Design of Intelligent Diagnosis System for Heavyweight Measurement System Based on IOT

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***Abstract*—Heavy-weight Measurement System in Heavy-load Truck-scale is proposed using fuzzy logic Combined the technology of Internet of things (IOT). This system makes an inference in Fuzzy Logic Controller for each load-cell state and manage information based on IOT system. We investigated validity of system on comparing with experimental data and decision value of Load-cell Trouble Diagnosis System by Fuzzy Logic.**

Keywords-load cell; diagnosis system; internet of things; zigbee

I. INTRODUCTION

It is a important task to measure the weight of freight between a customer and delivery company. But the weight of the truck is as high as dozens of tons. So how to get exact data is a difficult task. This can solved by means of Electronics heavyweight measurement system using Load-cell. A freight car and heavy-loaded vehicle with the load can be measured by the top of Load-cell Plate Board in Electronics heavyweight measurement system. The system could be independently controlled using Zigbee module, which has characteristic of high stability, fast speed and quick response.

Because of high heavy-loaded vehicle, it usually happens trouble of Load-cell. This trouble by malfunction of Load-cell happens serious problems better than other problems (power failure, be broken, etc) . In this paper, We solved this problem by means of Load-cell Trouble Diagnosis System that is stored information of a Load-cell expert and we transfer the measurement data using zigbee module.

The first, Load-cell Trouble Diagnosis System operating must not influence run of Electronics heavyweight measurement system. It was first problem of our development. The second problem is classification of normal Load-cell with trouble Load-cell. Using Fuzzy Logic Controller (FLC), it realized decisive knowledge of expert and diagnosed trouble of Load-cell [1]. In the end, we suggested utility, effect, and development form of Load-cell Trouble Diagnosis System.

II. ELECTRONICS HEAVY WEIGHT MEASUREMENT SYSTEM

A. *Hardware*

The System cross-sectional view is Figure I.

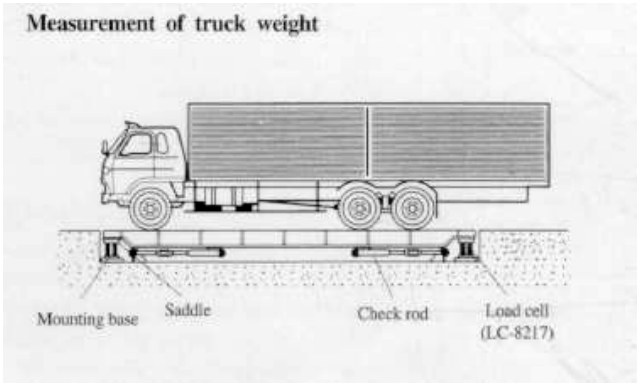

FIGURE I. ELECTRONICS HEAVYWEIGHT MEASUREMENT SYSTEM CROSS-SECTIONAL VIEW

A freight car and heavy-loaded vehicle include the load is measured the top of the Load-cell Plate Board that is installed Electronics heavyweight measurement system [2]. Loads calculate by automatic calculator in this system. Loads weights subtract truck weight from all weight [3]. These data is transferred by wireless information subsystem using Zigbee. The system consists of four parts: Load-cell, Junction-box , Indicator and information transmission system.

B. *Load Cell*

Load-cell include the Strain-gage that located Center of Load-cell inside and transforming resistance to voltage like Wheatstone-bridge by elasticity of Strain-gage. If Increase the weight, than increase the voltage product [4].

FIGURE II. LOAD CELL

C. *Junction-box*

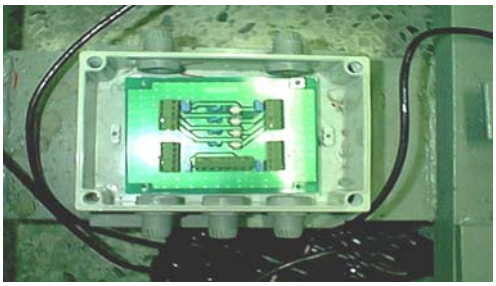

FIGURE III. JUNCTION-BOX

Junction-box connected Indicator directly that adjusting impedance Load-cell between indicator and protected from a flash of light like Figure III. Junction-box located outdoor of Electronics weight measurement system that watertight and needless power supply.

D. *Indicator*

Indicator display discrete number, include difference-amplifier made OP-AMP. Other indicator included automatic weight calculator and printer. Indicator has functions that zero point setting of Load-cell, measure the other weight same time, alarm of event for one and check of standard-weight.

FIGURE IV. INDICATOR

E. *Diagnosis System*

System connecting block diagram is shown as Figure V. Diagnosis System must be connected with Junction-box.

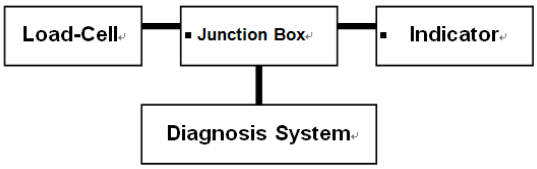

FIGURE V. CONNECTION BLOCK DIAGRAM

Load-cell Trouble Diagnosis System must be modified with Junction-box in order to combine the intelligent algorithm which is calculated by Fuzzy Logic Controller(FLC).

