RESEARCH ARTICLE OPEN ACCESS

Manuscript received September 28, 2023; revised October 02, 2023; accepted October 12, 2023; date of publication December 25, 2023
Digital Object Identifier (DOI):https://doi.org/10.35882/teknokes.v16i4.625

How to cite: Farahun Nisa Aulia, Andjar Pudji, Sumber and Naqeeb Ullah, "Digital Sphygmomanometer Detects Systole Diastolic Display", Jurnal Teknokes , vol. 16, no. 4, pp. 224-231, December. 2023.

Digital Sphygmomanometer Detects Systole Diastolic Display

Farahun Nisa Aulia, Andjar Pudji, Sumber and Naqeeb Ullah

[1] Department of Electromedical Engineering. Health Polytechnic Ministry of Health Surabaya, Surabaya, Indonesia
[2] Balochistan University of Information Technology Engineering and Management Sciences: Quetta, Balochistan, Pakistan

Corresponding author: Andjar Pudji (e-mail: andjar.pudji@gmail.com).

"This work was supported in part by Department of Electromedical Engineering. Health Polytechnic Ministry of Health Sur Supported by Health Polytechnic Ministry of Health Surabaya. Department of Electromedical Engineering."

ABSTRACT Hypertension. characterized by elevated blood pressure against artery walls. can be influenced by a patient's body temperature. Therefore. detecting body temperature before measuring blood pressure is essential for accurate assessment. Currently. Digital Tension and Body Temperature parameters are typically evaluated separately. To address this. we propose a novel approach to combine these parameters into a single unit. enhancing health monitoring. Utilizing MPX5050GP for blood pressure and MLX90614 for body temperature detection. Both sensors are directly connected to the Arduino UNO microcontroller. enabling seamless data processing and display on the Nextion LCD. Experimental results demonstrate the device's effectiveness. with systolic blood pressure measurements showing a Maximum error: 2.23%. minimum error: 0.53% for systolic measurements. Diastolic measurements have with a remarkable maximum error of only 4.69% and a minimal error of 1.79%. Additionally. the body temperature measurements exhibited a Achieved exceptional precision with errors as low as 0.45% and a maximum of 1.65%. Successfully completed. this design facilitates simultaneous measurement of two vital parameters. Its potential to streamline health monitoring could significantly impact hypertension management and other related conditions. Further validation and implementation in clinical settings are anticipated to enhance its utility and benefits.

INDEX TERMS Blood Pressure. Body Temperature. Hypertension. MPX5050GP. MLX90614. Arduino Uno.

I. INTRODUCTION

Blood pressure is the pressure of the blood pumped by the heart against the walls of the arteries[1][2]. In general. blood pressure conditions are divided into 2. namely systolic blood pressure and diastolic blood pressure[3][4]. Systole is the result of blood pressure which is usually depicted in the first number which indicates a person's blood pressure that occurs when the heart is working[5][6]. While the second number is called the diastole. which shows a person's blood pressure when the heart is resting. In general. the blood pressure of a normal and healthy person is 120/80 mmHg[7]. The number 120 is the systolic pressure and the number 80 is the diastolic pressure. Several human diseases are directly related to abnormal blood pressure conditions. including high blood pressure (hypertension) and low blood pressure (hypotension)[8]. Hypertension is a disease that is very common in society[9]. Hypertension is a dangerous disease because it can lead to other complications such as heart problems and strokes[10][11]. Therefore. the blood pressure of hypertensive patients must be monitored regularly. It is said to have high blood pressure if while sitting the systolic pressure reaches 140 mmHg or more. or the diastolic pressure reaches 90 mmHg or more. or both[12][13]. In the body there are 2 kinds of temperature. namely core temperature and skin temperature[14]. Core temperature is the temperature of the internal body and is kept constant. around ±1ºF (±0.6ºC) from day to day. unless a person has a fever[15]. Body temperature is defined as a vital sign that describes a person's health status. Normal body temperature is 35.8°C – 37.5°C[16]. In the morning the temperature will be close to 35.5°C. while in the evening it will be close to 37.7°C [17]. Excessive heat exposure in the work environment is also associated with dyslipidemia. cardiovascular and digestive diseases. and can even cause death[18]. In addition. these conditions cause vasoconstriction of deep blood vessels so that cardiac output and oxygen demand increase and blood pressure increases. The digital sphygmomanometer is the latest development among the three sphygmomanometers. Measurements using this analog sphygmomanometer do not use electronic technology so that the results are not perfect and precise. there are still frequent scale reading errors[19]. According to research. even though the mercury sphygmomanometer has good accuracy. there are many deficiencies. for example, the tube is dirty or the mercury is not at zero which will affect the blood pressure reading. When it comes to maintenance. mercury is also a little dangerous because even if mercury is exposed to the skin too often it can cause irritation. itching and burning of the skin and also allergies [20].

