

## Development of Real-time Checking System on Ringer s Solution Using Load Cell

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**Abstract:** Therefore this study focused on developing real-time system, which makes it possible for nurses to check the residual quantity and changing time of Ringer s solution in nurses room. Load Cell is utilized as a sensor to check the residual quantity of Ringer s solution. This Load Cell detects the physical changes of Ringer s solution and transfers electronic signal to the amplifier. Amplified analog signal is converted into digital signal by A/D converter. Developed Embedded system, which computes these data with microprocess(8052) then makes it possible to monitor the residual quantity of Ringer s solution real-time on a server computer. A Checking system on Residual Quantity of Ringer s Solution Using Load cell cut costs using a simple design for a circuit

**Keywords:** Loadcell, Ringer s Solution, Embedded System, Nurse

### 1. INTRODUCTION

While a patient treated with ringer s solution, nurses had to trouble to check how much amount left frequently. Most of hospitalized patients are treated with ringer s solution, and considerable amount of time are spent for nurse checking the left amount of ringer s solution.

this study focused on developing real-time system, which makes it possible for nurses to check the residual quantity and changing time of Ringer s solution in nurses room.

Load Cell is utilized as a sensor to check the residual quantity of Ringer s solution. This Load Cell detects the physical changes of Ringer s solution and transfers electronic signal to the amplifier. Amplified analog signal is converted into digital signal by A/D converter. Developed Embedded system, which computes these data with microprocess(8052) then makes it possible to monitor the residual quantity of Ringer s solution real-time on a server computer.

The method to activate ringer s solution detecting system in this study measured the change of left amount of ringer s solution by using voltage from loadcell as A/D converter input of S3C2410 installed in embedded system. It increases the accuracy of measurement of left amount of ringer s solution by measuring time interval adjustment considering the nature of loadcell and self-developed data processing algorithm. The measured temperature data is stored in memory, and shown in the web screen through CGI application program.

### 2. S STEM DESIGN AND STRUCTURE

#### 2.1 ardware system design

Hardware system design is composed of loadcell to measure weight of ringer s solution, circuit part and microprocessor to detect signals, embedded board to convert the measured results and send to server computer in nurses room, nurses server computer, and clients.

##### 2.1.1 Loadcell to measure left amount of ringer s solution

Loadcell is designed to detect electronic signals generated by pressure on strain gauge attached to detecting surface of loadcell when a pressure applied to ringer s solution. The loadcell used in this study used BS-301A manufactured by Bongshin. It has to be sensitive on the change of the amount, loadcell with excellent temperature stability, low drift property, and high resolution are used.

##### 2.1.2 Circuit part and microprocessor

Circuit part, for detecting electronic signal from loadcell, is composed of operational amplifier to amplify minute signals of the left amount of ringer s solution, filter and electronic device.

Microprocessor used 8052 MPU core.

This is an analog circuit monitored by microprocessor, reduces offset of OP amp and drift characteristics, and the system circuit is designed for stable software algorithm and precise A/D convert. Also RS-232 transmission method enables data transfer to data acquisition(embedded board).

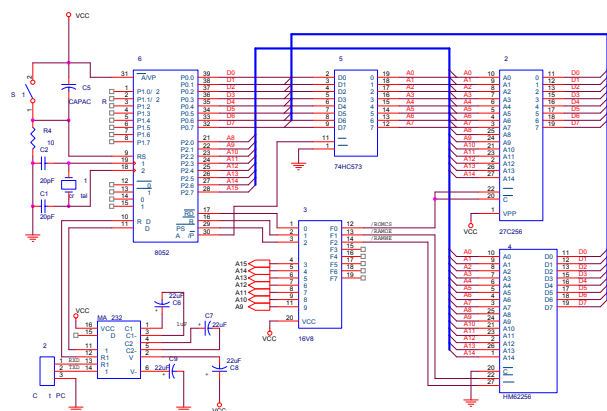


Fig 1. Block diagram of the electronics parts.

Since it should maintain stable output even when the temperature on loadcell changes, it enables A/D convert to minimize temperature compensation, offset pressure of analog circuit, and drift characteristics considering technical, and physical nature of loadcell, and increases sampling speed, and realizes signalized algorithm to enable stable A/D convert by software.

##### 2.1.3 Data Acquisition embedded board

Fig.2 shows embedded board produced by GES, which used S3C2410 SoC of Samsung. Operating system ported embedded Linux Kernel and installed root file system.

The version of embedded Linux Kernel used is 2.4.18-rmk7-pxa1-mz1. Kernel version has a patch against S3C2410

by manufacturer of MPU of 2.4.18 version, used a version that has a board patch by GES that produced embedded board.

