continuous conveying material [3], the formula is not editable. The resolution of user interface is not changeable in the study of He H. M's an intelligent signal processing method for high-speed weighing system [4] and Zhang Le's weighing system of vehicle automatic's equilibrium [5]. Therefore, this paper intends to design an intelligent weighing system with editable formula and variable resolution to meet the requirements of different enterprise scenarios.

2. INTELLIGENT WEIGHING SYSTEM

2.1 Topological structure of weighing system

Compared with the general weighing system, hardware is pluggable on external devices. The hardware topology is roughly as shown in figure 1.

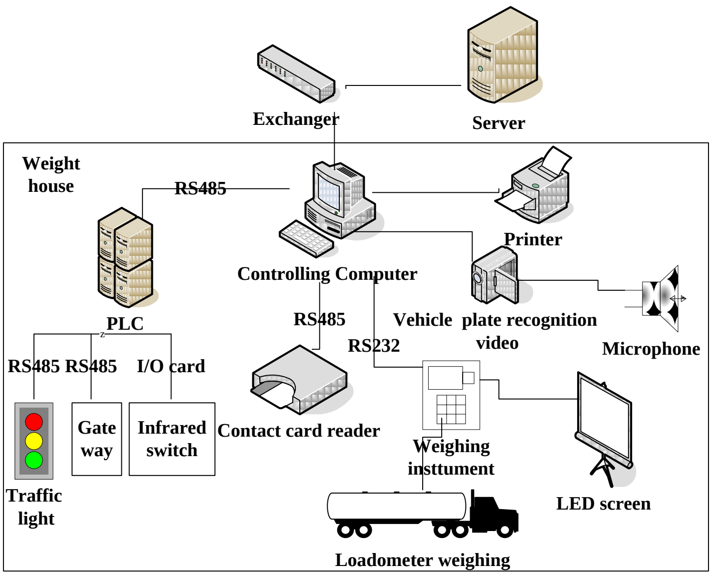

Figure 1.Topology structure of weighing system

The system mainly consists of controlling computer, programmable controller (PLC), contact card reader, vehicle plate recognition video, printer, LED screen, weighing instrument, gate way, infrared electric switch, microphone and other equipment. The vehicle plate recognition video takes charge of identifying license plate number, infrared electric switch determines whether or not a vehicle can get into automobile weighing apparatus, gate way brake controls vehicle in and out, computer of control center connects printer, the large screen displays weighing information.

2.2The workflow of system

The system makes corresponding operation for different vehicles, the procedures are as shown in figure 2.

