

A Noninvasive Blood Glucose Measurement System by Arduino and Near-infrared

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Abstract-- This paper proposes a new hardware system to measure the blood glucose concentration. This system has the characteristics of noninvasive, simple and quick. Firstly, we use near-infrared light irradiation fingers. The infrared light transmittance can receive a signal about the blood glucose concentration. Then after an amplifier amplification, this signals will transmit to the Arduino. We use the Arduino Uno board as the CPU to analysis and processing the signal. Through comparison with the standards set, our system can determine blood glucose concentration of the measuring signal. Finally, the results will show on the LCD screen, and it can transmission to a phone or laptop for storage via Bluetooth at the same time. It is convenient that customers to know their changing trends in blood glucose levels. Patients will try to take measures to control the adverse effects caused by high blood glucose when they know their blood glucose levels.

I. INTRODUCTION

Diabetes mellitus(DM) is a chronic and normally leading to hyperglycemia, which may cause many complications. Thus, the role of blood glucose monitoring and measurement becomes very important for diabetic therapies[1].

The number of diabetics is increasing. According to the world health organization(WHO),the number of people with diabetes has risen from 108 million in 1980 to 422 million in 2014.In 2012,an estimated 1.5 million deaths were directly caused by diabetes and another 2.2million deaths were attributable to high blood glucose. WHO projects that diabetes will be the 7th leading cause of death in 2030[2].

Thus, diabetic patients need to measure their blood glucose content at least three every day to avoid serious complications. But currently, the main method used for blood glucose is invasive, which has disadvantages. Near-infrared non-invasive blood glucose technology has the advantages of no pain, no risk of infection, rapid measurement, without any chemical reagents or consumables. It is considered one of the most promising non-invasive detection technology.

In order to design a non-invasive system, we use the near-infrared light to measure the blood glucose[3],and next step we use the Arduino Uno board as the CPU to analysis and processing the signal. At last, we can show the result in the LCD. At the same time, the result will transmission to a phone for storage via Bluetooth .

The outline of this paper is as follows. Section 2 proposes our methods to test blood glucose. Section 3 present results and future work about our model. Finally, Section 4 concludes

this paper.

II. Methods

We proposed system consists of four parts electrocircuit. The hardware framework shown in Figure 1.

The first part is near - infrared system. when the near-infrared light transmission fingers, through this relationship of the receive near-infrared light sensor signals with the concentration of blood glucose changes, this system can detect the blood glucose levels. The second part of the Arduino is the main control chip, responsible for analysis and processing the signal of received blood glucose. The third part is the LCD display. The function of this part is to display the result of Arduino processing. The fourth part is the storage function. Main control chip transmit the blood glucose concentration results to the phone via Bluetooth technology that it is convenient for the user at any time to view and analysis.

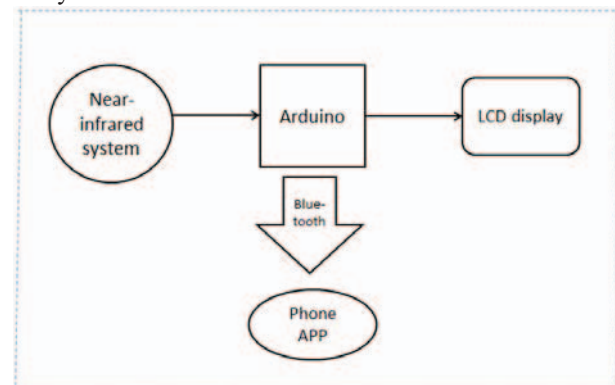


Figure 1.The hardware framework of our system

2.1 near-infrared system

Near infrared system consists of near-infrared LED transmitter, an near-infrared receiver and signal amplifier three parts. Its structure diagram shown in Figure 2.

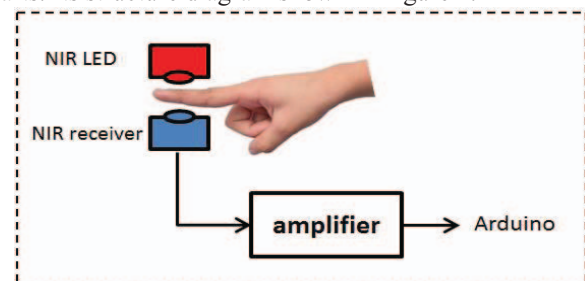


Figure 2.Near-infrared system

Near-Infrared(NIR) is located in the wavelength region of 730nm to 2500nm[4].NIR have many advantages than other media. The advantages and disadvantages of NIR shown in Table 1.

Table 1. The advantages and disadvantages of NIR

	Advantages	Disadvantage
NIR	<ul style="list-style-type: none"> ➤ High S/N ratio ➤ Sensitive to blood glucose ➤ Low Absorbance in skin tissue ➤ Nondestructive 	<ul style="list-style-type: none"> ➤ Temperature sensitive ➤ High scattering in skin

Many scientists to use NIR because of it has those advantages. Such as Heise, the pioneer of the non-invasive blood glucose techniques, has tried on many aspects of NIR applied to non-invasive blood glucose measurements[5]. Maruo et al. used NIR diffuse-reflectance spectroscopy through fibre optics on the forearms of diabetic patients[6]. Thus, the use of the NIR may be the most suitable for non-invasive blood glucose measurement through skin tissue.

2.2 Arduino

Arduino is a family of board oriented to prototyping based on Open Source hardware and software[7].Arduino provides an integrated development environment(IDE) that is capable of running on all major operating systems and has support for a simplified C/C++ programming language[8].Arduino also has a large online community that stimulates engagement in development and enables rapid prototyping and debugging[8].Further, a large number of high-grade sensors and devices have custom Arduino libraries and active support from manufacturers for the platform. Because the Arduino platform has been used successfully in several other similar data collection efforts. So the Arduino are becoming more and more useful in both life sciences [9]and neuroscience[10],as well as in other research areas.

Arduino Uno board shown in Figure 3.Arduino Uno board carries a set of digital and ADC input besides digital and PWM output. So in this project we used an Arduino Uno board as the CPU to data processing. The main reasons for choosing Arduino over its competitors were the affordable price and the active open-source community with enormous amount of projects, shields, and tutorials.



Figure 3.Arduino Uno board

2.3 LCD display

LCD display for real-time blood glucose data, user-friendly understanding of blood glucose concentration at this time, to take appropriate treatment.

2.4 Phone app

In order to facilitate users to understand the changes in their blood glucose levels, we use the Phone App to store glucose concentration.

Bluetooth technology has Characteristics of good flexibility and good resistance. So in this project, we use Bluetooth technology to keep communication with mobile phone and transfer data.

III. RESULTS AND FUTURE WORK

Our system can easy to measure the user's blood glucose levels, and it can save the blood glucose levels in the phone App. In order to adopt an appropriate method to control high blood glucose, user can readily understand and analyze theirs blood glucose data.

Although our system is able to measure blood glucose levels, but the measurement accuracy of the results is still to be improved. There is still a great demand for an accurate, non-invasive method for measuring the blood glucose of diabetic patient, both on a daily basis and over the long term. It is hoped that by reducing confounding factors, such as finger thickness and the physiological differences, more accurate methods of glucose measurement can be developed to help clinicians and patients.

IV. CONCLUSION

Our system using Arduino and near-infrared to achieve the measurement of blood glucose concentration. Our system has a non-invasive, quick and easy features. And its overall price is not high that easy to satisfy the user's price demand. This system can transmit the measured result to a mobile phone APP via Bluetooth technology, then it is convenient that customers to understand their changing trends in blood glucose levels.

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