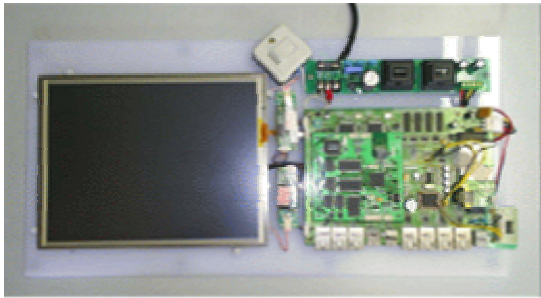


Fig. 2. Embedded board

Kernel source of embedded Linux installed in the host computer is located in the directory of /linuette /target /box/2.4.18-rmk7-pxa1-mz1. In the structure of sub tree in source code, arch has a dependent code to machine that Linux supports, and includes Intel, ARM, PPC, M68K, Mips, Sparc, etc. In the Kernel menu setting screen in Fig. 3, Kernel is set and compiled to suit the system in the Kernel source directory.



Fig. 3 Kernel menu operating screen

Kernel was compiled through make zImage command, the result was created as arch/arm /boot/zImage" file, the generated zImage" Kernel image was downloaded on embedded board through serial transmission.

**2.2 Protocol and algorithm reali ation**

In order for transmission between server computer and detecting part of the left amount of ringer s solution, the following transmission frame was used.

STX	RECIEVE	ID	data	ETX	LRC
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Protocol allotted 1 byte each to start(ST ), and finish(E T), and 1 byte for original ID and 2 bytes for data to enable measurement of left amount of multiple ringer s solution.

The command is in single word of ASCII code, which activates operation to set various functions and adjustments, and in case of data text, A/D converted data or preset data is transmitted.

Signal generated from loadcell is converted into digital signal through A/D convert circuit, then the stored data at the detecting circuit turns to waiting state for transmission interrupt by ID transmission on embedded board. When your ID and data transfer request confirmed by transmission

interrupt, the stored data is transferred to the server computer in nurses room. In the data on left amount of each ringer s solution for patients, the data is transferred in calling order of ID1 IDn. Loadcell of detecting part realized algorithm to collect data on left amount of ringer s solution on server computer. ID is composed of 8 bits, and able for up to 256 reception.

Processors share one circuit by multi-processing, there are 9 data bits in one frame in protocol. The 9th bit is to show address and data. 9 data bits are followed by stop bit, and when stop bit received, examine the 9th bit and if it is 1 , it is treated interrupt.

Multi-processing was realized through this method.

CGI program algorithm was organized as shown in Fig. 3.

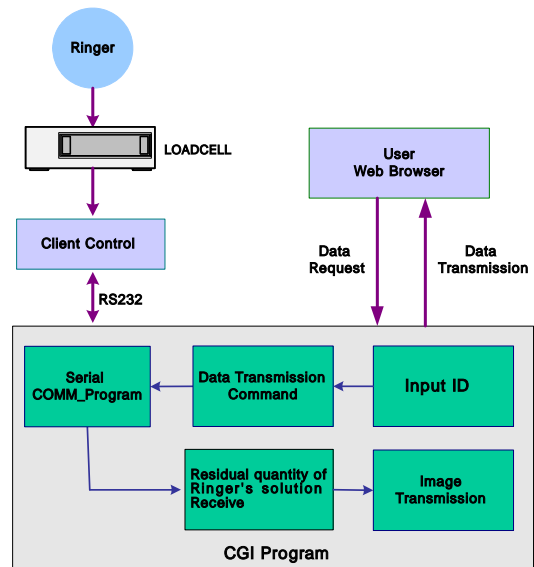


Fig. 4. CGI program algorithm

**3. S STEM ORGANI ATION AND TEST RESULT**

**3.1 System organi ation**

Loadcell was installed in upper part instead of lower part in order to measure the precise left amount when measuring the left amount of ringer s solution, so that the measuring mechanism that can detect weight change of the container of ringer s solution can be realized.



Fig. 5 Installation of the bottle of ringer s solution on loadcell

And 1.5kg of loadcell was used considering the maximum weight of ringer s solution of 1kg.

Data acquisition has a memory limitation, therefore NFS file system of the host computer is used in development process and hard disk of the host computer is considered memory of embedded board.

Ftp server is installed on the host computer to download program from development computer.

Serial transmission is installed after downloading minicom program, and used for embedded board and transmission in Linux in the same way of hyper-terminal program in windows.

Table 1. Minicom transmission program setting

Serial Device	/dev/ttyR0-R7
Bps/Par/Bits	115200 8N1
Hardware Flow Control	No
Software Flow Control	No

The transmission method used between the host computer and target board uses JTAG(Joint Test Access Group) cable, which downloads boot loader, serial cable, which downloads boot loader, Kernel, and root file system, and network cable, which improved transmission speed.

The IP address of the host computer and embedded board to use network on embedded board was set as followed.

```
HOST NAME= "Ringer server"
eth0 IPADDR="203.249.97.58"
eth0 NETMASK="255.255.255.0"
ROUTE DEFAULT="203.249.97.1"
DNS SERVER="nameserver 203.249.96.100"
NFS SERVER IP="203.249.97.55"
NFS SERVER DIR="/nfs/work"
MOUNT CLIENT DIR="/mnt"
```

Fig. 6 is the diagram of embedded system that detects left amount of ringer s solution..

