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DESIGN AN INTERNET OF THINGS-BASED BLOOD PRESSURE DETECTOR AND MONITOR

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Abstract

A sphygmomanometer is a tool for measuring blood pressure that is often used in the medical world. Sphygmomanometers are generally divided into 2, namely analog and digital sphygmomanometers. In modern times now Android smartphones have developed with various features that are already very sophisticated. Therefore, the author wants to design a digital sphygmomanometer that can measure blood pressure and provide a history of measurement results so that the public or patients candetermine the state of their blood pressure. To present this tool in this study, the author will try to integrate a digital blood pressure measuring instrument with IOT (internet of things) so that it becomes a blood pressure detection and monitoring tool. NodeMCU ESP8266 will be used to process data and also serve to connect to the internet. Then, the sensor used is the MPX5050GP sensor as a pressure measurement tool and then the pressure calculation data from the sensor is sent to Firebase which acts as a database, and later it can be accessed and monitored via a smartphone. Theresults of testing the sphygmomanometer tool that the researcher made and the testing of the comparative sphygmomanometer tool. On average, this test gets an accuracy difference of approximately 1%.

Keywords: *Tensimeter, Blood Pressure, NodeMCU ESP8266, MPX5050GP.*

1. INTRODUCTION

Blood pressure is one of the factors of the onset of several diseases, namely hypertension (high blood pressure) and hypotension (low blood pressure). Most of the average person does not care how important it is to know their own blood pressure, there are several reasons why people are reluctant to check how much their blood pressure is , namely the lack of information about blood pressure checks, then the place where blood pressure check providers are small, and the lack of medical facilities in some health agencies. A sphygmomanometer is a tool to measure how much blood pressure is in humans, a sphygmomanometer that is widely used in health agencies is an analog sphygmomanometer. An analog sphygmomanometer is a sphygmomanometer whose use still uses a stethoscope as a tool to listen to the sound of systolic and diastolic pressure sounds. Along with the development of the times, now there are many circulating digital sphygmomanometers which are sphygmomanometers that are used more easily without having to use a stethoscope as a tool measurement of blood pressure.

Then, to develop the digital sphygmomanometer that already exists today, the author will design a digital sphygmomanometer that can be monitored via a smartphone, a history of the results of periodic blood pressure calculations. The sphygmomanometer in this study uses NodeMCU as a microcontroller in charge of processing sensor data and as a module connecting tools with the internet network then the detected sensor data will be is displayed on the lcd screen and can be monitored via a smartphone. With this sphygmomanometer, it is hoped that people will be more helped because users can monitor and get information related to the history of using this sphygmomanometer tool easily through a smart phone.

2. LITERATURE REVIEW

The components that will be used in this study are as follows:

2.1 NodeMCU ESP8266

NodeMCU ESP8266 is a microcontroller equipped with a usb port as power to turn on NodeMCU. Then nodeMCU is also equipped with a wifi module which will function as a link between NodeMCU and the internet network. Similar to Arduino UNO, nodeMCU can be programmed using the Arduino IDE application, which distinguishes only on the board when installing the code.

2.2 Pressure Sensor MPX5050GP

The MPX5050GP sensor is an air pressure sensor that functions as an air pressure gauge into an analog data. The accuracy of this sensor is relatively good, the accuracy level is 50kPa with a pressure of 0-300 mmHg, then this sensor works at a voltage of 4.75 – 5V.

2.3 Relay 5V 2 Chanel

A 5V relay with 2 Chanel outputs serves as a switch to control electrical devices that require large voltages and currents. This module is suitable for use in various controllers, such as Arduino and NodeMCU.

2.4 HandCuff/Sphygmomanometer Cuff

This handcuff / cuff is a medium to measure air pressure which will be installed on the user's arm.

2.5 Mini Air Pump Motor

This air pump motor works at a voltage of 12V and the maximum pressure that can be reached is up to 350 mmHg.

2.6 Solenoid Valve

It is a useful tool for converting electrical signals into mechanical movement. The function of the tool in this study is to cover the in and out of the wind on the sphygmomanometer.