III. FUZZY LOGIC CONTROLLER

Isosceles triangle method is chosez for Fuzzifier method. Fuzzy Approximate Reasoning used Mamdani's Max-Min compositional Rule [6] .Membership function of each input and output are show is Figure VI and Figure VII.

$$FI_1 = \left(\frac{Vi - Vr}{Vi}\right) \times 100 \ [\%] \quad (1)$$

First Fuzzy input variable (FI1).
Vi is each Load-cell initial voltage near to Zero.
Vr is each Load-cell measuring voltage with Load.

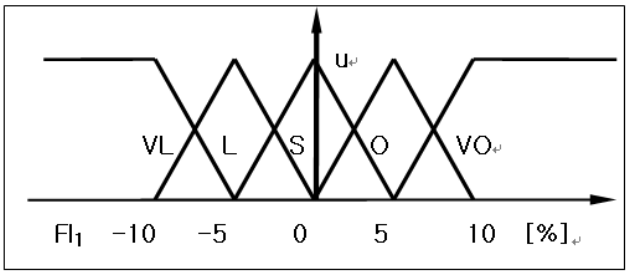

FIGURE VI. MEMBERSHIP FUNCTION OF FI_1

Second Fuzzy input variable (FI_2).

$$FI_2 = \left| \frac{Vnr}{Var} \right| \times 100 \ [\%] \quad (2)$$

Vnr is variation of each Load-cell(Δ V each).
Var is variation of all Load-cell (Δ V all).

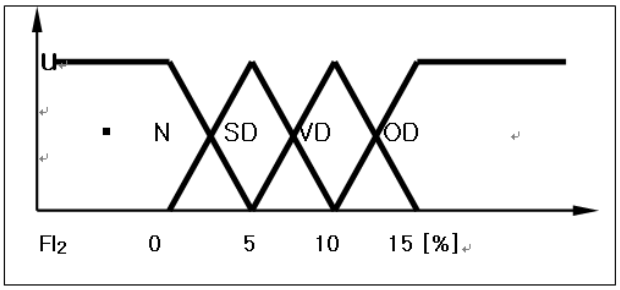

FIGURE VII. MEMBERSHIP FUNCTION OF FI_2

Linguistic Variables are defined in Table I.

TABLE I. DEFINITION OF LINGUISTIC VARIABLE USED IN THE FLC

Variable	Definition	Variable	Definition
VL	Very Low	N	Normal
L	Low	SD	Small Difference
S	Stable	VD	Very Difference
O	Over	OD	Over Difference
VO	Very Over	AL	Alert
CH	Change	GS	Good Stable

TABLE II. RULE BASE TABLE

FI1\ FI2	VL	L	S	O	VO
N	AL	GS	GS	GS	AL
SD	AL	AL	GS	GS	AL
VD	CH	AL	AL	AL	CH
OD	CH	CH	AL	CH	CH

Fuzzy Inference output example and rule base Table.

" IF FI1 is N and FI2 is N Then OUT is GS "

" IF FI1 is O and FI2 is VD Then OUT is AL "

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" IF FI1 is VO and FI2 is VD Then OUT is CH" [7]

IV. INFORMATION EXCHANGE SYSTEM

Information exchange system is designed based on Zigbee module[10]. As a new popular way to realize the Short-range wireless communications, ZigBee starts to develop with a quite fast speed since December 2004 when ZigBee Alliance released the first official ZigBee protocol standard[9].

Figure VIII shows sensor position of weight measure instrument. We design this wireless information exchange system to transfer all the sensor data to PC[13], and design utility software[8]-load cell diagnosis system with user interface, which can calculate all the sensor data to get the state of all sensors and obtain the exact weight of heavy trunk.

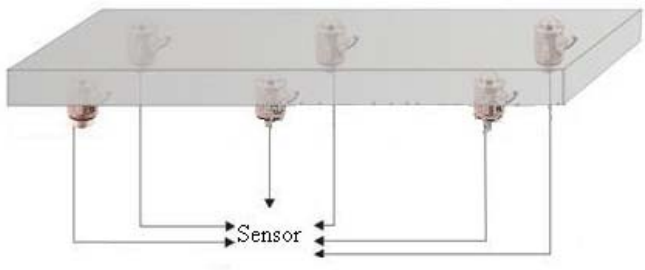

FIGURE VIII. SENSOR POSITION OF WEIGHT MEASURE INSTRUMENT

The schematic diagram of wireless sensor networking on ZigBee which is used to send and receive data is shown as Figure IX.