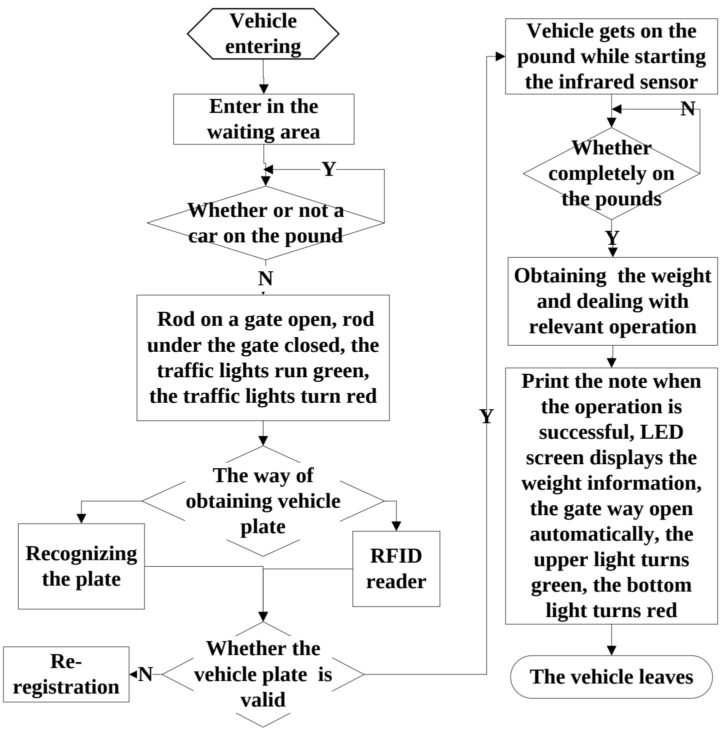

Figure 2. Procures of weighing system

When a vehicle comes in, I/O card will judge whether there is a car on the pound by reading the infrared electric signal. Once entering induction area, the signal will be transmitted from PLC controller to control computer by infrared sensors, then the computer issues opening instructions to indicate the vehicle weighing on the pound. The information of vehicle will be obtained by recognizing the license plate or swiping card. In the mean time, weighing signal of the vehicle is transmitted from sensor to weight gauge, computer identifies the weight information through weighing instrument. When the weight information is gained, control compute compare present weight with the previous weight of the vehicle and save the greater weight value as gross weight and smaller value as tare weight record. After saving the weighing records, the weight note printed, then, the green traffic light and voice instruction indicate the vehicle leave the weight platform.

3. THE ALGORITHM BASED ON EDITABLE FORMULA

3.1 problems based on editable formula

Different enterprises have different weight calculation in weighing system that a fixed calculation formula is written into the process of coding in most weighing system. Thus, it is only suitable for enterprises with same or similar calculation, the programmer have to change system code when the calculation changes. For instance, when calculating the weight of fine sand and cotton, the unit price of fine sand is Yuan per ton while unit price of cotton is Yuan per cubic meter. The amount of sand can be computed directly according to the weight, yet due to different calculation unit, the weight of cotton have to be converted to volume by setting a discount coefficient to calculate the amount. The calculation formula of fine sand is: sum= price unit ×(gross weight - tare weight), the calculation formula of cotton is: sum = (gross weight - tare) ×discount coefficient ×unit price. Accordingly, since the traditional weighing system formula is not editable for personalized demand of each enterprise, this article puts forward the solving algorithm based on editable formula.

By adopting the editable formula in the intelligent weighing system, the algorithm can be synthesized and set with flexibility either by the number of variables or by four mixed operation, which makes the system more comprehensive application to enterprises. Taking the calculation of sum as example, Figure 3 will demonstrate the workflow of recursive splitting of designed algorithm.

Define variables as following: Gross is presented by g w (gross weight), tare is presented by tare, unit price is represented by price and the amount is presented by sum. The calculation rule is changed as: the unit price is the price of per n, for the price per unit is price/n. After completion of weighing, offer appropriate subsidies on the basis of sum of goods, the subsidies per car is presented by bonus, sum of goods = f (price, n, g w, tare, bonus) = (price/n)×(g w - tare) - bonus.

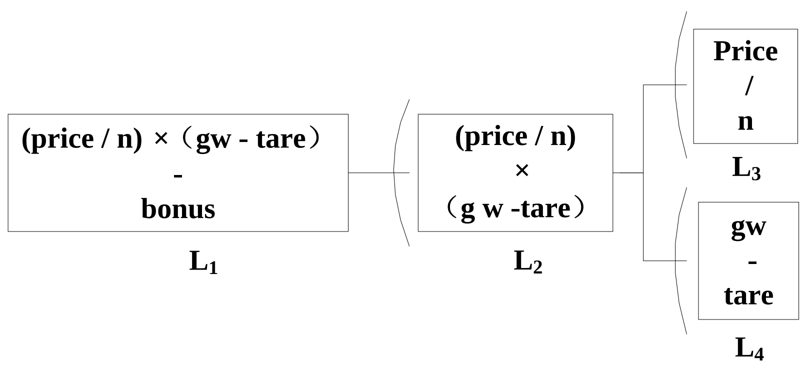

Figure 3. Recursive process of sum formula

According to the above example, when transforming it into the minimalist style, the recursive export L_3: price/n and L_4: g w - tare, calculation results returned to the upper level L_2: (price/n)×(g w - tare), the result of L_2 is back to upper level L_1, final result is the results of infix expression calculation.

3.2 Algorithm based on editable formula

In section 2.1, the editable formula is calculated via infix expression, including three aspects: At first, it is need to start from the lowest of priority operator; secondly, the brackets of infix expression shall be removed; thirdly, the evaluation is split and then return back to calculate the result. The designed algorithm is shown as figure 4.

