Computer-based Reverse Engineering of a Manual Weighting Spring Balance.

Ituma, Chinagolum[1], Igboke Eshina Monday[2],Onwukwe Ogonnaya C[3]

Computer Science Department, Ebonyi State University Abakaliki
chinagolumituma@yahoo.com

Abstract

Every man from birth till date has been affected by weight and weight measurement in one way or the other. Weight is a body's relative mass or the quantity of matter contained by it, giving rise to a downward force. A weighting spring balance is a machine used to measure the weight of an object. Some weighing balances are manual weighing balance and the others are digital weighing balance. Computer based reverse engineering of the weighing spring balance is a systematic reconstruction of a manual spring weighting balance to include a digital hardware circuit that can interfaces the spring balance to the computer. This research work shows the benefits of interfacing a weighting balance to a digital computer. Weights of objects can be read directly off the computer and the records of transactions kept in the computer. Computer based reverse engineering of a manual weighting spring balance involves a systematic study of the existing weighting balance, the design and development of the hardware interface and the development of the software to read from the manual spring balance. The researchers came up with digital encoder interface that connects to the computer through the parallel port. The weighting spring balance spindle that indicates the weight of the measured object is connected with a conductor that runs through the digital encoder. Modularization research methodology is used in this research work were the research work is broken down into modules; the different modules were designed, developed, tested and integrated. The result of the research is a manual spring balance that can be interfaced to a computer so as to directly capture the data of a weighed object and other associated data or parameter into a digital computer.

Keywords: Reverse Engineering, Weighting Spring balance, Systematic reconstruction, Digital interface, Digital encoder.

1.0 Introduction

The Online Dictionary defines weight as: **(i)** a measure of the heaviness of an object. [1] and (ii) The force with which a body is attracted to Earth or another celestial body, equal to the product of the object's mass and the acceleration of gravity.[1]

Every human being on our planet is affected by weight and measures in some ways from the moment we are born and throughout our daily living. Weighing and measuring are important and vital part of our existence. Our body, food we eat and all the products we use as an integral part of modern living have all been weighed and measured at some stage in their development and production.

Computer based reverse engineering of a manual weighting balance is the interfacing of a weighing scale (spring balance) with a computer system. The system is made up of software and hardware components. The hardware make-up include: encoder, spring balance, printer cable and computer system etc.

The system measures objects placed on the spring weighting device and with the help of an encoder reads the signal (measurement) into a computer system. The digital signal, read into the computer

will be processed using a mathematical algorithm to produce on the computer video display unit a corresponding and the exact weight that is displayed on the spring weighting balance.

A software designed using visual basic does the software processes and it reads in digital signals. The same software multiplies the processed weight with a dynamic unit price to produce a cost price if the weighed material is a market commodity. The software sends the cost price and the particulars of the sales to the systems owner's mobile phone. This system ensures that the business owner is immediately aware and updated any moment there is a market transaction using the weighting spring balance

.

2.0 Literature Review

A spring weighing balance is a spring fixed at one end with a hook to attach an object at the other end. The object attached will create a force needed to extend the spring a distance proportional to the weight of the object. The distance created by the extension of the spring is read from the calibrations as the weight of the object.

2.1 Reverse Engineering

According to Eilam, et al [2], Reverse engineering is the process of discovering the technological principles of a device, object, or system through analysis of its structure, function, and operation. It often involves taking apart and analyzing in details the structure and function of anything so as to understand and or enhance the structure and function of the thing without duplicating the original. Reverse engineering has its origins in the analysis of hardware for commercial or military advantage (Chikofsky, et al)[3]. Today the same techniques are subsequently being researched for application to legacy software systems, not for industrial or defense ends, but rather to replace incorrect, incomplete, or otherwise unavailable documentation [4].