In 2019 Rahman. Md Hasibur Islam. Md Rabiul Ahmad. Mohiuddin conducted research with the title Design and implementation of a smart health band for the measurement of blood pressure. pulse rate and body temperature. where this research also used the MPX5050GP sensor. However. in the results of the study there were differences in the results of the output of the health band and the output of the normal process. in other words. this research still needs to be developed in terms of the final measurement results.

Also. in 2019 Puspitasari. Ayu Jati Endarko. Fatimah. Iim made a tool based on the results of their research entitled Blood Pressure Monitor Design Using MPX5050GP Pressure Sensor and Visual C# 2010 Express. In this study the results of measuring pulse. systolic and diastolic pressure will be displayed and recorded in an application designed using Visual C# 2010 Express. From the results of this study. there is an average error value for systolic pressure. diastolic pressure (2.72%). (5.55%). where these values exceed the tolerance threshold of 5%. Even though it uses the same sensor. namely the MPX5050GP. different software settings can affect the results of the measurements.

In 2018 Mahmood. Salwan N. Ercelecbi. Ergun made a tool entitled Development of Blood Pressure Monitor by Using Capacitive Pressure Sensor and Microcontroller where this tool uses a digital blood pressure monitoring system with biomedical real-time blood pressure (BP) signals measured using a series pressure to capacitance with pulse width modulation (PWM) technology and connected to the PIC18F4550 microcontroller. The microcontroller detects the blood pressure signal and by using the enhanced module function. with the help of the proposed algorithm. blood pressure results (systolic. diastolic. pulse) have been calculated and sent to the Android smartphone health application via Bluetooth communication with the presence of a mini-LCD screen. However. the resulting reading of the pressure value still has drawbacks.

Looking at the problems mentioned above. there are still various detection errors in systolic diastolic pressure. and there is no digital sphygmomanometer equipped with a body temperature measuring device and a Nextion LCD display. In previous studies there were also weaknesses in finding diastolic values and imperfect LCD displays. The sensor used also still has a small accuracy value and the data processing still uses the PIC18F4550. but there is also a microcontroller that displays the results in Visual C# 2010 Express. Therefore. the author had the idea to make a tool "Digital Sphygmomanometer Detects Diastolic Systolic Display (Body Temperature)" which aims to make it easier for medical personnel to measure blood pressure better. and measure 2 parameters in one operation. Making digital blood pressure is also intended for ordinary people to make it easier to use. considering that aneroid blood pressure and mercury blood pressure require expertise in their detection. It features a larger and clearer 3.2-inch Nextion LCD display. improving the legibility of blood pressure results. The design combines Utilizing the MPX5050GP sensor as a blood pressure detector and the MLX90614 sensor as a body temperature detector ensures precise health monitoring. Both sensors connect directly to the Arduino Uno microcontroller for seamless data processing and display on the Nextion LCD.

Considering the aforementioned problem background. there persist various errors in the systole diastolic pressure detection. and the absence of a sphygmomanometer digital equipped with body temperature measurement and an LCD Nextion display. In previous studies there were also weaknesses in the discovery of diastolic values and imperfect appearance on the LCD. The sensor used also still has a small accuracy value and data processing still uses AT Mega 32. but there is also a microcontroller that already uses Wemos D1 Mini where the module will display results on Android. Sensors that already have good accuracy values

Therefore the author had the idea to make a tool "Digital Sphygmomanometer Detects Diastolic Systolic Display (Body Temperature)" which aims to facilitate medical personnel in measuring blood pressure in a better way. as well as measuring 2 parameters in one single operation. Making this digital blood pressure is also intended for ordinary people to make it easier to use. bearing in mind that aneroid blood pressure and mercury blood pressure require expertise in their detection. The tool features a larger and clearer Nextion 3.2-inch LCD display. enhancing readability of blood pressure results. The design incorporates the MPX5050GP sensor as the blood pressure detector and the MLX90614 sensor as the body temperature detector. Both sensors are directly connected to the Arduino Uno microcontroller for seamless data processing and display on the Nextion LCD. The MPX5050GP sensor is a sensor that is classified as accurate with an accuracy level of 50 kPa with a pressure of 0 – 300 mmHg [21].

II. MATERIALS & METHOD

This research was carried out at the Electromedical Technology department of the Surabaya Ministry of Health Polytechnic. Digital Tensimeter brand Omciron and Thermogun brand Conec were utilized for data comparison. The study involved 10 respondents. and each respondent underwent 10 repetitions for data collection purposes. Data collection for each respondent was given a distance of 5 minutes for each repetition. so that the resulting measurement results or data are good and correct. The independent variables in this study are where there is pressure pumped into the cuff using a DC motor and there is body temperature detection on the module. The dependent variable is the value of blood pressure measurement results using the MPX5050GP and body temperature measurements using the MLX90614 which will later be processed on the Arduino Uno microcontroller and displayed on the Nextion LCD.