3. METHOD

This study aims to design an internet of things-based blood pressure measuring and monitoring device using the NodeMCU ESP8266 Module as a microcontroller. Inthis research, there are several stages, namely: Research Design, Product Test, Variables and Variable Operational Definitions.

In the design of this study, there are several stages to design a blood pressure detection and monitoring system including hardware and software design.

3.1 Hardware Design

The hardware design consists of a sphygmomanometer cuff, mini motor pump, solenoid valve, relay, blood pressure sensor, microcontroller, wifi module, and LCD. This system uses an MPX5050GP type sensor as an air pressure detector which will later be converted into digital data.

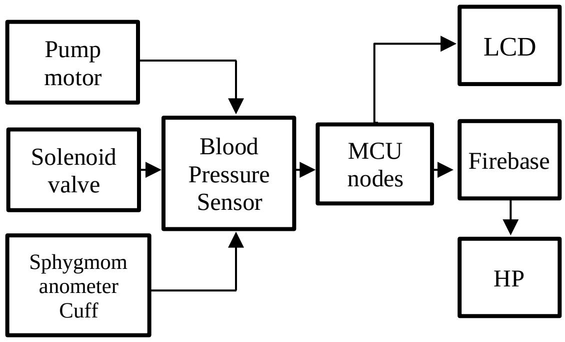

Figure 3. 1 Circuit diagram block

How the tool works :

a) A Nodemcu module that serves as the brain of theemograman p system to be created by the researcher.
b) The sphygmomanometer cuff serves as a medium for air pressure readings.
c) Motor pumps and solenoid valves are useful for pumping wind into the cuffs.
d) Furthermore, there is an MPX5050GP sensor that functions to detect blood pressure.
e) The output of the MPX5050GP sensor is an analog signal that will be received by the microcontroller and converted into a digital signal in mmHg units.
f) If the sensor has reached a certain pressure, the result of the calculation will be displayed to the LCD layer
g) Then the data results will be sent to the database via firebase
h) Once the data is stored in the database, it can be accessed through the Kodular application on android.

3.2 Software Design

The design of this software begins with registering patients on a smartphone application. After the registration process is carried out, the patient is directed to the login menu to log in to the account that has been previously registered, then the installation of the device to the patient's upper arm presses the start button on the device to start calculating blood pressure . If the sensor cannot display the data then the reading process is carried out again, namun, if the sensor data reading is successful, then the pressure measurement result data is displayed on the lcd layer. The blood pressure data that was successfully detected will be saved to the *database*. Furthermore, the blood pressure data stored in the *database* can be displayed again in the form of tabel which suits the needs of the smartphone application.