This research work, dealt with the taking apart of a spring weighing balance, analyzing of the spring weighting balance and the building of a digital encoder. The digital encoder is connected to the computer through the printer port. According to Webster, Edward C.[5], a parallel port is a type of interface found on computers (personal and otherwise) for connecting various peripherals. In computing, a parallel port is a parallel communication physical interface. It is also known as a printer port or Centronics port. The IEEE 1284 standard defines the bi-directional version of the port. This transmits particular amount of bits in parallel at the same time. This is opposite to serial transition where one bit will be transmitted at a time. When signals from the manual spring balance get into the computer through the interface, a software processes the digital signals that came in to produce the required result.

The required result is sent to the database and to the system owner's mobile phone through a modem. This is an aspect of e-business or e-commerce.

2.2 e-business, e-commerce

According to Beynon-Davies P.[6], Electronic commerce focuses on the use of information and computer technology (ICT) to enable the external activities and relationships of the business with individuals, groups and other businesses.

Gerstner, L.[7] and Amor, D.[8] stated as follows: e-business may be defined as the conduct of industry, trade, and commerce using the computer networks. The term "e-business" was coined by IBM's marketing and Internet teams in 1996. From the above definitions, the research we embarked on fully supports e-business and e-commerce.

3.0 Materials and Methods

The materials used in this project include the encoder. The research work adopted the modular method of building each component of the project differently and letter integrating and testing them.

3.1 The Spring weighing machine.

Fig 1 is a photograph of the weighing spring used for the reverse engineering. It is calibrated from 0 to 250 g. The calibration is as follows 0,25,50,75,100,125,150,175,200,225 and 250 grams.

0 to 250 as shown above gives us eleven numbers, which implies that 0 to 10 can be used to represent the numbers on the spring weighing scale. Using mathematical proportionality, we see that 1 = 25g. Then giving N which ranges from 0 to 10 the value of Xg can always be found by using Xg = N x 25g.

Based on this we can build a simple table representing the numbers 0 to 10 in binary. We will keep the table side by side with the digital encoder representation of the binary numbers

Fig 1. A spring weighing machine

Table 1: Binary Representation of 0 to 10

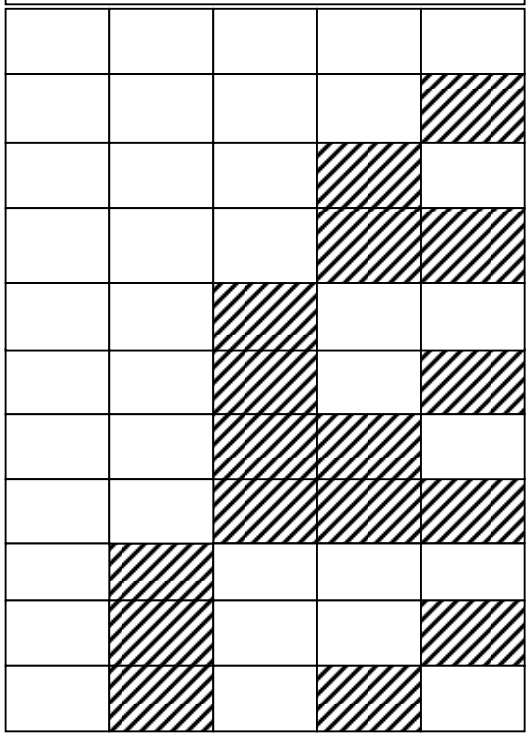

Fig 2: Digital Encoder

3.2 The digital Encoder used to monitor and control transfer of signal

Table 2: Digital Encoder

Value	bits				
0	0	0	0	0	0
1	0	0	0	0	1
2	0	0	0	1	0
3	0	0	0	1	1
4	0	0	1	0	0
5	0	0	1	0	1
6	0	0	1	1	0
7	0	0	1	1	1
8	0	1	0	0	0
9	0	1	0	0	1
10	0	1	0	1	0

Below in Table 1 is the tabular representation of the binary numbers 0 to 10 and attached beside it as fig 2 is the diagrammatical representation of 0 to 10 in digital encoder. Any cell in the digital encoder that is like represents 1 (one), the

any empty cell represents 0 (zero). The cells representing the 1s were implemented in the real digital encoder using turns of wires as shown in Fig 4 below. Fig 4 also shows a complete set up of the spring balance and the digital encoder. All the coils of wire on the digital encoder are all tired together column by column. The right most column of the digital encoder is column one, the next to it is column two, the next column three etc

.