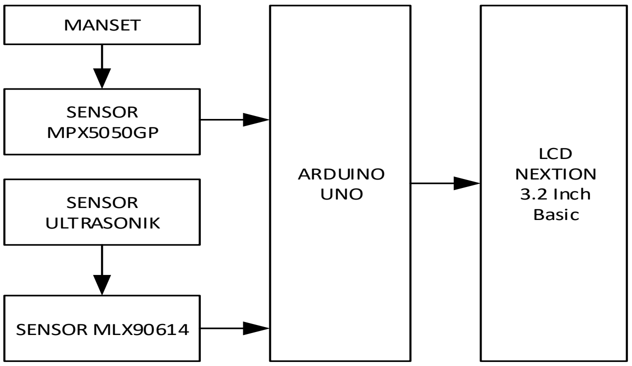

FIGURE 1 Block Diagram Display of Sphygmomanometer Diastolic Systole (Body Temperature) Detector Module with MLX90614 sensor as temperature and MPX5050GP for blood pressure and displayed on Nextion LCD

This study uses the MPX5050GP sensor where this sensor is used as a blood pressure detector with a sensor that is classified as accurate with an accuracy level of 50 kPa and has a pressure of 0 - 300 mmHg and works at a voltage of 4.75 - 5.25 volts[22]. There is also an MLX90614 sensor. this sensor functions to detect body temperature[23]. This sensor can sense electromagnetic waves in the range of 700 nm to 14.000 nm and can accurately measure human body temperature at a distance of 5 cm. then all data will be forwarded or processed on the Arduino Uno microcontroller. so that all measurement data that has been processed will be displayed on the Nextion LCD. For a more detailed explanation. it can be seen in FIGURE 1 that a block consists of three components. namely input. process. and output. each of which plays a different role in the system as a whole. In the input section there is a cuff and ultrasonic sensor as a starting point to apply pressure to the arm and object distance. there is also an MPX5050GP sensor and an MLX90614 sensor to detect blood pressure along with body temperature. There is also an ultrasonic sensor. where this sensor functions to detect objects in the form of hands which will later activate the MLX90614 sensor to work to detect body temperature in these humans. This sensor has a maximum range of 400-500 cm and also the MPU 6050 contains a MEMS Accelerometer and a MEMS Gyro which are integrated with each other[24]. In the processing section there is an Arduino Uno microcontroller. after the data is received the microcontroller will process the data and it will be ready to be sent later. Finally. on the output section. there is a Nextion LCD which will display the measurement results of the 2 parameters that have been processed on the microcontroller.

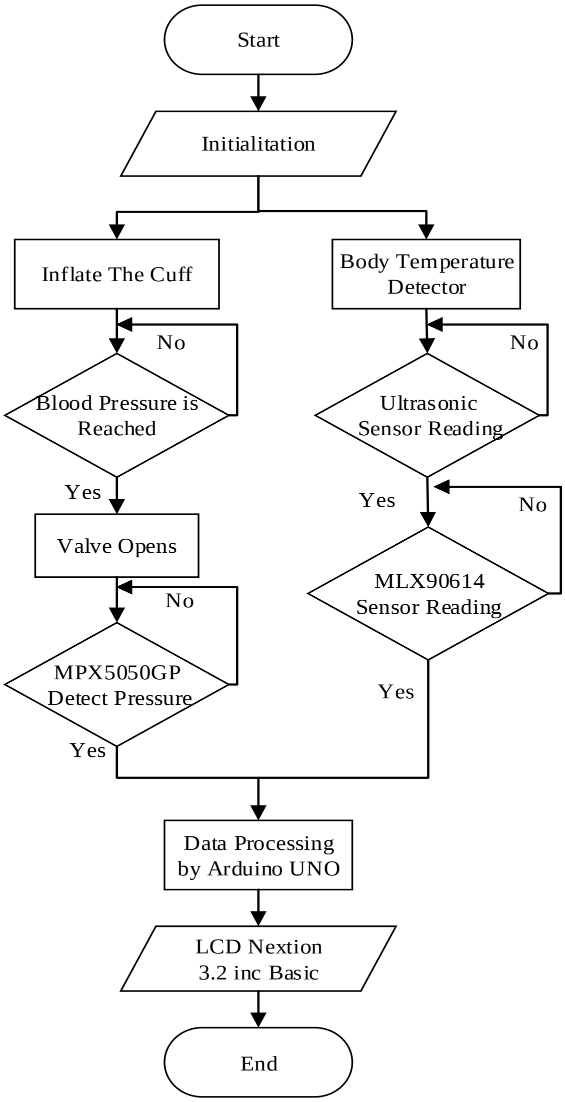

FIGURE 2 Process flow on the Sphygmomanometer Detector Module for Diastolic Systolic (Body Temperature) Display. starting from the initial detection of temperature and blood pressure until it appears on Nextion

In FIGURE 2 you can see how the process is modul in detecting blood pressure along with body temperature until the final result. When the module is on or in an active state. there are two measurements that can be taken alternately. To measure blood pressure. there is a push button that must be pressed so that the motor turns on and the valve is closed so that the cuff will pump up to a certain pressure. after the pressure is reached the valve will open and the MPX5050GP sensor will read the systolic/diastolic pressure while at body temperature when the object is brought close to the Ultrasonic sensor then the MLX90614 sensor will be active and then body temperature will be detected and a temperature reading will be taken. All data will be processed on Arduino uno and will be displayed on the Nextion LCD.