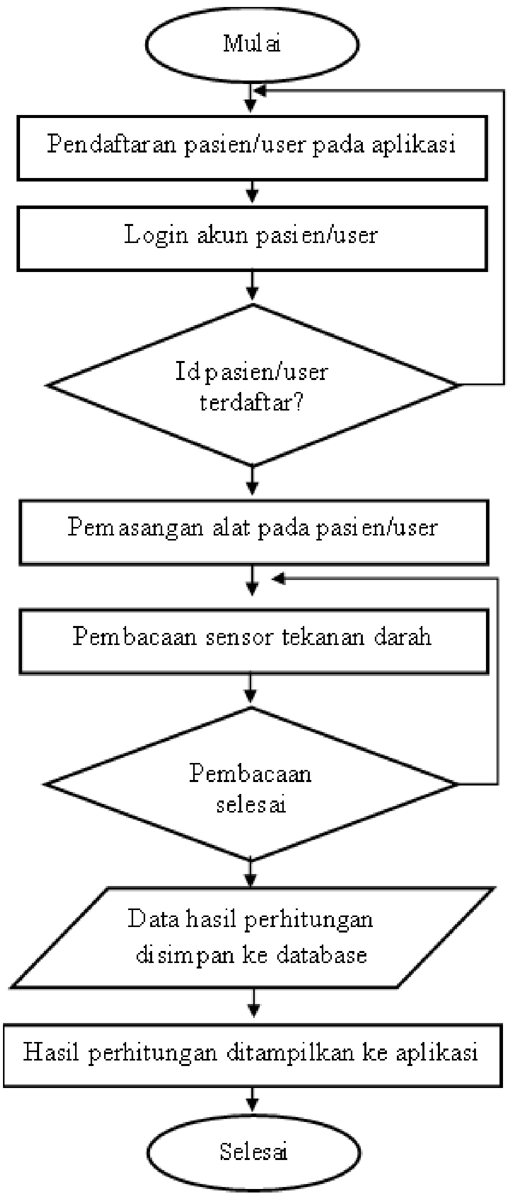

Figure 3. 2 Software role flowchart

3.3 Wiring Products

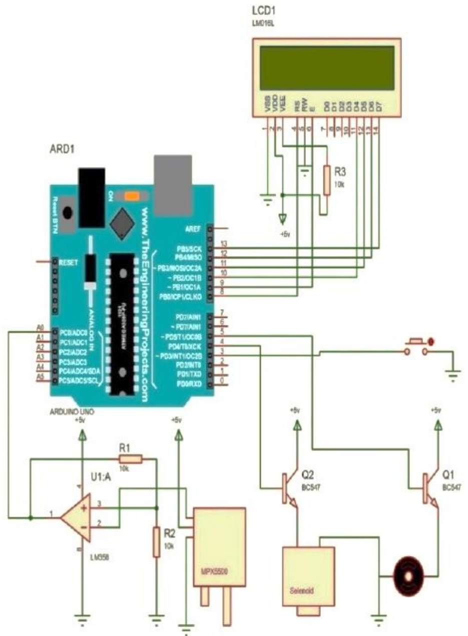

Figure 3. 3 Wiring Products

3.4 Product Design

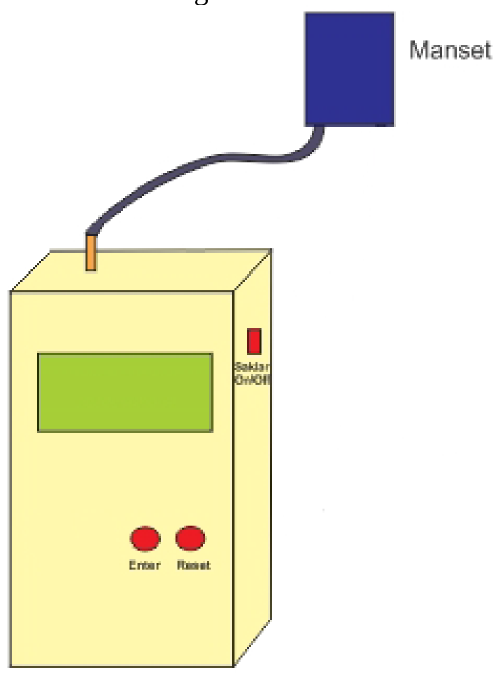

Figure 3. 4 Product design

Figure 3.4 is an overview of the product design that the researcher will make. This tool uses a custom project box and there is an LCD, start and reset buttons, then for blood pressure measurement media using a sphygmomanometer cuff.

3.5 Application Design and Programming

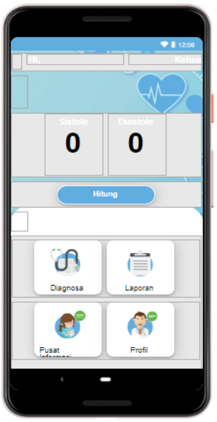

Figure 3. 5 Application design

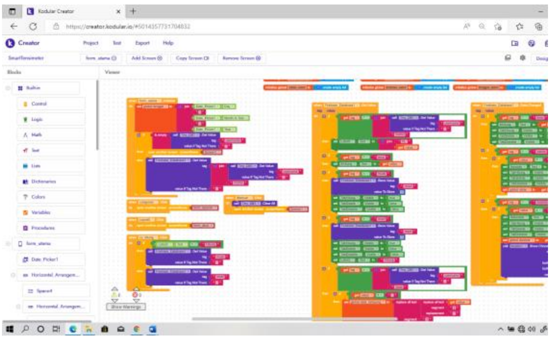

Figure 3. 6 Application programs

In figure 3. The 5 above is the application design that will be used in this study, asshown in figure 3. 6 is blok programming which is the process of forming blocks of code to run an application that is in the Kodular software. At the time of compiling the program we only need to shift the blocks we want in order to get the program according to the wishes of the researcher

4. DATA ANALYSIS RESULTS

In this chapter, the researcher discusses the results of data from the blood pressure device made by the researcher, there are several sub-chapters discussed by the researcher in this chapter, namely: hasil and product evaluation, data presentation, data analysis.