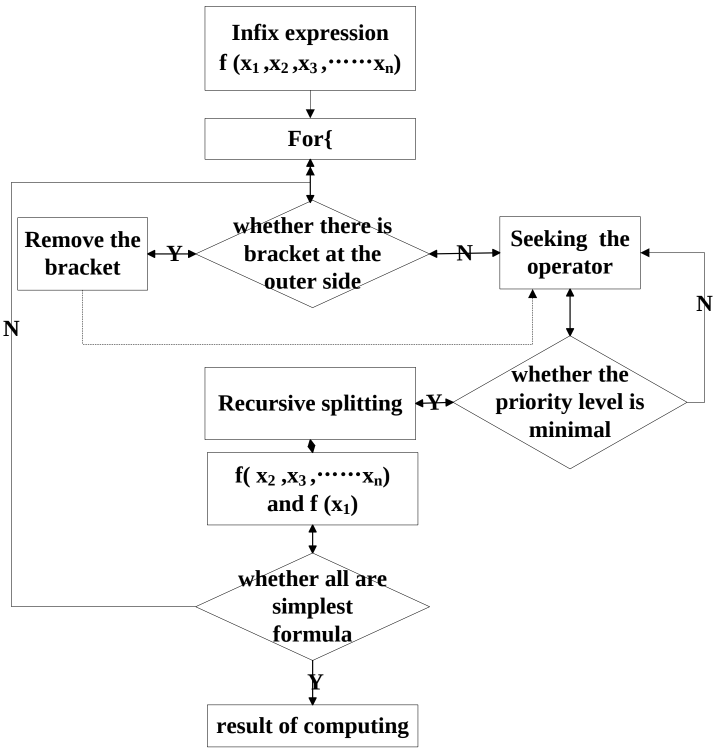

Figure 4. Algorithm based on recursive splitting of infix expression

4. ALGORITHM OF INTERFACE LAYOUT BASED ON VARIABLE RESOLUTION

Because many weighing systems cannot be well adapted to different computer resolution, once the resolution of the computer changes, the controls of interface will present problems of pile-up, position disturbance, arrangement without rule, etc., which influences the aesthetics of interface as well as the functions of system. For the purpose that the system interface can be compatible with different resolutions, a layout algorithm based on coordinate mapping is proposed, so that the controls can change in accordance with the change of the form size and regional controls can increase and decrease freely. The algorithm of interface layout is divided into two situations: one is that the controls change as window size change; the second is that the layout is redesigned as the quantity of workspace controls change.

4.1 Related definitions of layout algorithm

A form interface contains numbers of local area, such as Panel, Container, etc. A complete form can be divided into different editable blocks. Various controls can be portrayed in different parts of the block, such as Text, Button, etc.

The flexible layout of interface is divided into two parts: One is to change the size of the form, another is the control quantity of change. The two kinds of changes will lead to size changes of the internal controls in work areas. Figure 5 shows the setting for window coordinates.

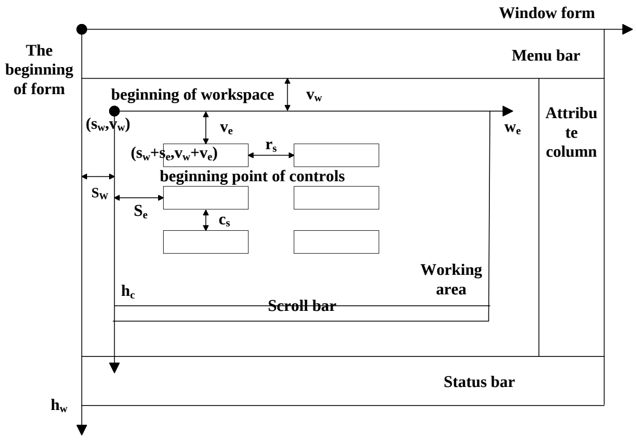

Figure 5. Map of form coordinates

4.2 Layout algorithm on window size change

When users change the size of the system interface, the controls of workspace will change in certain proportion to avoid terrible-looking interface due to pile-up and loss of function.

The height and width of the changed window are respectively defined as h'_w and w'_w (in pixels), then calculate the zoom factors of height and width of window forms.

$$R_W = w'_w / w_w \tag{1}$$

$$R_h = h'_w / h_w \tag{2}$$

Where, w_w and h_w are the original width and height of form, w'_w and h'_w are the width and height of the changed form.

The width and height of the original controls are width and height, the calculation formula is as:

$$\text{width}' = \text{width} \times R_w \tag{3}$$

$$\text{height}' = \text{height} \times R_h \tag{4}$$

height', width' are the height and width of the changed control respectively.

In case that the height and width of each control in the workspace change in accordance with changes of form, the size of controls will also be changing according to changes of the form.