How to collect data is done with the position of the respondent sitting and in a relaxed state. Before taking measurements. it was suggested to respondents to rest for approximately 5 minutes. This aims to keep blood pressure in a stable state. For measurements taken on the left arm with a distance of 2-3 fingers above the elbow[25]. Placement on the left hand because it is closer to the heart which aims to get more accurate results. In addition. the size of the cuff used must be appropriate. namely the size of an adult cuff with a size of 27-44 cm. The measurement process from the start until the sensor detects pressure takes 3 to 5 minutes. To measure body temperature by placing the palm of the hand on the ultrasonic sensor as a distance detector and the MLX90614 sensor to detect temperature with a distance of 3-5cm. The detection results will be processed by the microcontroller and will appear on the LCD display.

A. DATA ANALYSIS

The study involved ten respondents. and each respondent underwent ten repetitions of systolic. diastolic. and body temperature measurements. The mean the obtained value is derived from the average. providing a measure of central tendency. Eq. (1).

$$\overline{x} = \frac{x1+x2+x3....+xn}{n} \quad (1)$$

Where denotes the mean (average) value for n-measurements. x1 denotes the first measurement. x2 denotes the second measurement. and xn denotes the nth measurement. The standard deviation is a statistical measure that quantifies the degree of variation within a dataset relative to the mean. It is a vital indicator of data dispersion. The standard deviation (SD) value is mathematically using the value Eq. (2).

$$\text{SD} = \sqrt{\frac{\sum(xi-\overline{x})^2}{(n-1)}} \quad (2)$$

In this context. UA represents the uncertainty value. represented by SD (standard deviation). is based on the total measurement. with 'n' indicating the number of measurements taken. % error serves as a measure of critical system error. showing average difference among data points. Measure of variation within dataset. Errors may signal standard-design discrepancies in the model or design. The error formula is expressed mathematically. providing a concise and precise representation of the calculation process Eq. (3).

$$\%\ \text{error} = \frac{(x_n - \text{x})}{x_n} \times 100\ \% \quad (3)$$

In this context. xn represents it measures the value on the comparator. while the X value indicates Enhance the measured outcomes of the design to optimize its performance and achieve better results.

III. RESULT

In this study. the module was tested using a calibrator. namely DPM (Digital Pressure Meter) with a value range of 60/30 mmHg. 120/80 mmHg. and 150/100 mmHg. An example of calibration results is shown in FIGURE 3. The figure clearly demonstrates that the calibration tool closely aligns with the module. with a negligible difference of less than 5 mmHg. The calibration process was meticulously conducted. involving six measurements for each value range. ensuring precision and reliability. For detailed calibration measurement data. kindly refer to the accompanying documentation. This robust calibration enhances the accuracy and trustworthiness of the module's performance. TABLE 1 .

FIGURE 3 Calibration Using a Fluke brand DPM with measurements five times per setting

TABLE 1
The results of the Digital Sphygmomanometer calibration value with a fluke brand calibration tool

Arrangement (mmHg)	Measurement Result (mmHg)				
	X1	X2	X3	X4	X5
60/30	57 /33	61 /33	54 /33	58 /32	61 /33
120/80	121 /80	119 /77	117 /79	123 /74	18 /77
150/100	153 /93	157 /95	155 /93	157 /96	153 /97

FIGURE 4 are the overall circuit or circuit in this research module. This module uses the Arduino UNO microcontroller as the main data processing component. The program stored on the Arduino UNO includes the detection of systolic. diastolic and body temperature values. In addition. the stored program functions to display results on the Nextion LCD. This module also has a circuit. namely a motor driver circuit and a solenoid valve driver circuit. Inside the circuit there is a transistor that functions as a switch. the purpose here is to start and stop the circuit.

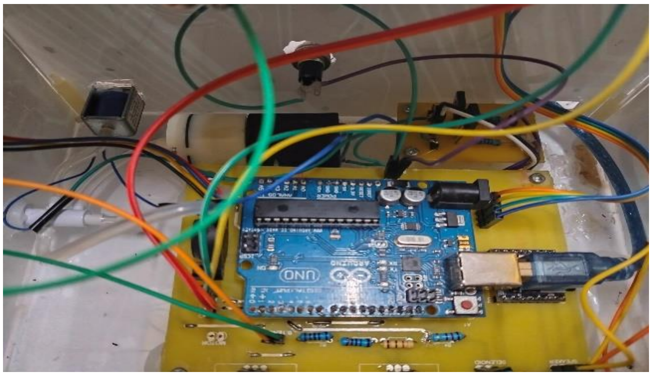

FIGURE 4 **the inner circuit of the digital sphygmomanometer module with body temperature has a microcontroller as a processor**

Tests were also carried out on the MLX90614 sensor to find out how stable body temperature measurements are at a predetermined distance. The distance range for temperature detection starts from 1 cm–5 cm. This measurement is carried out by measuring the distance between the object and the sensor using a ruler and each measurement is repeated twice. To find out the range of stable body temperature measurements. see below TABLE 2.