The results and product evaluation aim to find out whether the product can be used or there is still something that needs to be repaired again, so that the presentation of data in the tool can be carried out optimally.

4.1 Product Results

Figure 4. 1 Product results

This series of internet of things -based blood pressure detection and monitoring tools (IoT) the author named SmartTensimeter which can be used by the general public easily without having to come to health agencies, and also this tool can monitor the development of blood pressure measurements from time to time through applications on Android.

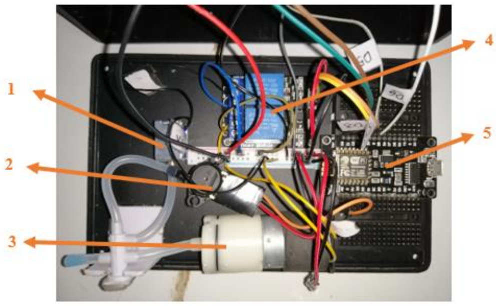

Figure 4. 2 Product components

The components installed in the equipment are:

1) Solenoid valve
2) Pressure sensor MPX5050GP
3) Motor pump
4) Relay 2 chanel
5) NodeMCU ESP8266

4.2 Product Evaluation

In the internet of things (IOT) based blood pressure detection and monitoring tool made by the researcher, there are several evaluations that can be refined again by subsequent researchers. Theevaluation of this product is that it is necessary to add a speaker module and mp3 player for sound output so that it can be used also for blind people, and can also add tool operation features through applications on Android.

4.3 Data Presentation

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1) Pressure sensor testing MPX5050GP

In table 4.1 is a pressure sensor test using an aneroid sphygmomanometer carried out at a voltage of 5v. this test is useful for sensor calibration and for converting analog data into data with mmHg units.

Table 4. 1 Mpx5050GP pressure sensor test table

MPX5050GP Sensor Calibration	
Mmhg	**Data Analog**
0	70
20	150
40	225
60	300
80	370
100	460
120	530
140	605
160	670

From the calculation data above, a formula is obtained to convert analog data into the data needed in mmHg units, namely Y = 3.7792x + 73.222, and then the formula will be entered into the NodeMCU program code.

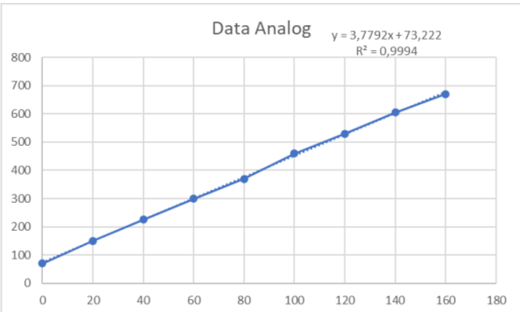

Figure 4. 3 MPX5050GP sensor alignment chart

2) Tool Accuracy Testing

This test is carried out to find out how accurate the design tool (SmartTensimeter) is so that it can be used correctly. The tool will be tested and compared to a standard medical sphygmomanometer. Testing will be carried out 3 times on each volunteer and the value that will be taken as data is SBP (Systolic Blood Preassure) is the systolic pressure value and DBP (Diastolic Blood Preassure) is the diastolic pressure value.

Table 4. 2 Tool accuracy testing table

Nama	Umur	Standar Medis		Smart Tensimeter		Rata-rata Standar		Rata-rata Smart Tensimeter		Error (%)	
		SBP	DBP	SBP	DBP	SBP	DBP	SBP	DBP	SBP	DBP
Fina	9	116	78	120	82	116	80	118	79	1%	-2%
		118	80	116	80						
		114	82	117	74						
Galih	15	122	77	121	82	120	79	122	83	1%	4%
		119	81	120	82						
		120	80	124	84						
Yoga	23	126	88	131	91	125	86	128	88	2%	3%
		129	87	129	89						
		121	82	125	85						
Santi	31	128	77	130	82	125	81	129	81	3%	0%
		123	83	128	82						
		125	82	128	79						
Khoirur	49	135	87	130	83	133	88	131	82	-1%	-7%
		133	90	133	82						
		130	88	131	82						

