Electronic Drawer Application for High Risk Medications in Hospital Inventory

Mustafa Umut AYDIN, Serdar KUCUK

Kocaeli University, Technology Faculty, Department of Biomedical Engineering, Turkey

Umuttepe Campus, 41380, Kocaeli, Turkey

mustafaumut.aydinn@gmail.com, skucuk@kocaeli.edu.tr

Onur FILIZOGLU

Ege University, Engineering Faculty, Department of Biomedical Engineering, Turkey

Ege University Campus, 35100, Izmir, Turkey

onur.filizoglu@gmail.com

***Abstract* - In recent years, starting from the pharmacy, in order to meet the medication needs of patients, dispatching to the service points and ending with the application to the patient, there is a risk of heath loss and high cost loss due to drug losses. These losses occur as follows; theft, losing during transport between floors, counting errors, incomplete billing. In particular, drug group losses, known as high risk drugs, which can have a significant impact on the functioning of the body, lead to serious health risks first, followed by financial losses. Due to these losses in hospital inventory, wrong results can be obtained. The developed system is intended to operate exactly at this point. With the use of an electronic drawer, high-risk drugs are controlled by means of specially protected medication pockets and the required safety process can be accessed before each use. In this way, a special measure is taken for high-risk drugs and each process is followed. As a result of all these studies, thanks to the features of the drawer, in installed area, the high-risk drug management is taken under control in a short period of time and the aim was to minimize patient health risk and to reduce the cost of drug losses.**

Keywords – electronic drawer; high risk medication; hospital inventory; medication pockets.

I. INTRODUCTION

In recent years, medication inventory is kept in many hospitals with manual methods. The medications are sent from the hospital pharmacy and the patient's use is lost in the process and time problems occur. Especially because of the high costs of high-risk medications, it is dangerous to send the patient manually. For all these reasons, high risk medications must be kept under control and transmitted to patients in a registered manner and this control must be independent of human factor. In the study titled "An Investigation on the Effect of Electronic Management İnformation Systems on Inventory Control of Hospital Pharmaceutical", the necessity and benefits of the medication management system are explained[1]. But, there are no detailing definitions for related to the system which will protect the high risk medications. There is just information which how it should be total medication management system. On the other hand, when mechanisms for the protection of high risk medications are examined, the number of pocket in which the medications are place is not enough and the system cannot be used flexibly in the field of usage. Additionally, these systems can protect single type of medication, and a large number of systems are needed to maintain multiple types of medications. Therefore, the electronic drawer application, which is developed considering all these conditions, can actively maintain both a large number of medications and number of different types of medications. On the other hand, with an external intervention, it can inform the system instantly with its current system on it when there is unauthorized access to the medications.

The necessity of the developed system, when consider with official data, the most common errors in all steps in hospital medication management are as follows;

- Dosage errors,
- Medications not being ordered,
- Missing dose,
- Lack of patient ID verification.

On the basis of the process, the error percentages per transaction are as follow;

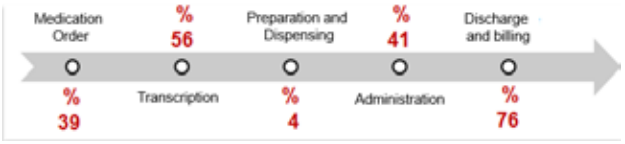

Fig. 1. Errors in Pharmaceutical Management Process[2]

All these data show us, system how much is necessary in the period from the entry of the drug to the hospital until it is used for patient. The percentage value given for each

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process represent the error rate made in that process and each process is in relation to each other.

In general, the Project has benefited from PicBasic, SolidWorks and Altium Designer programs while it is assembled. Mechanical structure built in SolidWorks, electronic cards design built in Altium Designer and electronic embedded software built in PicBasicPro. PicBasicPro run in the Micro Code Studio program. Definitions, assignments and all of codes are made in this program.