3.3 The Parallel printer port.

Fig. 4: A complete reverse engineered spring weighing balance.

The parallel printer port is made up of three ports, namely: the control port, the data port and the statues port. Each of these three ports has an address in decimal. The address of the status port is 889. This is the address with which we will read in the weighed value through the digital encoder into the computer. The following pins makes up the 5 input lines (pin 10, 11, 12, 13, 15) in the printer port. They are the status pins designated as s4,s5,s6, s7 and s8 respectively. All the wire ends in column one of the encoder are all tired to pin 10 in the status port, those of column two tired to pin 11 and so on. A simple user interface designed in Visual Basic as shown in Fig 5 is used to read in the measured weight, do the mathematical calculation so as to convert the read in bits to reasonable weight, capture some other parameter as displayed on the form, sends will be calculated and displayed when the "take weight and price" button is clicked.

the information to the database as well as to the system owner's mobile phone. In the input form, one can only type in the customer's name. The weight and price

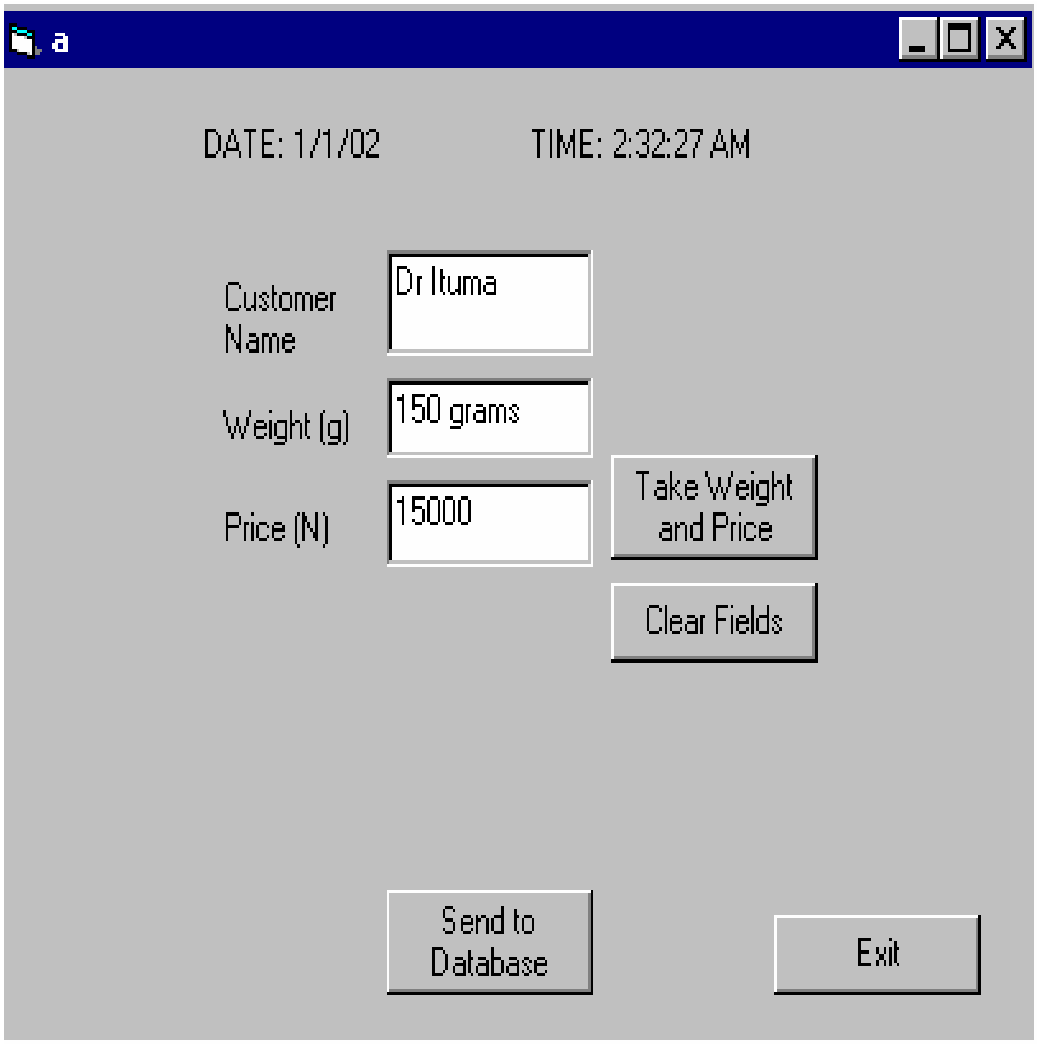

Fig 5: The Input Form

The button "send to database" sends the captured and calculated information to the database and to system owner's mobile phone. The code displayed bellow, captures the weight and sends it into the computer.

.

```
Private Sub
cmdTakeWeightAndPrice_Click()
vbOut 888, 0
fromInputPort = vbInp(889)If fromInputPort =
120 Then txtWeight.Text = "0 grams"
If fromInputPort = 56 Then txtWeight.Text =
"25 grams"
If fromInputPort = 248 Then txtWeight.Text =
"50 grams"
If fromInputPort = 184 Then txtWeight.Text =
"75 grams"
If fromInputPort = 88 Then txtWeight.Text =
"100 grams"
If fromInputPort = 24 Then txtWeight.Text =
"125 grams"
If fromInputPort = 216 Then txtWeight.Text =
"150 grams"
If fromInputPort = 152 Then txtWeight.Text =
"175 grams"
