Arduino Based Probe Bag Alert System Design

Arduino Tabanlı İdrar Torbası Uyarı Sistemi Tasarımı

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***Özetçe*— Günümüzde pek çok hasta hastanede veya evde yatılı olarak tedavi görmektedir. Sadece 2014 yılında İstanbul Şişli Etfal Eğitim ve Araştırma hastanesindeki hastaların %74'ünün sonda torbası kullandığı belirlenmiştir. Sonda torbaları sıklıkla kullanılan, kullanımı oldukça basit fakat bir o kadar da kritik bir torbadır. Zamanında boşaltılmadığı durumlarda hastalarda enfeksiyona sebep olabilmekte, patlama durumunda ise etrafı batırmaktadır. Neden oldukları enfeksiyonlar insan hayatını ciddi derece etkilemektedir. Bu sebepten dolayı torbanın doluluğunu ölçüp, uyarı verecek Arduino mikroişlemci tabanlı bir sistem geliştirmeyi amaçlandı. Projede flex sensörler yardımıyla torbanın belirli yerlerinden ölçüm alınacak ve sistem bunların hangisinin doğru olduğuna karar verecek. Sistem içinde oluşturulması hedeflenen algoritma ile belirli doluluk seviyelerinde farklı uyarılar verilecek. Bu çalışmayla beraber çeşitli enfeksiyon hastalıklarının önüne geçilmesi, hastanın yaşam kalitesinin yükseltilmesi ve sağlık çalışanlarına düşen yükü azaltmak amaçlanmıştır. Alınan sonuçlara göre çalışmalar umut vaat etmektedir. Umarım önümüzdeki dönemde daha çok bu tarz projeler görebiliriz.**

Anahtar Kelimeler*— *böbrek, hastalık, enfeksiyon, hastane, Arduino.

***Abstract*— Today, many patients are treated in hospital or at home. It was determined that only 74% of the patients in 2014 Şişli Etfal Training and Research Hospital used probe bags. Probe bags are frequently used, very simple to use but also a critical bag. In cases where it is not emptied in time, it can cause infection in patients, and in case of explosion, it can sink around. The infections they cause seriously affect human life. For this reason, it was aimed to develop an Arduino microprocessor based system that would measure the bag's fullness and give a warning. With the help of flex sensors in the project, measurements will be taken from certain parts of the bag and the system will decide which of these is correct. Different warnings will be given at certain occupancy levels with the algorithm aimed to be created within the system. With this study, it was aimed to prevent various infectious diseases, to increase the quality of life of the patient and to reduce the burden on healthcare professionals. According to the results, the studies are promising. I hope we can see more of these kinds of projects in the coming period.**

Keywords*— *kidney, disease, infection, hospital, Arduino.

I. INTRODUCTION

We see a smart and developing world around us. We are building certain systems for most of what we want or need to do. The systems we have established are called the Internet of Things (IoT) systems. These types of systems do the little things people need to do in their place, saving them convenience, time, and aiming to improve their quality of life. Enabling objects to communicate through an internet infrastructure allows multiple devices to work in harmony.

It is possible to design a system with the Internet of Things infrastructure for the patients who have nobody in the hospital and those who are treated in a bed-dependent manner at home. The responsibility of not only the patients but also the accompanying persons and hospital staff will be reduced to some extent.

URINARY SYSTEM

Bean-shaped kidneys, an urethra, a bladder, and ureters are major elements of the human urinary system. It removes the waste products formed in the body after filtration from the body. It also balances blood pressure, maintains electrolyte and metabolite levels and regulates the pH of the blood[1]. Urinary System has some main elements like kidneys, urinary bladder, ureters, and urethra. Among the main features of the urinary system:

- The excretion of waste materials that are formed as a result of digestion and formed after filtering the blood.
- Ensuring water and electrolyte balance

- Production of Erythroprotein Hormone
- Renin enzyme production
- To convert vitamin D into its active form[2].

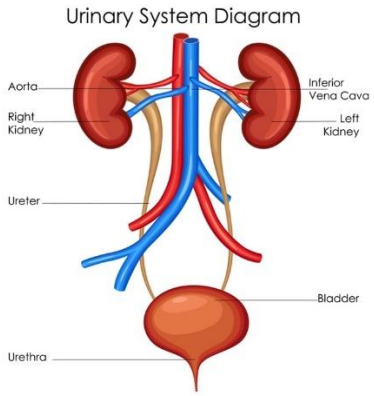

Figure 1. Structure of the Urinary System

URINARY SYSTEM DISEASES

Acute Kidney Failure

Acute Kidney Failure occurs when the filtering feature, which is the main function of the kidneys in the human body, is lost. Therefore, the kidneys cannot remove waste materials from the body, which means that these waste liquids are entangled in a way that could endanger our lives[3]. According to the latest research, this disease can cause multiple organ failure[4].