TABLE 2
MLX90614 Sensor Test Results to find out a good distance to be measured

Distance (cm)	Tool Measurement (°C)	Comparison (°C)
1 cm	37.88	36.5
2 cm	37.87	36.6
3 cm	36.57	36.4
4 cm	36.55	36.4
5 cm	36.53	36.4

In this study. the parameters of blood pressure and body temperature were compared with digital blood pressure devices from the Omicron brand and the thermogun from the Conec brand by measuring 10 respondents and repeating 10 times for each respondent. The error value. measured in mmHg (Millimeters of Mercury(Hydrargyrum)) and ºC. represents the discrepancy between the values obtained from the comparison tool and the module results. In TABLE 3 is the result of the recapitulation of 10 respondents with repetition of 10 times per respondent on the results of systolic blood pressure measurements. The table clearly compares the average value and standard deviation using the Omicron sphygmomanometer digital. These comparisons provide valuable insights into the measured data. From these data there are differences in the value of the systolic blood pressure measurement module. with the largest difference being 3.5 and the smallest being 0.7. In addition. the standard deviation obtained in the highest module is 4.77 while in the comparison tool it is 4.72.

TABLE 3
Recapitulation of average results and STDEV of measuring systolic blood pressure with a comparison of Omicron digital sphygmomanometer

Resp	Module (mmHg)		Comparison (mmHg)	
	Mean	STDEV	Mean	STDEV
1	109.7	4.77	112.2	4.72
2	111.9	3.33	113.1	5.12
3	111	2.64	113.2	3.78
4	113.5	2.45	114.1	4.25
5	111.2	2.89	113.5	2.5
6	119.3	4.33	118.6	3.9
7	113.8	4.58	115.2	2.63
8	108.2	4.82	111.7	4.12
9	112.9	3.41	114.1	2.84
10	109.4	3.74	111.3	4.36

TABLE 4
Recapitulation of average results and STDEV of measuring diastolic blood pressure with a comparison of Omicron digital sphygmomanometer

Resp	Module (mmHg)		Comparison (mmHg)	
	Mean	STDEV	Mean	STDEV
1	70.8	2.78	74	2.79
2	73.6	2.57	75.6	2.87
3	71.2	2.67	74.7	2.41
4	72.8	2.71	74.3	3.1
5	72.3	2.75	74.8	2.92
6	75	2.48	76.5	1.68
7	72	2.64	75.1	2.46
8	72.4	2.83	74.1	2.84
9	73.4	2.37	75.7	1.84
10	71.5	2.5	72.8	3.54

TABLE 4 is the result of the recapitulation of 10 respondents with repetition of 10 times per respondent on the results of diastolic blood pressure measurements. The table clearly presents the average value and standard deviation. enabling easy comprehension of the data. have been compared with the Omicron digital tensimeter. From these data there is a difference in the value of the diastolic blood pressure measurement module. with the largest difference being 3.5 and the smallest being 1.3. In addition. the standard deviation obtained from diastolic measurements can still be said to be in a good range. because the results do not exceed the average diatolic blood pressure measurement.

TABLE 5 is the result of the recapitulation of 10 respondents with repetition of 10 times per respondent on the results of body temperature measurements. The table clearly presents a comparison between the average value and standard deviation of the Conec brand thermogun. From these data there is a difference in the value of this body temperature measurement module. with the largest difference being 0.54 and the smallest being 0.18. In addition. the standard deviation obtained from measuring body temperature can still be said to be in a good range. because the results do not exceed the average body temperature measurement.

TABLE 5
Recapitulation The average results and STDEV of body temperature measurements with a comparison of the Conec brand Thermogun

Resp	Module (°C)		Comparison (°C)	
	Mean	STDEV	Mean	STDEV
1	35.72	0.578	36.38	0.188
2	35.70	0.435	36.3	0.184
3	36.06	0.388	36.23	0.223
4	35.65	0.466	35.95	0.229
5	36.015	0.370	36.43	0.232
6	35.80	0.405	35.98	0.116
7	35.974	0.503	36.2	0.219
8	35.76	0.477	36.3	0.340
9	35.861	0.510	36.37	0.19
10	35.846	0.513	36.23	0.195

TABLE 6
Recapitulation of error measurement results on systolic. diastole and body temperature measurements using a comparison of the Omicron digital sphygmomanometer and the Conec thermogun

Resp	Error (%)		
	Systolic (mmHg)	Diastolic (mmHg)	Body Temp (°C)
1	2.23%	4.32%	1.58%
2	1.06%	2.65%	1.65%
3	1.94%	4.69%	0.45%
4	0.53%	2.02%	0.82%
5	2.03%	3.34%	1.14%
6	0.59%	1.96%	0.49%
7	1.22%	4.13%	0.62%
8	3.13%	2.29%	1.49%
9	1.05%	2.02%	1.40%
10	1.71%	1.79%	1.06%

Of the three measurement results. there are error values that have been explained or listed in TABLE 6. where the largest systolic error value is 2.23% and the smallest is 0.53%. The diastole errors ranged from 1.79% to 4.69%. while body temperature errors varied between 0.45% and 1.65%. These variations highlight the importance of accurate measurements in medical assessments.

