Hasta Yatağı Tartısı Tasarımı
Design and Realization of a Patient Bed Scale

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***Özetçe*—Çalışmamızda, hasta yatak tartısı tasarımı gerçekleştirilmiştir. Hasta yatağının her bir ayağının altına birbirinden bağımsız çalışan ve ağırlık ölçen mekanizma yerleştirilmiştir. Son olarak, oluşan net ağırlık Bluetooth aracılığı ile dijital monitöre yansıtılmıştır.**

Anahtar kelimeler— hasta yatağı tartısı; hasta; mikrodenetleyici; kablosuz iletişim

***Abstract*—In this study, we describe design principles and report the preliminary performance of a realized digital patient bed scale. Four of these scales are placed under each castor of a patient bed. Then, the patient weight is displayed on a digital weight indicator mounted on a separate controller board which communicates with each four channels of independent weight sensors via Bluetooth means.**

Keywords— bed scale; patient; microcontroller; wireless communication

I. INTRODUCTION

A conventional weighing scale is a measuring instrument for determining the weight or mass of an object [1]. Weighing scales are born of necessity. The oldest evidence for the existence of weighing scales dates to c. 2400-1800 B.C.E. in the Indus River valley near present day's Pakistan [2]. By 1940s various electronic devices were being added to designs to make readings more accurate. These were not true digital scales as the actual measuring of weight still relied on springs and balances. Load cells which convert pressure to a digital signal, have their beginnings as early as the late nineteenth century, but it was not until the late twentieth century that they became accurate enough for widespread usage.

Weighing scales are used in many industrial and commercial applications, and products from feathers to loaded tractor-trailers are sold by weight. Specialized medical scales are used to measure the body weight of patients. Today, column scales, baby scales, chair scales, hoist scales, platform scales and bed scales are some examples of medical weighing devices.

There is scarcely any situation in which a patient's weight is not important. The fine graduation of the load cells helps in even measuring the smallest fluctuations in weight example the fluid balance of patients with a malfunction of kidneys or with burns can be reliably monitored.

Using Bluetooth communication ensures the system mobility and flexibility. In addition, the weight values can be stored into an internal EEPROM. A real-time clock is also used for labeling time-scale data to mark whenever the recording is started and finished. In this way, a doctor can access to the patient weight data when required.

Such digital medical scales allow bed ridden patients to be weighed simply and are indispensable aid in dialysis and intensive care departments. These electronic healthcare scales are easy to the use with the four load cells that can be placed under the castors of the patient's bed. The bed scale can be left under the patient's bed for closely monitoring the weight change of a patient. The weight of the patient can be determined by deducing the previously determined weight of the bed.

Four pieces of measuring equipment can be stored on the convenient medical scale equipment trolley.

Weighing without having to move the bed is important for the patient's comfort.

In this work, we aimed to study design and development of a patient weight management system. This system has enabled easy accessibility as neither the bed nor the patient have to move between rooms. In order to provide these facilities, patient weight measurement system is designed by placing four weigh scale system under each base of the bed. Then, this measured patient weight can be displayed on the digital weight indicator by using Bluetooth communication. The easy to use user friendly display section consists of a bright display of weight with large characters so that one can easily view the actual weight correctly.

II. EXPERIMENTAL

The designed patient bed scale consists of two main parts. These are the weighing scale on which the weight of the patient is measured and the digital weight indicator on which this weight is displayed.

A. Weighing Scale

Four single strain gauge load cells and HX711 module were used for the weighing scale that is placed under each base of the patient bed. Fig.1. shows the block diagram of the weighing scale.

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A load cell is a sensor or a transducer that converts a load or force acting on it into an electronic signal. This electronic signal can be a voltage change, current change or frequency change depending on the type of load cell and circuitry used. In this study, load cells were used to convert applied weight to the voltage.

There are five types of the load cells depending on the primary and secondary element that is used to sense the force. These types are hydraulic, pneumatic, strain gage, piezoelectric and capacitance load cells.