4.3 Layout algorithm on quantity change of controls

In the traditional weighing system, the height and width of the controls shall be prescribed in the interface when users input the new form information. The input information is fixed so it only can be used for one or a similar situation. Therefore, the layout of flexible interface control is very important. However, the changed quantity of interface controls will lead to the change of the layout. So the layout of the flexible interface control is required. But the quantity of interface control's change will lead to the change of layout. So it is very important to the make total dynamic change and rearrangement of controls in the workspace effectively.

When selecting number of controls through the interface setting with the window size remaining the same, it is assumed that controls are fully spaced accordance with the relevant provisions in the workspace:

$$h_e = 2v_e + \text{height} \times r + c_s \times (r - 1) \tag{5}$$

$$w_e = 2s_e + \text{width} \times c + r_s \times (c - 1) \tag{6}$$

$$n = c \times r \tag{7}$$

Where, h_e-w_e are the height and width of workspace;

s_w, v_w the horizontal and vertical intervals of workspace and the form;

v_e the distance between the controls of the first line and the boundary of workspace, the minimum distance between the controls of the last line and the under boundary of workspace is v_e;

s_e the distance between the controls of the first line and the left boundary of workspace, the minimum distance between the controls of the last line and the right boundary of workspace is s_e;

c_s the distance between controls of every lines;

r_s the distance between controls of every columns;

c the numbers of columns of controls, users can choose proper number at will;

n the quantity of controls, users can add number freely.

The top left corner of form is the original point (0, 0), the coordinates of workspace on the left upper corner is (s_w,v_w), the coordinates of the first line and column is ($s_w + s_e$, $v_w + v_e$).

The result of calculation is，

$$r = [n/c] \tag{8}$$

Where, r is the number of controls in every lines, considering that n may not be the multiple of c, thus obtain [r].

$$height = [h_e - 2v_e - c_s \times (r - 1)]/r \tag{9}$$

$$width = [w_e - 2s_e - r_s \times (c - 1)]/c \tag{10}$$

Generally, according to user's habit of using the system interface, the width of controls can be uniformly distributed in the workspace, and the height of controls will appear larger when distributing vertically in well-proportion. At this point, it is needed to deal with the *height*. According to the habits, the height of controls is controlled in a certain range [*min* - *height*, *max* - *height*], for instance, when the default font is 16 ×16 pixels, the height range of controls is [25, 35]. If *height*∈[*min-height*, *max-height*], then *height* is the *height* of controls; else when *height*> *max-height*, takes the value of *high*; when *height*< *min-height*, takes the value of *min-height*. If the controls are too many, the scroll bar displays. Where, *height* represents the height of controls, *width* presents the width of controls. Thus, it is easy to rearrange the layout of the selective controls in corresponding workspace according the height and width of controls. It is worthy noted that the problems of covering the input information due to the too-small height or influencing the beautiful interface because of too-much height can be avoided through controlling height range of controls.

5. AN EXPERIMENT

In order to meet varying needs of users, the developers design an intelligent weighing system with user-defining selection for different scenarios and interface layout, which creates a visual operation environment.

Taking the quantity change of controls as an example, the data of weighing will generate pound list in the interface of weighing. Pound note may have lots of fields that will also be different in different occasions and its number will be different either. Figure 6 represents the information that users need to fill in or automatically fill in. These fields are the basis of generated pound note and reports. 11 controls sorted by six lines and two columns are demonstrated as following.

Figure 6. Initial interfaces without adding fields

As shown in figure 7, weighing interface will increase the same number of fields after adding 10 fields. The form resolution is same in Figure 6 and Figure 7. According to the layout algorithm, the height and width of controls are calculated. At this point, there is no change in form size, only increased the number of controls, control the number of n = 21. Set the number of columns c = 3, then calculate knowable lines (r = 7) according to formula (7). Hereby the height and width values of working area are obtained, namely w_e =650 pixels, h_e=250 pixels. In process of system implementation, the distance between the first line of controls and the upper boundary of workspace 4 is set by v_e=5, the space between the first column and the left boundary of workspace 4 is s_e=2, the line space between controls is c_s=2， the column spaces is r_s=30 (unit are all pixels).

Then, according to the formula (9) and (10), the result is:

$width=[650-2\times 2-30\times(3-1)]/3=195$；

$height=[250-2\times 5-2\times(7-1)]/7=33$，（integer is obtained）

In accordance with the rules of height controlling, the knowable range of height controlling is [25, 35], the calculated height 33 is within controlling range and obtains 33 pixels.