If fromInputPort = 104 Then txtWeight.Text =
"200 grams"
If fromInputPort = 40 Then txtWeight.Text =
"225 grams"
If fromInputPort = 232 Then txtWeight.Text =
"250 grams"
txtPrice.Text = Val(txtWeight.Text) * 100
End Sub
Private Sub Form_Load()
Label3.Caption = "DATE: " & Date

Label4.Caption = "TIME: " & Time
End Sub
```

4.0 Discussion and conclusion

We may not need to invent a new machine to meet the digital need of this generation. If we look critically and analytically into the already existing machines we can reverse engineer them. The analogue spring weighing machine after this research is now able to support the transmission of its measured weight to the computer. The measured weight becomes a raw data that is processed by the computer to give out a result that is stored in the database and sent to the mobile phone of the system's owner. The previous analogue spring balance now after reverse engineering supports e-business and e-commerce

Reference

[1] http://www.thefreedictionary.com/weight visited May 25th 2013

[2] Eilam, Eldad & Chikofsky, Elliot J. (2007). "*Reversing: secrets of reverse engineering*". John Wiley & Sons. p. 3. ISBN 978-0-7645-7481-8.

[3] Chikofsky, E. J. & Cross, J. H., II (1990). "*Reverse Engineering and Design Recovery: A Taxonomy*". *IEEE Software* **7** (1): 13–17. doi:10.1109/52.43044.

[4] Michael L. Nelson, (April 19, 1996). "*A Survey of Reverse Engineering and Program Comprehension. ODU CS 551 – Software Engineering Survey"*. Furthermore, Reverse Engineering concept is used to modify or change premade .dll files in an operating systems

[5] Webster, Edward C. (2000). "*Print Unchained: Fifty Years of Digital Printing:A Saga of Invention and Enterprise"*. West Dover, VT: DRA of Vermont. ISBN 0-9702617-0-5.
[6] Beynon-Davies P. (2004). *"E-Business. Palgrave, Basingstoke"*. ISBN 1-4039-1348-
[7] Gerstner, L. (2002). "*Who says Elephants Can't Dance? Inside IBM's Historic Turnaround"*. pg 172. ISBN 0-06-052379-4
[8] Amor, D. (1999). "*The e-business (r)evolution"*. Upper Saddle River: Prentice Hall.