DESIGN OF THE DIGITAL SPHYGMOMANOMETER USING PRESSURE SENSOR

RANCANG BANGUN TENSIMETER DIGITAL MENGGUNAKAN SENSOR TEKANAN

Tito Yuwono[1], Erwin Yan Irawan[2], Medilla Kusriyanto[3], Siti Isti'anah[4]

[1,2,3]Electrical Engineering Department, Islamic University of Indonesia, Yogyakarta
Jalan Kaliurang KM 14 Yogyakarta, Indonesia 88854
[4]Medical Department, Islamic University of Indonesia, Yogyakarta
Jalan Kaliurang KM 14 Yogyakarta, Indonesia 88854
Email: [1]tito@uii.ac.id, [3]medilla@uii.ac.id

ABSTRACT

Blood pressure measurement is a very important activity. Blood pressure determines the strength of blood flow circulating in the body. If blood pressure is too high or too low, it will cause vital impact and even lead to death. The measuring of blood pressure commonly uses mercury sphygmomanometer. Disadvantages of this instrumention are users should have good hearing and sight, depending on the sensitivity of the stethoscope, and not user-friendly. In this paper, the writers will discuss the design and development of digital blood pressure instrumentation that is user-friendly. Some of the components used in this instrumentation are MPX5050GP pressure sensor, comparator, voice circuit, and LCD circuit. The result of blood pressure measurement is displayed on the LCD and sound. With these features, user can use this instrumentation easily. The performance of this intrument was tested by comparing it with mercury sphygmomanometer. The accuracy of this instumentation is 99.33%. The advantages of this instrumentation are it doesn't depend on the sensitivity of stethoscope and the level of blood pressure can be viewed and heard directly on the LCD and Speaker.

Keywords: Blood pressure; Digital sphygmomanometer; Pressure sensor; user-friendly.

ABSTRAK

Pengukuran tekanan darah merupakan aktivitas yang sangat penting. Tekanan darah adalah penentu kekuatan aliran darah dalam sirkulasi tubuh. Jika terlampau tinggi atau terlampau rendah akan menyebabkan dampak yang vital bahkan menyebabkan kematian. Alat untuk mengukur tekanan darah yang biasa digunakan adalah sphygmomanometer air raksa. Beberapa kekurangan sphygmomanometer air raksa adalah bahwa penggunaan alat ini harus dengan daya dengar dan lihat yang tinggi serta tergantung sensitivitas stetoskop, alat ini juga kurang user friendly. *Pada artikel ini didiskusikan desain dan pembuatan tensi meter digital yang akan mempermudah pengguna untuk menentukan seberapa besar tekanan darah seseorang. Bentuk luaran dari peralatan ini ada dua jenis, yaitu yang ditampilkan di LCD dan dalam bentuk suara sehingga sangat memudahkan pengguna. Sensor yang digunakan adalah sensor tekanan MPX5050GP. Dari hasil pengujian disimpulkan bahwa alat ini bekerja dengan baik dan tidak ada perbedaan nilai bila dibandingkan dengan pengukuran menggunakan air raksa. Dari pengujian disimpulkan bahwa akurasi alat ukur ini 99,33% dibandingkan dengan sphygmomanometer air raksa. Kelebihan alat ini dibandingkan sphygmomanometer air raksa adalah bahwa alat ini tidak tergantung pada sensitivitas stetoskop, hasilnya langsung bisa dilihat melalui LCD dan didengar melalui pengeras suara.*

Kata kunci: *Tekanan darah, sphygmomanometer digital, sensor tekanan*, user friendly

1. INTRODUCTION

Measurement of blood pressure is a medical activity that is important in medical care. Blood pressure is the force of blood flow to circulate in the blood vessels. There are two types of blood pressures which are measured: first, the types of blood pressure in the arteries when the heart contracts and it is called the systolic pressure and second, the blood pressure when the heart is in relaxation (rest) and it is called the diastolic pressure.[1,2] The magnitude of the systolic and diastolic pressures are divided into

several categories, such as hypotension, normal, pre-hypertension, hypertension I, hypertension II, and hypertension and critical hypertension.[3,4] These categories are shown in Table 1.