IV. DISCUSSION

After data collection and measurement of the digital sphygmomanometer module for the detection of systolic diastolic displays (body temperature). through meticulous data collection and rigorous analysis. we ascertained the module manufacture's stability and accuracy. These measures helped us gain valuable insights into its performance and enhance overall quality. The study measured adults' blood pressure and body temperature while ensuring respondents were in a relaxed state. Measurements were taken at the Health Polytechnic of the Ministry of Health in Surabaya on the Electromedical Technology campus with 10 measurements taken on 10 respondents. After the first respondent was measured 10 times. the error value obtained at systole was 2.23% and the error value for diastolic measurement was 4.32%. The second respondent's measurements were recorded with impressive precision. The error in the systolic measurement was a mere 1.06%. while the diastolic measurement error was also low at 2.65%. These accurate results highlight the reliability of the data obtained from the second respondent. Measurements were made on the third responden. the systolic error value was 1.94% and the error value for the diastole measurement was 4.69%. The measurements for the fourth. fifth. and sixth respondents were recorded. revealing slight variations in systolic and diastolic error values. For the fourth respondent. the systolic error was found to be 0.53%. while the diastolic error was 2.02%. Similarly. the fifth respondent exhibited a systolic error of 2.03% and a diastolic error of 3.34%. Lastly. the sixth respondent's measurements showed a systolic error of 0.59% and a diastolic error of 1.96%. These minor discrepancies highlight the importance of precision in our data collection process to ensure accurate and reliable results for future analysis. Measurements were taken on the seventh responden. the systolic error value was 1.22% and the error value for the diastolic measurement was 4.13%. Measurements were taken on the eighth responden the obtained error value for measurement was 3.13%. while diastole measurement had an error of 2.29%. Measurements were made on the ninth responden. the systolic error value was 1.05% and the error value for the diastolic measurement was 2.02%. Measurements were made on the tenth respondent the systolic error value was 1.71% and the error value for the diastolic measurement was 1.79%. There is also an error value in measuring body temperature. namely 1.58% for the first respondent. 1.65% for the second respondent. 0.45% for the third respondent. 0.82% for the fourth respondent. measurements taken on the fifth respondent 1.14%. measurements taken on the sixth respondent 0.49%. measurements taken on the seventh respondent 0.62%. measurements taken on the eighth respondent 1.49%. measurements made on the respondent ninth 1.40%. measurements made on the tenth respondent 1.06%. The results of the error are obtained from several factors such as the patient's condition that is not relaxed. the measurement distance between one and the next has a distance that is too fast. the patient's condition when the measurement is carried out a lot. the placement of the cuff that is still not quite right. and also, the ambient temperature which makes the patient's body temperature changed. In this study apart from the error value. the results of the measurements are the average and standard deviation. The average values for systolic. diastole and body temperature measurements when compared with digital tensimeters and thermoguns have values that are not much different. The biggest difference from the average measurement is 3.5 and for the smallest value is 0.6. Then for the results of the standard deviation obtained. all of them get good results. which do not exceed the average value.

This research is a development of previous research[11][4]. From existing research. there is a similarity in the method used. namely the oscillometric method. However. there are differences in the sensors used that give different accuracy results. If the previous study required an amplifier because the output from the sensor was small. in this study the MPX5050GP sensor was used. which has a larger output. Thus. minimizing the existence of additional circuits such as the amplifier. In addition. the LCD display used in the previous study used a character LCD which was small in size and also lacked screen illumination. so, this research will develop an LCD that makes it easier to read. In previous studies. there was also no increase in body temperature in the modules that were made.

Despite the author's efforts. the modules created still exhibit several imperfections in planning. manufacturing. and functionality. These shortcomings have been thoroughly analyzed. revealing room for improvement. Addressing these issues through continued research and development will undoubtedly lead to enhancing the quality and efficiency of the modules. bringing them closer to perfection. Utilize the initial supply for the project's initiation process. This module uses a power bank as a supply for the device. so the room size becomes larger. Then the error values obtained in several measurements are high. although they still do not exceed the tolerance limit of calibration. which is 5%. And the last drawback of this module is that there is no indicator on body temperature to find out whether the temperature has been detected or not. However. the temperature results shown are good and the range from the comparator is not too far away.