Urinary Tract Infections

Urinary tract infection can be explained as bacterial growth in the urinary tract, which should be sterile. If bacteria reproduce without any symptoms, this is called asymptomatic bacteriuria. Fever in newborns and infants is a symptom of UTI[5].

Urinary Incontinence

Urinary incontinence is a common disease among people. It is thought that only 26 million people in America have experienced this disease once in their lives. Although it is a very common condition, the percentage of people who are treated is only 25%. This disease reduces the quality of life of patients, however, it also puts patients in a difficult situation psychologically. Patients who experience urinary incontinence suffer from Urinary Tract Infections more than those who do not.

Urolithiasis

It is called clogging of the urethra by certain substances. They are similar to stones as a structure. That's why they are called kidney stones. The reasons for the formation of kidney stones can be said as drinking less water or using more salt. Small stones can be removed from the body during the urine. However, it will not be so easy to remove large stones from the body[6].

URINARY CATHETERIZATION

Urinary catheterization is auxiliary medical equipment that allows urine accumulated in the bladder to be emptied when the person cannot empty it on their own. There are two types of catheterization. These are permanent catheterization and intermittent catheterization[7].
Catheters have synthetic coatings such as rubber and latex. Although expensive, catheters can also be covered with silicone. Silicone-coated catheters are more common in Foley-type catheters because the silicone coating is resistant to scaling, which may occur if left in the bladder for a long time[8].

Permanent(Indwelling) Catheterization

The permanent catheter has a double lumen system. This lumen system helps urinary excretion as well as swelling of the balloon at the tip of the catheter. The permanent catheter has advantages such as ensuring continuous urinary excretion and reducing an obstruction in the bladder. At the tip of the permanent catheter, there is a balloon inflated by sterile water. The balloons can be found in two different sizes, 5 cm^3 and 30 cm^3. Permanent catheters made of materials such as rubber or silicone are covered with antibacterial agents[9, 10].

Intermittent Catheterization

Intermittent catheterization, another method of catheterization, is mostly used in patients with spinal cord injury. At the end of the catheter has an opening to drain the accumulated urine. The other end is placed inside the body until the bladder. These types of catheters are generally disposable catheters. It should be removed after replacement and replaced with a new one[11].

II. MATERIALS AND METHODS

Arduino Nano

Arduino Nano; It is one of the small size models of Arduino series microcontroller boards, which are widely used, and uses the Atmega328 microcontroller. It has 14 digital input/output pins (6 of which can be used as pulse-width modulation), 8 analog inputs, 16Mhz crystal, USB socket,

ICSP connector, and reset button. There is everything necessary for the microcontroller to work on the board. It can be easily connected to the computer via USB cable, powered by an adapter or battery.

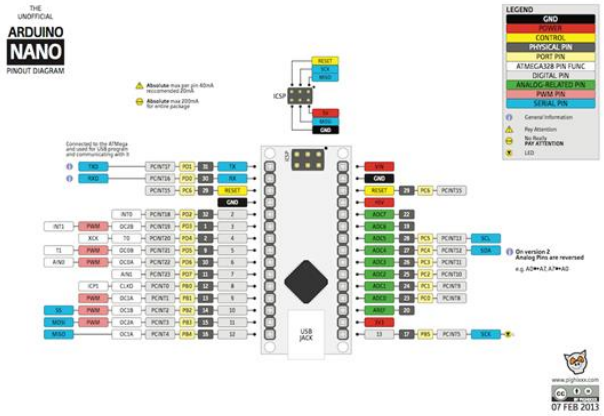

Figure 2. Arduino Nano pin diagram

MPU-6050 Sensor Card

It is a 6-axis sensor board with a 3-axis gyro and 3-axis angular accelerometer on the MPU-6050. It can work with a voltage between 3V and 5V. It can output I^2C from both of its outputs. The resolution of their output is 16 bits.

Figure 3. MPU 6050

Flex Sensor

It has a logic that creates tension as it bends. Generally, the resistance when bending can double. This resistance increase can be detected by a voltage divider circuit. In this way, it is used in applications that perceive hand movements. It can be of various sizes. Applications include robotics, medical devices, and the gaming industry.