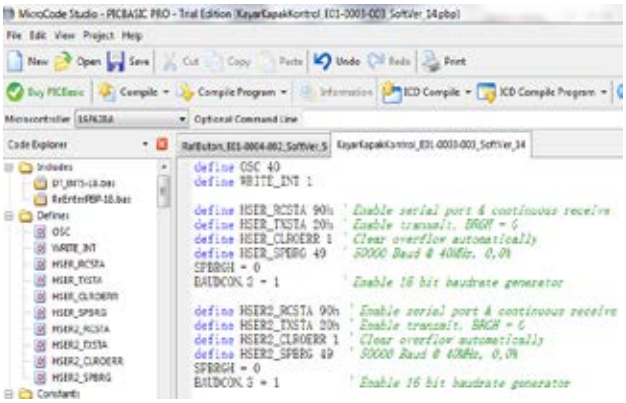

Fig. 2. MicroCode Studio Definitions Section

II. METHOD

The electronic drawer is equipped with 4 stepper motors to control 4 different mechanisms. In practice, 2 of all can be mapped by moving on plane X. 2 of the other stepper motors can be mapped by moving on plane Y. Each one of four mechanisms is called "Wing Mechanism".

Fig. 3. Stepper Motor[3]

In the background, A-N (y axis) between the letters, between 1-16 with the pocket numbers (x axis) and pocket address is determined and the pocket size to be opened in the form of "a * b" is entered.

Size in pocket to open on a=x axis

Size in pocket to open on b=y axis

For example, A03-3 * 2 means that 3 pockets from point A on the x axis and 2 pockets from the 3rd index on y axis are to be opened.

General pocket index equation

$$Xyz - a*b \qquad (1)$$

Stepper motors are connected to gear mechanism, and then plastic-metal curtains are added at same place. Each step of stepper motor is provided to drive these curtains forward and backward. The connection of the stepper motors and wing mechanism is shown below;

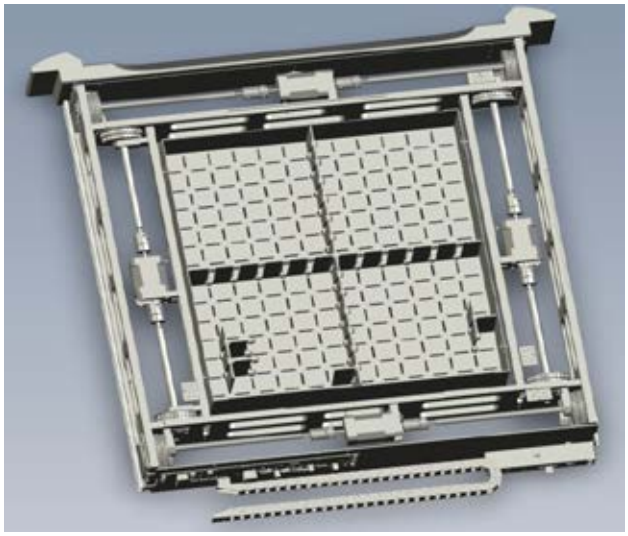

Fig. 4. The Electronic Drawer Mechanic Structure

In the middle of stepper motors, there is a tray where medicines are kept. This tray is addressed as follows, so that the address to be opened on the software is physically known. Tray is divided by separators to form the medication pockets. Pocket can be created in the desired size. If we keep size minimum, 168 pockets can be created.

Table. 1. Pocket Structure into Electronic Drawer

1	2	3	4	5	6	7	8	9	10	11	12	
												A
												B
												C
												D
												E
												F
												G
												H
												I
												J
												K
												L
												M
												N

When changes are made at the equation (1) address shown, the motors move at the same time and take the curtains to the address where the new pocket will be opened.

The DRV8821 step motor driver integra of the Texas Instruments family, which has two step motors driving capacity, is used to run the step motors in this way. Two motor drivers are added on the control board and the necessary components are arranged to work around it. Step motor can be used in full step-micro step modes as desired.