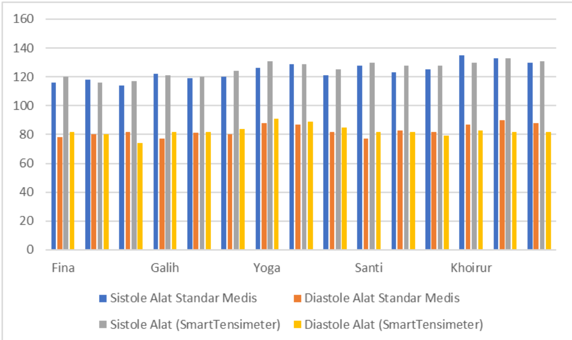

Figure 4. 4 Tool accuracy testing graph

In Figure 4. 4 there is a display of data obtained from the test results of the sphygmomanometer tool that the researcher made (SmartTensimeter) and the testing of the comparison sphygmomanometer tool. On average, this test gets an accuracy difference of approximately 1%.

3) Testing Blood Pressure Calculations Based on Anxiety

This test is to find out whether anxiety is one of the factors that affect blood pressure or not. This test is carried out as many as 2 measurements, namely measurements before being given several directions and secondly after being given directions.

Table 4. 3 Blood pressure calculation testing table based on anxiety

Name	Age	Before		After		Information
		SBP	DBP	SBP	DBP	
Desti	16	132	84	121	79	After the first check,

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Name	Age	Before		After		Information
		SBP	DBP	SBP	DBP	
Riki	24	140	82	131	82	volunteers were given directions to calm down during the blood pressure calculation process.
Irfan	23	139	78	125	80	
Susiyati	36	135	83	118	82	
Nur Isniyah	46	131	86	117	82	

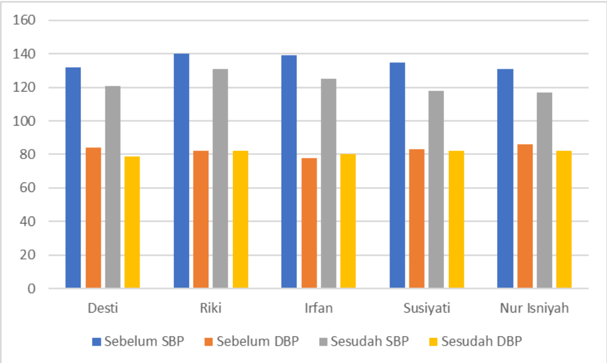

Figure 4. 5 Blood pressure testing graph based on anxiety

In Figure 4. 5 there is a display of data obtained from the test results of a sphygmomanometer (SmartPhygmomanometer) based on a person's anxiety. On average, these tests get a 6% drop in blood pressure from the 1st and 2nd tests of all volunteers.

5. CONCLUSIONS AND SUGGESTIONS

The purpose of researchers in making an internet of things (IoT)-based blood pressure detection and monitoring tool is so that the general public cant check blood pressure independently at home without having to come to health agencies and can also make it easier for the public to monitor the development of blood pressure calculations from time to time.

From the research and testing of internet-based blood pressure detection and monitoring devices of things (IoT), it can be concluded as follows:

1) This heart rate monitoring tool uses several components, namely NodeMCU ESP8266 as a microcontroller and also a wifi module, and an MPX5050GP pressure sensor as the sensor, as well as a codular as making android applications, and firebase as the web server.
2) Theresults of testing the sphygmomanometer tool that the researcher made and the testing of the comparative sphygmomanometer tool. On average, this test gets an accuracy difference of approximately 1%.

Some suggestions that can be given for further research purposes are as follows :

1) For further research, it is hoped that it will use a more up-to-date sensor so that the measurement results are more accurate than the old sensor.
2) It is hoped that further research can add features to the tool and more complete application features, for example the addition of tool operation features through the application.
3) More research in the field of medical electro for the needs of the general public.

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