Making this module has advantages and also benefits for the community besides non-medical members. With a portable device design. it is very suitable for everyday use for monitoring blood pressure. especially for someone who suffers from high blood pressure (hypertension). In addition. with the addition of body temperature measurements. it can make it easier for medical personnel to take measurements at once in one device. considering that every blood pressure check is the first step taken. namely checking the body temperature of respondents or patients. In addition. the tool can be used for ordinary people who do not can use a blood pressure detector in general. so that it can be used independently by someone. The principle of the module is also very easy. namely just attaching the cuff to the arm and then pressing the existing push button. and placing your palms on the temperature sensor. then the results will come out in 2 ways. namely on the LCD.

IV. CONCLUSION

The purpose of making this module has advantages and also benefits for the community besides non-medical members. With a portable device design. it is very suitable for daily use to monitor blood pressure. especially for someone who suffers from high blood pressure (hypertension). In addition. the addition of a body temperature measuring device can make it easier for medical personnel to take measurements at once in one tool. considering that each blood pressure check is the first step to take. namely checking the body temperature of the respondent or patient. In addition. this tool can be used for ordinary people who cannot use blood pressure detectors in general. so that someone can use it independently. The principle of the module is also very easy. all you have to do is attach the cuff to the arm and then press the push button. and place your palm on the temperature sensor. then the results will come out in 2 ways. namely on the LCD. Research aims to uncover valuable insights for meaningful advancements is to make it easier for medical personnel and ordinary people to measure blood pressure and body temperature in one tool in an easy-to-understand way.

From a measurement experiment of 10 respondents with comparison results using a Digital Tensimeter and Thermogun and 10 repetitions for each respondent. introduce our latest digital tensimeter which is designed for accurate blood pressure and body temperature measurements. This device uses the MPX5050GP sensor for pressure detection and the MLX90614 sensor for body temperature detection. Embrace the convenience and accuracy of a single device for comprehensive health monitoring. The manufacture of this tool is the development of the original digital tensimeter which is modified by adding body temperature parameters and displayed on Nextion. From the results of testing a blood pressure measuring device with a comparison tool. namely a digital tensimeter which was carried out on 10 respondents. the largest systolic error was 2.23%. The biggest diastolic error is 4.69%. The biggest body temperature error is 1.65%.

For further development of where this module utilizes the initial supply for the project initiation process. This module uses a power bank as a device supply. so the room size becomes larger. Then the error values obtained in several measurements are high. although they still do not exceed the calibration tolerance limit of 5%. The last addition that can be given to this module is the addition of a body temperature indicator to find out whether the temperature has been detected or not.

REFERENCES

[1] P. J. Colquitt, "Will the millimetre of mercury be replaced by the kilopascal? [2]," *J. Hypertens.*, vol. 17, no. 2, pp. 305–306, 1999, doi: 10.1097/00004872-199917020-00017.
[2] C. A'Court, R. Stevens, S. Sanders, A. Ward, R. McManus, and C.

Heneghan, "Type and accuracy of sphygmomanometers in primary care: A cross-sectional observational study," *Br. J. Gen. Pract.*, vol. 61, no. 590, pp. 598–603, 2011, doi: 10.3399/bjgp11X593884.

[3] G. I. Varughese and G. Y. H. Lip, "Goodbye Mercury? Blood Pressure Measurement and Its Future," *J. R. Soc. Med.*, vol. 98, no. 3, pp. 89–90, 2005, doi: 10.1177/014107680509800301.

[4] S. N. Mahmood and E. Ercelecbi, "Development of Blood Pressure Monitor by Using Capacitive Pressure Sensor and Microcontroller," *Int. Iraqi Conf. Eng. Technol. its Appl. IICETA 2018*, pp. 96–100, 2018, doi: 10.1109/IICETA.2018.8458099.

[5] T. Panula, J. P. Sirkia, D. Wong, and M. Kaisti, "Advances in Non-Invasive Blood Pressure Measurement Techniques," *IEEE Rev. Biomed. Eng.*, vol. 16, pp. 424–438, 2023, doi: 10.1109/RBME.2022.3141877.

[6] Y. Wan *et al.*, "Determining which automatic digital blood pressure device performs adequately: A systematic review," *J. Hum. Hypertens.*, vol. 24, no. 7, pp. 431–438, 2010, doi: 10.1038/jhh.2010.37.

[7] K. A. Johnson, D. J. Partsch, P. Gleason, and K. Makay, "Comparison of two home blood pressure monitors with a mercury sphygmomanometer in an ambulatory population," *Pharmacotherapy*, vol. 19, no. 3, pp. 333–339, 1999, doi: 10.1592/phco.19.4.333.30936.

[8] R. Mukherjee, S. Ghosh, B. Gupta, and T. Chakravarty, "A Literature Review on Current and Proposed Technologies of Noninvasive Blood Pressure Measurement," *Telemed. e-Health*, vol. 24, no. 3, pp. 185–193, 2018, doi: 10.1089/tmj.2017.0068.