Table 1. The Classification of Blood Pressure

Classifications	Sistolic	Diastolic
Hypotension	< 90	< 60
Normal	90 – 119	60–79
Pre-hyperten-sion	120–139	80–89
Hypertension I	140–159	90–99
Hypertension II	160–179	100–119
Critical Hypertension	> 180	>120

High blood pressure will cause several diseases, such as heart disease, kidney disease, hardening of the arteries, and stroke. Meanwhile, too low blood pressure causes reduced oxygen supply to vital organs such as the brain, heart, and kidneys. Therefore, the vital organs do not work properly.[5]

Patients can measure their own blood pressure level complement measurement by doctore. It will give a more complete and accurate picture of the patients, and help doctors make decissions.

One of instrumentations that is often used to measure blood pressure is mercury sphygmomanometer. Mercury sphygmomanometer has excellent accuracy to measure blood pressure. So, this sphygmomanometer is the most widely used by health professionals. However, several shortcomings are found in mercury sphygmomanometer, such as the use of this tool requires a good sense of hearing and sight, as well as dependent sensitivity of stethoscope. This tool is also not user-friendly.[5,6,7] Figure 1 shows mercury sphygmomanometer. The disadvantages of this instrumention are users should have good hearing and sight, depending on the sensitivity of the stethoscope, and it is not user friendly.

Based on this problem, it is required a sphygmomanometer that is easy to use by the layman.

Figure 1. The Mercury Sphygmomanometer

2. RESEARCH METHOD

In this research, the writers designed a digital sphygmomanometer. The output of this research is a sphygmomanometer based on pressure sensor. The result of measurement is displayed on the LCD and in the format of sound. Therefore, the users can easily use it. This tool uses a pressure sensor mpx5050gp. This sensor has a pressure limit 7.25 psi which is enough to be used as a blood pressure sensor that only requires 3.87 psi pressure.

The other components are the oscillator circuit, comparator, microcontroller, LCD, and voice circuits. Figure 2 shows the block diagram of this instrumentation.

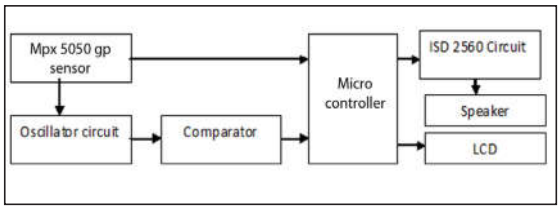

Figure 2. The Block Diagram of Digital Sphygmomanometer

Figure 3. MPX5050GP Sensor[8]

The second component is the oscillator circuit. The function of the oscillator circuit is to generate the pulse when there is a sudden rise of input voltage from the sensor so that it can provide interruptions to the microcontroller to determine the systolic and diastolic blood pressure. Oscillator circuit is shown in Figure 4.

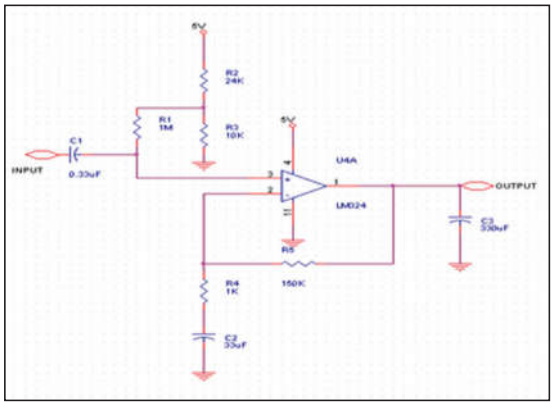

Figure 4. The Oscillator Circuit

The third component is a comparator circuit. Comparator circuit will limit the input voltage and will continue an interruption to the microcontroller. In addition, comparator circuit will change the input voltage to 5 volts so it will be easier to read by the microcontroller. The comparator circuit is shown in Figure 5.

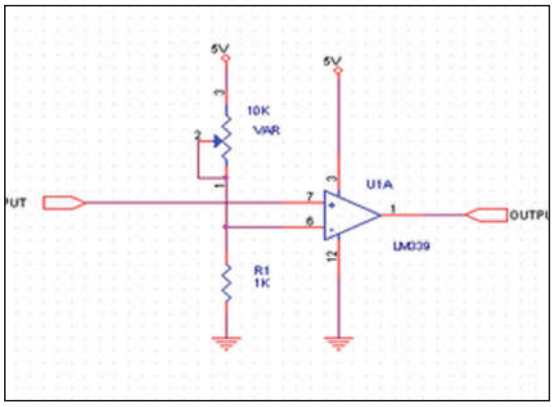

Figure 5. Comparator Circuit

The fourth component is the microcontroller. In this research, we use the AT Mega8535. The microcontroller will process all input data and will continue to enter the voice circuit and the LCD to show the result of measurement in text format.