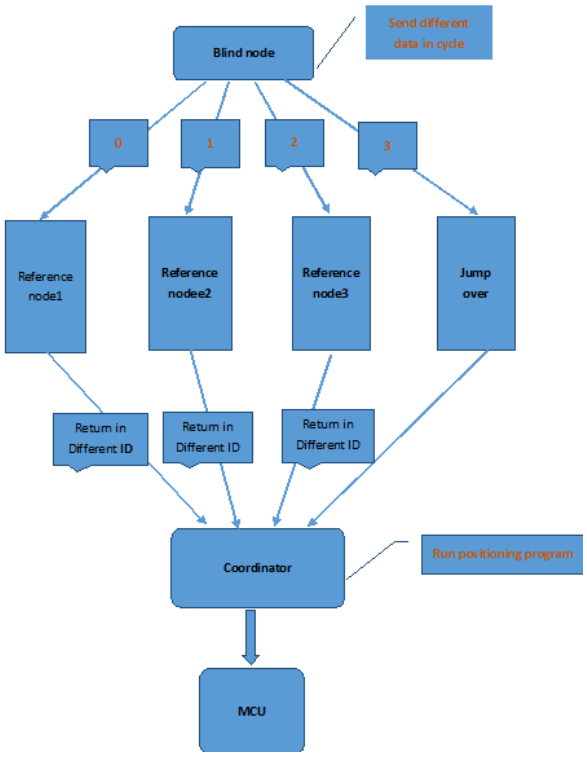

FIGURE IX. SCHEMATIC DIAGRAM OF WIRELESS SENSOR NETWORKING

This figure shows the corresponding relationship of data's transmission between nodes. And ZigBee hardware network is shown as Figure X.

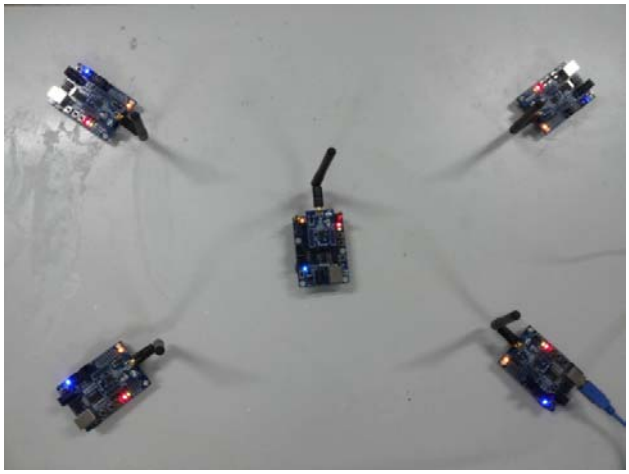

FIGURE X. ZIGBEE HARDWARE NETWORK

Figure XI shows the flowchart of information exchange system. Date transmission is realized by using Zigbee module which encludes two parts: sensor module and recieve module.

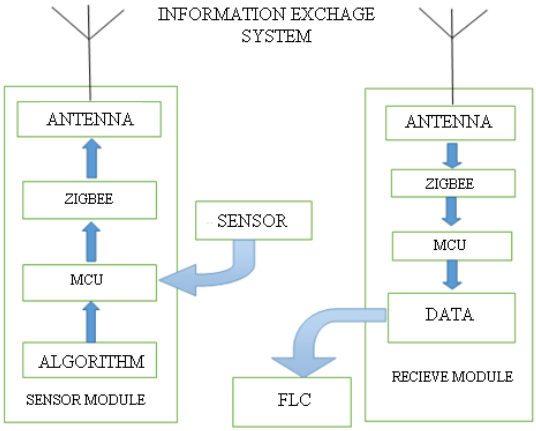

FIGURE XI. FLOWCHART OF INFORMATION EXCHANGE SYSTEM

It was possible to check condition by the FLC and displayed on PC screen like Figure XII.

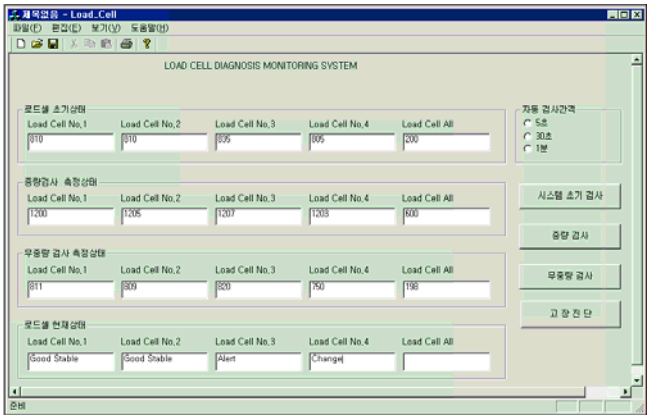

FIGURE XII. USRE INTERFACE OF WEIGHT MEASUREMENT SOFTWARE

V. CONCLUSION AND FUTURE WORK

The weak point of this design is that it has to modify a Junction-box in case of using heavy-load measurement system that is attached Load-cell Trouble Diagnosis System and need a PC. But it has merit that can diagnose Load-cell trouble without an expert and can easily manage Load-cells.

It is implementing each Electronics heavyweight measurement system now. Also, it enable to remote control and diagnosis using Internet and to monitor Load-cells of Electronics heavyweight measurement system simultaneously.

We were researching remote control and management technology using Internet now and designing one-chip IC of Fuzzy Logic Controller for Load-cell Trouble Diagnosis System needless PC. In the end, we can design a dedicated PCB with programmable control chip such as STM32 so that we can implement manufacture special equipment for heavy weight measurement.

ACKNOWLEDGMENT

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