In conclusion, the height of available controls is 33 pixels and the width is 195 pixels. After removing the fixed width 50 pixels of the label, the width of input form is 195-50 = 145 pixels, the height is 33 pixels.

Figure 7. Interface diagram with added fields

As can be seen from Figure 7, when adding fields in system interface, the size of the input box will rearrange according to the added number of attributes. During this process, the size of the input box itself will also change in regular rules. This will endow the system with adaptability of interface and flexibility of use.

6. CONCLUSION

In this paper, an intelligent weighing system based on editable formula and variable resolutions is designed to meet flexible requirements of different users, whether for the function or the interface layout. The empirical case shows that the intelligent weighing system can achieve the flexibility in formula calculation, reports designing and data restoring. It is not only can be embedded into the big enterprise system as a subsystem, but also can be employed as an independent intelligent weighing system towards medium-sized enterprises. The system is widely applied to industries such as cotton, steel, cement, textiles, logistics and other fields for its flexibility of self-adaptive to the environment as well as its flexibility in hardware.

ACKNOWLEDGEMENTS

This research is supported by High School Education Research Program, under Grant 2016239 from Hubei Province, by the special task project of Humanities and Social Sciences Research- Engineering Science and

Technology Talent Training Research, under Grant 13JDGC009 from the State Education Ministry, by Natural Science Foundation Under Grant 2014CFB804 from Hubei Province, China.

REFERENCES

[1] Qian Ting-ting, Li Zheng-ming, Shi Xin, et al.(2014). The automatic weighing system based on single chip microcomputer . Journal of manufacturing automation, (16): 116-117.(in Chinese)

[2] Niedzwiecki M, Pietrzak P.(2016). High-Precision FIR-Model-Based Dynamic Weighing System. IEEE Transactions on Instrumentation & Measurement, 65(10):1-11.

[3] Li Yongwei, Zhu Qianfei, Liu Zhanyang, et al. (2013). Research on weighing system of continuous conveying material. Journal of Hebei university of science and technology, 34 (3): 213-217.(in Chinese)

[4] He H. M., Huang P. J., Hou D. B., et al.(2015). An intelligent signal processing method for high-speed weighing system. International Journal of Food Engineering, 9 (2): 179-186.

[5] Zhang Le, Lu Renquan, Xu Shenglin.(2010). The design and implementation of weighing system of vehicle automatic's equilibrium . Journal of Zhejiang University of engineering science,44 (7): 1414-1417.(in Chinese)

[6] YOSUB HAN.(2013)AN IMPROVED PREFIX-FREE REGULAR-EXPRESSION MATCHING. International Journal of Foundations of Computer Science, 24(05):679-687.

[7] Laurent, N., Mens, K. (2015). Parsing expression grammars made practical. 167-172.

[8] Feng Shan, Zhang Ruijun, Wang Pan, et al. (2015).Intelligent weighing system design based on the flexible demand development. Information and Communications,(2) : 92-94.(in Chinese)

[9] Marafini I, Sedda S, Pallone F, et al.(2014). Agricultural implement having hopper weighing system. Inflammatory Bowel Diseases, 20(Issue):1885-1889.

[10] Jamil, N., Needell, D., Muller, J., & Lutteroth, C. (2013). Kaczmarz algorithm with soft constraints for user interface layout, 818-824.

[11] Li J.(2014). A Study on the Application of the Vehicle's Intelligent Weighing System. World Applied Sciences Journal, 68(7):582–583.

[12] Zhou Feng, Zhou Jun, He Yuewen, et al. (2015).Based on KJ method and ANP method of the human-computer interaction interface usability research. Science technology and Engineering, 15(6):241-245.(in Chinese)

[13] Paladhi S, Bandyopadhyay S.(2013).Generation of Referring Expression Using Prefix Tree Structure. Ijcnlp, 1283 - 1285.

[14] Zeng Shuigen. (2016).Based on reverse polish algorithm formula editor of power wave record data analysis system. Software Guide,15(1):91-93. (in Chinese)

[15] Hahn H, Ganagin W, Hartmann K, et al.(2014). Cost analysis of concepts for a demand oriented biogas supply for flexible power generation. Bioresource Technology,170C(5):211-220.