This research uses ISD2560 as main component in the voice circuit. Figure 6 and Figure 7 show the ISD2560 and voice circuit. Meanwhile, Figure 8 and Figure 9 show the LCD circuit and product of research (Digital sphygmomanometer) respectively.

Figure 6. The ISD2560 [9]

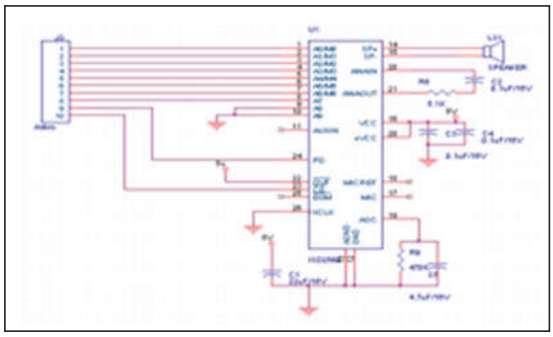

Figure 7. The Voice Circuit Using ISD2560

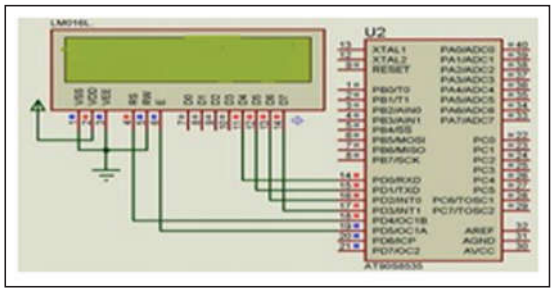

Figure 8. The LCDCircuit

Figure 9. The Digital Sphygmomanometer

3. THE RESULTS AND ANALYSIS

Performance of this device was tested with two type experiments. First, the writers tested the work of the sensor. Second, the writers tested the accuracy of the instrumentation. Table 2 shows the relation of the sensor output and sensor input (Pressure). Furthermore, Table 3 shows accuracy of digital sphygmomanometer.

Table 2. The Performance of Sensor

No.	Pressure (mmHg)	Voltage (volt)
1	0	0
2	10	0.19
3	20	0.42
4	30	0.63
5	40	0.76
6	50	0.89
7	60	1.02
8	70	1.16
9	80	1.28
10	90	1.39
11	100	1.53
12	110	1.66
13	120	1.78
14	130	1.91
15	140	2.04
16	150	2.16
17	160	2.28
18	170	2.40
19	180	2.54
20	190	2.67
21	200	2.88

The sensor performance testing aims to validate whether pressure sensors are still working well or not. The test is performed after the sensor is installed on the system, the input of sensor connected to 5 Volt (DC sources), and the ground of the sensor connected to PCB ground. Then, the writers give air pressure to the sensor hole. Table 2 shows the relationship between pressure input and output voltages. From the table, it can be seen that the greater the pressure, the greater the output voltage will be produced, so the sensor justified the work properly.

The performance testing also aims to analyze the accuracy of the instrumentation compared to mercury sphygmomanometer. Table 3 shows the data of measurement result with 15 respondents.

Table 3. The Data of Measurement Result with 15 Respondents.

No.	Digital sphygmoma-nometer	Mercury sphygmoma-nometer	Sound
1	130/80	130/80	ok
2	100/70	100/70	ok
3	120/90	120/80	ok
4	90/70	90/70	ok
5	100/60	90/60	ok
6	120/90	120/90	ok
7	130/70	130/70	ok
8	100/70	100/70	ok
9	150/90	150/90	ok
10	100/70	100/70	ok
11	130/80	130/80	ok
12	120/80	120/80	ok
13	110/70	110/70	ok
14	110/70	110/70	ok
15	140/80	140/80	ok

Table 3 shows that most of measurement using digital sphygmomanometer and mercury sphygmomanometer is same, except the fifth respondent. The level of accuracy of this instrument compared to mercury sphygmomanometer is 99.33%. Therefore, this instrumentation is suitable to use.

3. CONCLUSION

Digital sphygmomanometer design was described previously. Some of the components used are MPX5050GP pressure sensor, comparator, voice circuit, and LCD circuit. The accuracy of this instumentation is 99.33%. The advantages of this instrument are firstly, it does not depend on the sensitivity of the stethoscope and secondly, blood pressure can be viewed and heard directly on the LCD and speaker.

4. ACKNOWLEDGMENT

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