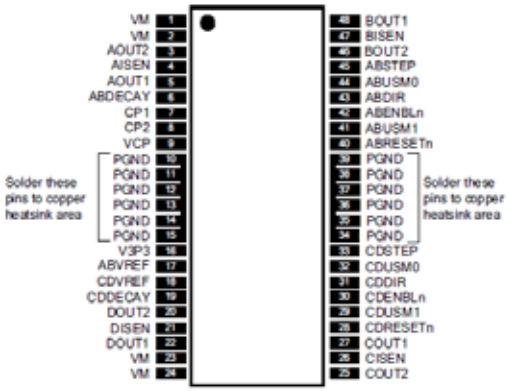

Fig. 5. DRV8821 Pin Configuration [4]

Fig. 6. Magnetic Encoder [5]

Briefly, the electronic drawer will be divided into the pockets and medications will placed in the drawer. By entering the pocket addresses of the medications, only those pockets of the wing mechanism will be opened and the necessary take process will be realized. If you want to open different pockets by manually intervening in the wings, the encoder system is activated.

And to top it all off, if we wish to access a pocket other than the pockets opened by the wing mechanism with any outside interference, we will learn the interference with the information received from the encoder readers.

Magnetic crystal encoder is used to calculate the position of the motor according to the value of turns, if the motors are dragged outside the desired position, the system can be informed about the event and can be recorded. For this reason, the encoder cards are connected on the main shafts that the motors move. There is a magnet inside the main shaft for the encoder to work properly. It appears green colour below;

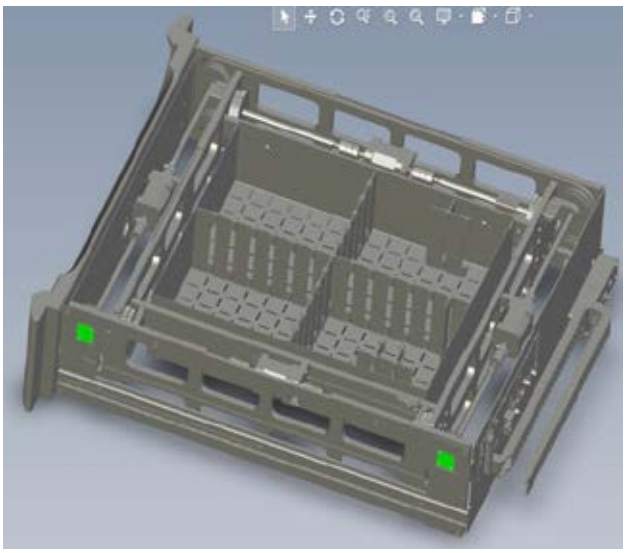

Fig. 7. Encoder Card Position on the Electronic Drawer

Electronic drawer can do start-up from a fixed point which is called "starting position" and then can go to pocket index. Magnet buttons are used for this operation. 4 magnets are fixed on wings mechanism for reading to stop data. Motors continuously move on axis until reading to stop data. After magnet buttons read magnet, electronic drawer ready to go for pocket index.

If any wing mechanism cannot go starting position, drawer send data problem about which one wings mechanism cannot go starting positions.