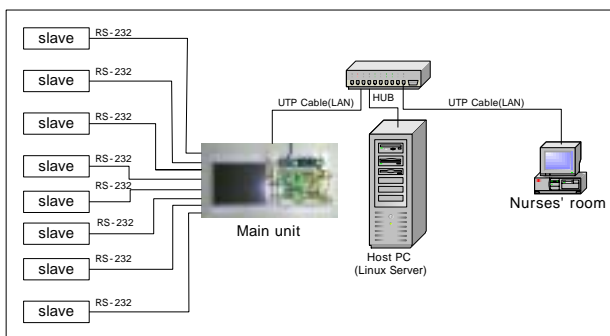


Fig. 6 Diagram of embedded system

3.2 Result data analysis and filtering

In order to prevent less accuracy caused by the tubes when injecting ringer s solution to patients, data that exceeds the range of 2% per second when physical pressure applied on the tubes by patients is excluded to reduce error ratio. Also data out of range of average and variation per second is

excluded to avoid erroneous data caused by weight change of ringer s solution due to the movement of patients or beds.

Table 2. Weight of ringer s solution measuring data

NO	DATA	NO	DATA	NO	DATA	NO	DATA
1	0.6400	11	0.6000	21	0.5900	41	0.6300
2	0.6400	12	0.6200	22	0.5900	42	0.6600
3	0.6300	13	0.6300	23	0.5900	43	0.6600
4	0.6300	14	0.6400	24	0.5700	44	0.6400
5	0.5300	15	0.6300	25	0.6300	45	0.5800
6	0.6100	16	0.6000	26	0.6200	46	0.5800
7	0.6100	17	0.6100	27	0.6200	47	0.5800
8	0.6100	18	0.6100	28	0.6300	48	0.5700
9	0.6000	19	0.6500	29	0.6200	49	0.5700
10	0.6000	20	0.6100	30	0.6100	50	0.5700

fig 7. shows the moving average filter applied by this system. It was effective to obtain stable data..

Discrete-time systems if modeled well can take a given input and process it to generate a desired set of output sequences.

The goal of a moving average system is to smooth irregularities and random variations in a data set or signal.

Fig 7. shows a situation where a moving average filter can help remove noise (agn[n]) that has been added to the desired signal (sig[n]).

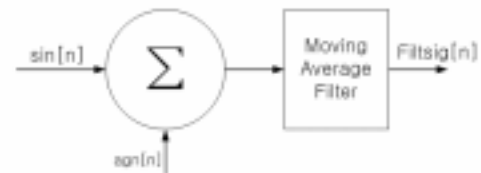


Fig 7. Corrupted Signal through a Moving Average Filter.

A moving average filter can be modeled mathematically as shown in Equation (1). Looking at Equation (1), tell that the upper bound M in the summation can be any number of values.

$$Y[n] = \frac{1}{M} \sum_{k=0}^{M-1} \dots \dots \dots (1)$$

3.3 Web programming and operation

The image below shows the number of a patient who needs replacement of ringer s solution and the time left in real time. When logging on to the server through client of the nurses room, and clicking on left amount of ringer s solution detection ,

it shows numbers of patients who need replacement through CGI program in embedded system

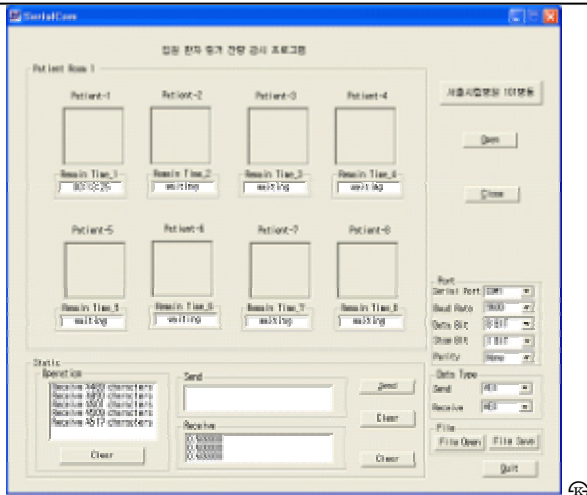


Fig. 8 Web programming operating screen

When completing injection of the solution during web programming, a message that says *The injection of ringer s solution for patient 1 on room 1 is complete.* appears as shown in Fig. 8.

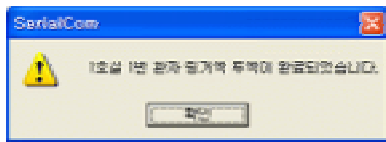


Fig. 9. The message screen of the solution injection complete

**4. RESULT**

This study realized system that measures left amount of ringer s solution in real time from nurses room through loadcell. Network is possible by applying Linux to embedded system, and measuring patients temperature and blood pressure are also possible from nurses room. And algorithm that was self-produced on embedded board was applied for system operation to increase accuracy considering the nature of loadcell. Remote controlling measuring system enables detection of left amount of the solution wherever the network can be organized.

This study indicates that the extension of application of embedded Linux, developmental efficiency, and security when remote detecting needed elements for hospitalized patients are to be explored.

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