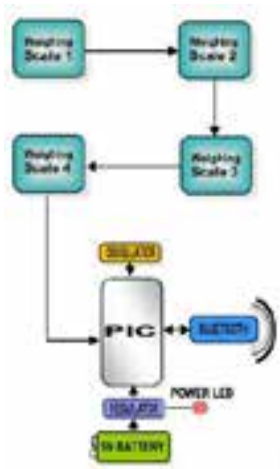

Fig. 1. Block diagram of the weighing scale

Fig. 2. Strain Gage Load Cell

Fig. 3. HX711 Module

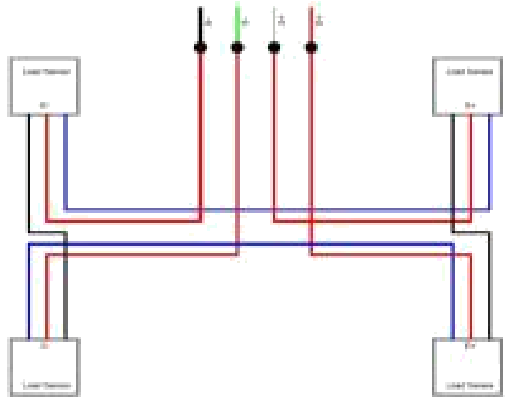

Fig. 4. Combining twelve wires into a Wheatstone bridge configuration

Strain gage load cells are the most common and they are defined as devices that converts a force or load into an equivalent electrical signal. Strain gage load cell was used for this study, as seen in Fig. 2.

HX711 module uses 24 channel high precision A/D converter chip. It is designed for high precision electronic scale design and the internal integration of 128 times the programmable gain amplifier with two analog input channels. HX711 IC allows easily reading the signal generated out of load cells to measure weight. By connecting the amplifier to a microcontroller, the changes in the voltage generated by the load cell can be read and with some calibration very accurate weight measurements can be obtained. HX711 uses a two-wire interface (Clock and Data) for communication. Load cells use a four-wire Wheatstone bridge configuration to connect to the HX711.

At first, four single strain gauge load cells in the weighing scale are combined using the same Wheatstone bridge principle. Each single strain gauge load cell has three wires and a total of twelve wires of four single strain gauge load cells are connected, as seen in Fig.4.

As a result of this connection, four standard load cell wires were obtained and they were connected to the HX711 module's
E+, E-, A+ and A- pins, as seen in Fig.5.

All design processes for one of the weighing scales are repeated for other three weighing scales. Then, SCK, DT, GND and VCC pins getting signals from HX711 modules of each weighing scales were transmitted to the microcontroller in the last weighing scale with the jumper.

Electronic circuit of the last weighing scale contains HX711 connection, but in addition to this PIC16F873A, Bluetooth module, voltage regulator and 12V adaptor are added to this circuit. Finally, VCC, GND, DT and SCK pins that are transmitted from other three weighing scales are connected to PIC16F873A pins, as seen in Fig.6. Then, necessary calculations are made in this microcontroller with the required codes.

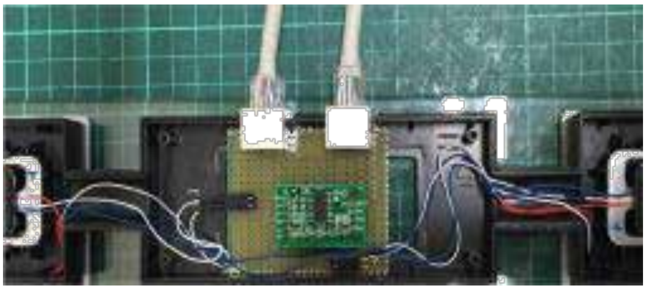

Fig. 5. Connections between HX711 and four single load cells

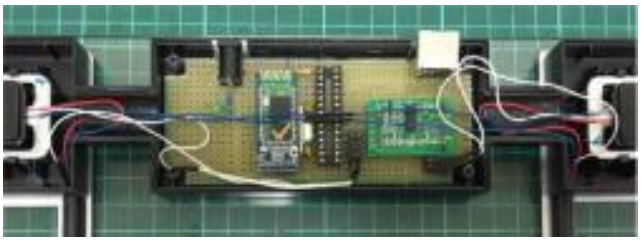

Fig. 6. Electronic circuit of the last weighing scale

B. *Digital Weight Indicator*

Digital weight indicator on which the weight is displayed consists of PIC16F873A, 16x2 Alphanumerical LCD, Bluetooth module, four buttons, voltage regulator and battery. Fig.7. displays the block diagram of the digital weight indicator.