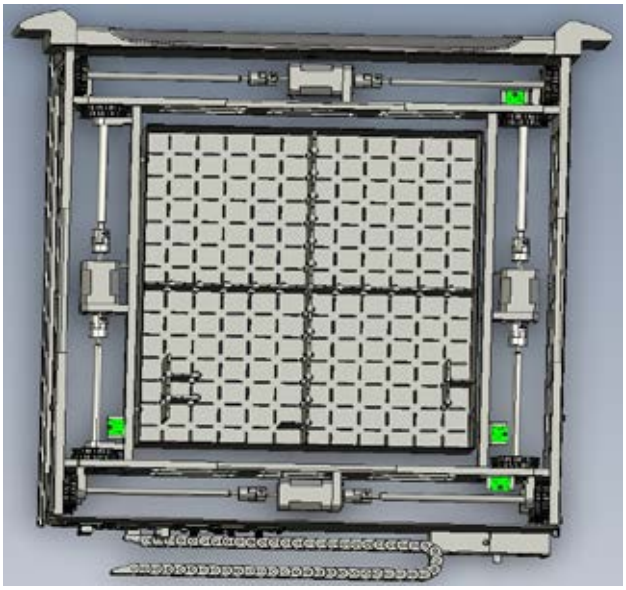

Fig. 8. Magnet Reader Cards Position on the Electronic Drawer

All of these processes are controlled by a micro controller on the control board. For many operations and necessary interrupt operations, Microchip's pic18f8722 family of pic 18f8527, which has enough I/O ports and is used as interrupt for all B ports has been selected.

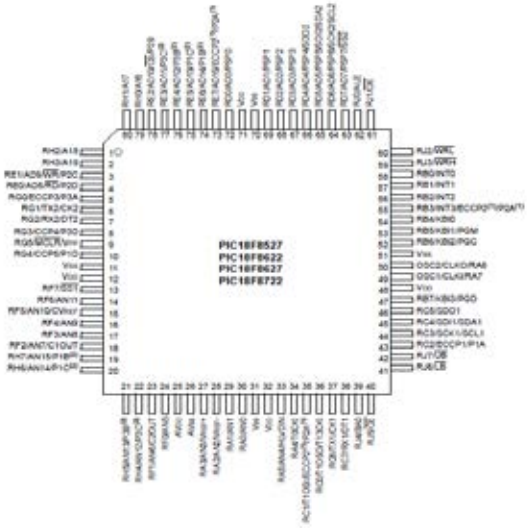

Fig. 9. PIC18F8527 Pin Configuration [6]

III. CONCLUSION

The electronic drawer application for high-risk drugs in hospital inventory project was found to be necessary as a result of investigations and it was found that the results obtained were successful as calculated. In this way, the drugs within the hospital were taken under control and minimized the risk of errors in the drawer application made to the patients, and the cost caused by the hospital drug losses direction the profit situation. With the resulting profitability, the hospital can successfully recycle its expenses for the system. In this way, the patient's health and safety increased while the quality factor was completely achieved.

In a nutshell, with the electronic drawer application, the pockets in the high-risk medications are monitored actively and information can be made in the interventions to the mechanism. In this way, medication losses are prevented and medications can be kept under control outside the pharmacy.

Figure 10 shows the efficiency of Baskent University Hospital which can be obtained when our system is actively applied. "Before ADC" shows us result of system normal working, "After ADC" shows gain cost if our system is installed in hospital;

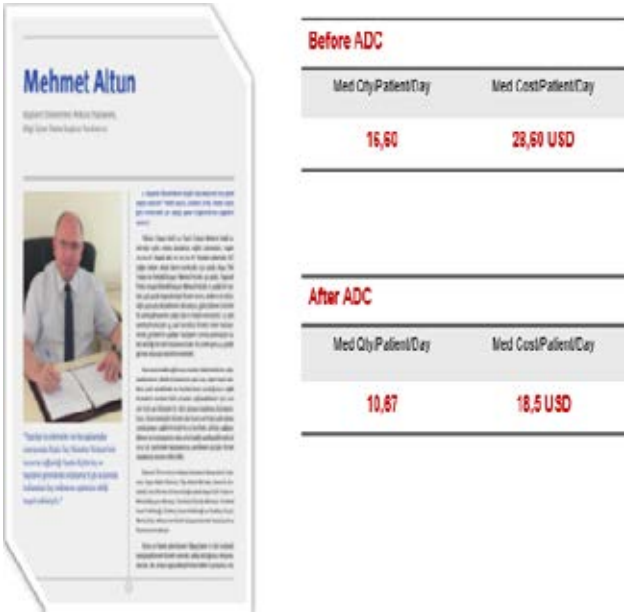

Fig. 10. Baskent University Hospital Case Study

INFORMATION

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