[9] K. Tan, M. H. F. Rahiman, R. A. Rahim, M. Jaysuman, and S. Buyamin, "Online micro-controller non-invasive blood pressure monitoring system (E-BPM)," *J. Teknol. (Sciences Eng.*, vol. 54, pp. 403–423, 2011, doi: 10.11113/jt.v54.824.

[10] M. G. Myers, M. R. Nelson, and G. A. Head, "Automated office blood pressure measurement for routine clinical practice," *Med. J. Aust.*, vol. 197, no. 7, pp. 372–373, 2012, doi: 10.5694/mja11.11545.

[11] A. J. Puspitasari, E. Endarko, and I. Fatimah, "Blood Pressure Monitor Design Using MPX5050GP Pressure Sensor and Visual C# 2010 Express," *J. Fis. dan Apl.*, vol. 15, no. 3, p. 99, 2019, doi: 10.12962/j24604682.v15i3.4929.

[12] J. Wiesel, D. Wiesel, R. Suri, and F. C. Messineo, "The use of a modified sphygmomanometer to detect atrial fibrillation in outpatients," *PACE - Pacing Clin. Electrophysiol.*, vol. 27, no. 5, pp. 639–643, 2004, doi: 10.1111/j.1540-8159.2004.00499.x.

[13] M. G. Myers, "Why automated office blood pressure should now replace the mercury sphygmomanometer," *J. Clin. Hypertens.*, vol. 12, no. 7, pp. 478–480, 2010, doi: 10.1111/j.1751-7176.2010.00301.x.

[14] T. Valler-jones and K. Wedgbury, "Measuring blood pressure using the mercury sphygmomanometer," vol. 14, no. 3, pp. 145–150, 2005.

[15] O. E. J., I. O. O., O. O. O., and O. O., "Development of a real time blood pressure, temperature measurement and reporting system for inpatients," *Int. J. Phys. Sci.*, vol. 11, no. 17, pp. 225–232, 2016, doi: 10.5897/ijps2016.4514.

[16] D. V. Reddy and Y. Sreenivasulu, "Body Temperature & Blood Pressure Remote Monitoring," *IJMTST | Int. J. Mod. Trends Sci. Technol.*, vol. 1, no. 1, 2015.

[17] I. Jahan, M. L. Rahman, A. W. Reza, and S. Das Barman, "Systolic blood pressure measurement from heart rate using IoT," *Int. J. Recent Technol. Eng.*, vol. 7, no. 4, pp. 135–138, 2018.

[18] K. Wedgbury and T. Valler-Jones, "Measuring blood pressure using an automated sphygmomanometer.," *Br. J. Nurs.*, vol. 17, no. 11, pp. 714–718, 2008, doi: 10.12968/bjon.2008.17.11.29642.

[19] N. M. Van Popele *et al.*, "Arterial stiffness as underlying mechanism of disagreement between an oscillometric blood pressure monitor and a sphygmomanometer," *Hypertension*, vol. 36, no. 4, pp. 484–488, 2000, doi: 10.1161/01.HYP.36.4.484.

[20] E. O'Brien, "Consequences of banning mercury and the cuff controversy," *Blood Press. Monit.*, vol. 5, no. 1, pp. 33–34, 2000, doi: 10.1097/00126097-200002000-00007.

[21] Alamsyah, M. Subito, S. Dewi, and A. Amir, "Heartbeat and Blood Pressure Monitoring System Wireless-Based," *Proc. - 2019 Int. Semin. Appl. Technol. Inf. Commun. Ind. 4.0 Retrosp. Prospect. Challenges, iSemantic 2019*, pp. 503–506, 2019, doi: 10.1109/ISEMANTIC.2019.8884316.

[22] C. Kaegi, M. C. Thibault, F. Giroux, and D. Bourbonnais, "The interrater reliability of force measurements using a modified sphygmomanometer in elderly subjects," *Phys. Ther.*, vol. 78, no. 10, pp. 1095–1103, 1998, doi: 10.1093/ptj/78.10.1095.

[23] Mr. Mahavir K. Beldar1, "Design and Development of Arm Manikin for Blood Pressure and \nPulse Simulation," *Ijmer*, vol. 4, no. 5, pp. 37–49, 2014, [Online]. Available: http://www.ijmer.com/papers/Vol4_Issue5/Version-5/IJMER-45053749.pdf

[24] R. J. McManus, J. Mant, M. R. P. Hull, and F. D. R. Hobbs, "Does changing from mercury to electronic blood pressure measurement influence recorded blood pressure? An observational study," *Br. J. Gen. Pract.*, vol. 53, no. 497, pp. 953–956, 2003.

[25] C. A. Martin, J. D. Cameron, S. S. Chen, and B. P. McGrath, "Measurement of blood pressure in the office," *Hypertension*, vol. 56, no. 1, pp. 420–442, 2010, doi: 10.1161/HYPERTENSIONAHA.110.154625.