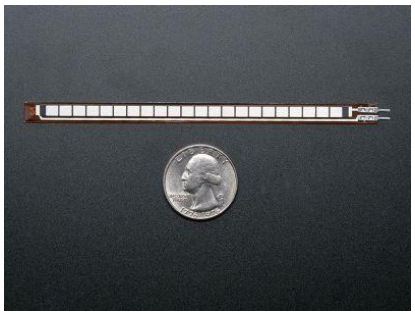

Figure 4. Flex Sensor

Fullness Determination

It is planned to make use of flex sensors and small size Arduino models whose resistance changes as they are bent to determine the filling of the probe bag. As the urine bag fills up, the bag will have a round surface so that the sensors tightly attached to it will bend. In this way, the resistance formed in the sensor is expected to give information about the amount of urine in the probe. It is thought that a single sensor will not be enough for different positions of the probe bag, therefore various trials will be made for different sensor positions. For example, while the probe bag is lying flat while the patient is lying down, the patient is transported perpendicularly to one another while being transported between the units. In both cases, the surfaces of the probe torch will take different geometric shapes and give different measurements. Therefore, it is planned to determine the position of the probe using the gyroscope and to decide which of the sensors give the most accurate results by processing the data from the sensors according to the probe location with a microcontroller card such as Arduino. According to the data coming from the sensors, it is planned to inform the people about SMS or email when the probe bag is sufficiently full.

In the testing phase of the presented project; Water will be sent to the urine instead of the syringe connected to the probe bag and hose. Since it will not be tested directly on the patient, the ethics committee permit was not required. Measurement results and real results will be entered into the SPSS program, and it will be examined with the in-class correlation test (ICC) for measurement accuracy and whether there is a statistically significant difference between the real results and the measurement results.

Statistical Analysis: Independent Sample t-Test

The t-Test is the most commonly used test among statistical hypothesis tests. It can be defined as an approach that tries to statistically determine whether there is a significant difference between the averages of the two group data. Small examples are also known as test techniques. This is

known because it is a statistical technique that can be applied even when n<30 or if the main mass means is normal. Whether there is a relationship with this technique can be said but the degree of the relationship is not mentioned.
In this project, it will be tested whether there is a significant difference between the actual probe occupancy rates and the values measured from the sensors. For this purpose, measurements will be taken at least 10 times for different locations of the probe and the data will be analyzed in the SPSS statistical data analysis program.

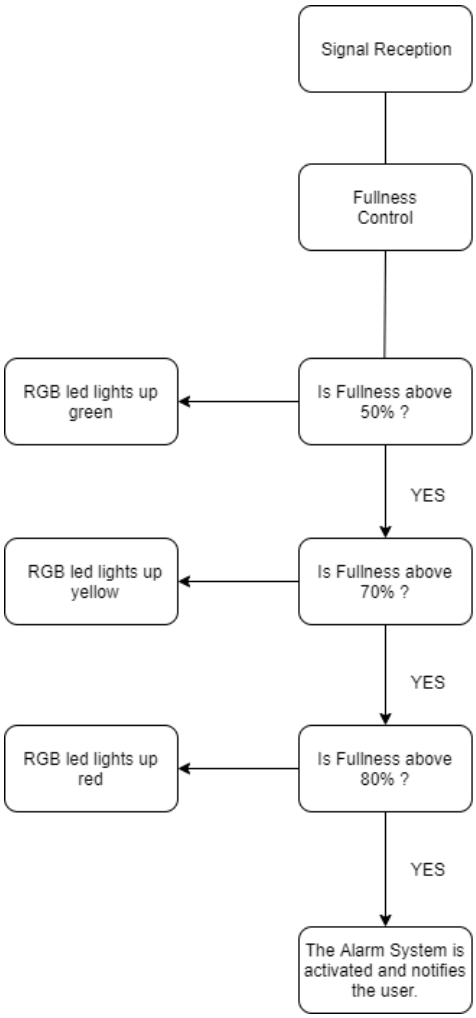

Figure 5. Working Principle of the System

III. Results and Discussion

In the tests conducted, it was observed that the project mostly gave correct results. It was found to be quite suitable according to the segment it addresses. Our device was designed to have a positive effect on the health of patients and for a more comfortable process for companions. Improvements for this device were determined after the feedbacks received from various hospital administrations. A nurse who expressed her opinion among these feedbacks stated that their work will really become easier thanks to this device and that the risk of people using probe bags to experience various infections is an element that cannot be ignored.

As a result, this project has accomplished its goal with its aspects that need to be improved. Hundreds of lines of code were written during construction. Thanks to multiple sensors and Arduino microprocessor, this project has been developed.

The project could be improved by improving the sensors used. It is possible to obtain more precise results by using more sensitive sensors. GSM Module could not be used in this project due to cost problems. By adding a GSM Module, the data obtained by the system can be sent to the companion's phone as a text message.

In this system, the occupancy rate was tried to be calculated according to the swelling of the probe bag. Gyro Module, on the other hand, is used to select the Flex Sensor which will give the most accurate result in case the bag is not in a vertical position.

My aim to choose this subject is the experiences I had during my stay with my grandfather who was hospitalized due to kidney disease. At that time, I had the opportunity to observe the difficulties experienced by the patient, the hospital staff and the companion myself. I hope my benefit has been touched in this project, where I pursue the goal of improving the quality of life for everyone.

Acknowledgments

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