The value from the scale's Bluetooth module is transmitted to the digital weight indicator's Bluetooth module. Then, this weight value is displayed on LCD.

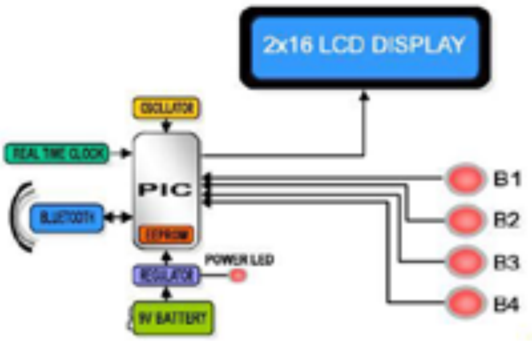

Fig. 7. Block diagram of the digital weight indicator

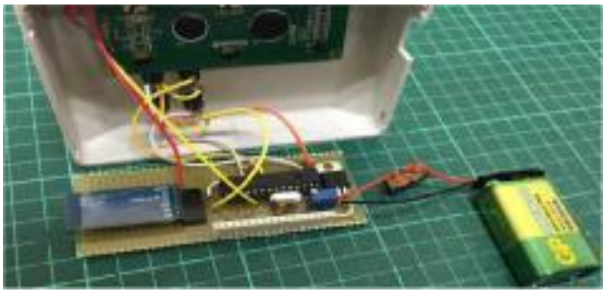

Fig. 8. Digital weight indicator

III. Results and Discussion

Load cells are quite sensitive to environmental conditions and they may easily be affected by different factors such as temperature, dust and humidity. Therefore, the load cells should be placed in containers where the correct measurement can be taken. In order to reduce the influence of environmental factors, a mechanical structure of the bathroom scale is used in this project.

Moreover, HX711 module is preferred among other commercially available modules, for this study. HX711 is an IC that allows easy integration of load cells used in this project. This module consists of an amplifier and a precision 24-bit analog to digital converter designed for weigh scale to interface directly with a load cell. Also, the module uses a two-wire interface as Clock and Data for communication. Compared with other chips, HX711 has added advantages such as high integration, fast response, immunity, and other features improving the total performance and reliability. Thus, it can be easily interfaced to PIC16F873A microcontroller to measure patient weight. In addition, the weight sensitivity of this design device is 100 gram. This feature provides to observe each 1 gram change on the weight of a patient.

Furthermore, using Bluetooth communication ensures the system mobility and flexibility. Also, weight values can be stored into an internal EEPROM. A real-time clock is also used for labeling time-scale data to mark whenever the recording is started and finished. In this way, a doctor can access to the patient weight data when required.

IV. Conclusion

The patient weight management system developed in this project represents a sustainable and traceable measurement of patient's weight. This system provides ease of weighing of bedridden, obese, disabled, intensive care and dialysis patients. In addition, when compared with the current sales price of existing units, the cost of the unit we designed is more efficient. Moreover, it can be extended in its design so that the patient bed has an integrated weighing scale.

References

[1] Sanders, L. A Short History of Weighing. Birmingham, England: W. & T. Avery, Ltd. (1947, revised 1960)

[2] Petruso, Karl M. "Early Weights and Weighing in Egypt and the Indus Valley", M Bulletin (Boston Museum of Fine Arts,), Vol. 79, (1981), pp. 44-51 (http://www.jstor.org/stable/4171634)