IMPLEMENTATION OF INTERNET OF THINGS (IOT) TO SIMULATE TEMPERATURE AND HUMIDITY IN NON STERILE MEDICINE PRODUCTION ROOMS USING TEMPERATURE SENSORS (LM 35) AND HUMIDITY SENSORS (DHT 22) BASED ON ARDUIN

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Submission date: 09-May-2024 11:16PM (UTC-0500)
Submission ID: 2375714782
File name: KSI_OBAT_NON_STERIL_MENGGUNAKAN_SENSOR_SUHU_LM_35_DAN_SENSO.docx (1.3M)
Word count: 7360
Character count: 38694

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Abstract

The development of increasingly sophisticated pharmaceutical industry technology requires researchers to develop technology in the pharmaceutical industry that can help employees carry out their duties. As we know, technology is very helpful in providing job data in industry. Information technology can improve the quality of work in industry. One of them is about monitoring temperature and humidity in the non-sterile drug production room. This temperature and humidity is monitored by the QA (Quality Assurance)/Quality Assurance department, which is used to see whether the temperature and humidity of the non-sterile drug production room are well conditioned.Based on the existing problems, it is necessary to have an intelligent system that can monitor temperature and humidity precisely and periodically. One of them is creating an Internet of Things (IoT) Implementation tool for Simulating Temperature and Humidity in a Non-Sterile Medicine Production Room Using an Arduino and Web Based Temperature Sensor (LM35) and Humidity Sensor (DHT 22). This tool will periodically detect the temperature and humidity in each non-sterile drug production room. If the temperature exceeds the maximum limit in the non-sterile drug production room, the fan will turn on to release the hot air inside. All the data that has been collected will be processed by the Arduino Uno R3 Microcontroller and will be displayed on the website as an interface . For early detection, a DC Fan appears on the website that rotates if the temperature exceeds the maximum limit. Data transmission uses ESP8266 as a wireless module .

Keywords *: Arduino, LM35 Sensor, DHT22 Sensor, DC Fan, Website, ESP8266 .*

I. INTRODUCTION

One of the current developments in internet technology is the development of the Internet of Things. The Internet of Things is a global infrastructure for the information society, enabling sophisticated services, by connecting objects (things) both physical and virtual based on current information exchange technology and its developments and communication technology.

Remote temperature monitoring is very useful if carried out over large areas, dangerous areas or for speed of data collection because only the sensor equipment and transmission system are on site. Remote access can be via cable, wireless or fiber optic media, either point to point or network.

Based on initial observations and observations at PT. Ciubros Farma, temperature and humidity monitoring in non-sterile drug production rooms is only carried out in rooms that are often used for production so there are several non-sterile production rooms where the temperature and humidity are not monitored every day. This is because the number of temperature and humidity monitoring devices (thermohygro) is limited so it cannot cover the entire non-sterile drug production room, and the job of monitoring the temperature and humidity environment in the non-sterile drug production room is the job desk of the QA (Quality Assurance) department, staff in the department QA (Quality Assurance) has 4 personnel, each personnel has their own job desk. QA (Quality Assurance) staff experience problems when monitoring every day. Temperature and Humidity Monitoring is determined by PT. Ciubros Farma is carried out from 10.00 to 12.00 WIB. Currently, the work of recording temperature and humidity is carried out by the production employees themselves.

Temperature and Humidity Recording functions to document environmental monitoring of temperature and humidity in non-sterile drug production rooms. Temperature and humidity monitoring in non-sterile drug production rooms currently still uses forms and there is no solution if the temperature exceeds the predetermined limit, namely 20-27ºC This means that the QA (Quality Assurance) staff must enter the non-sterile drug production room where the distance between the staff office and the non-sterile production building is relatively far and take readings of the temperature and humidity in the thermohygro then record it on the temperature, humidity and pressure difference monitoring form. QA (Quality Assurance) staff cannot enter the non-sterile production room every day, so temperature and humidity are often not recorded in one day. Apart from that, the data collection process which is carried out at the end of each month also takes time.

Based on the description above, the title was chosen " **Implementation of *Internet of Things* (IoT) for Temperature and Humidity Simulation in Non-Sterile Medicine Production Rooms Using Arduino and Web Based Temperature Sensors (LM35) and Humidity Sensors (DHT22) .**

From the description above, the problems that can be formulated include:

1. How do you monitor temperature and humidity every day without entering the non-sterile drug production building?
2. How do you ensure that all non-sterile drug production rooms have temperature and humidity monitored?

3. How is temperature and humidity monitoring data collected automatically every month?

4. How to deal with temperature and humidity exceeding the specified requirements?

II. THEORETICAL BASIS

2.1 Theoretical Description

2.1.1 Internet of Things

a. Understanding *the Internet of Things* (IoT)

Internet of Things (IoT) is a network that connects various objects that have identifying identities and IP addresses, so that they can communicate with each other and exchange information about themselves and the environment they perceive. Objects in IoT can use or produce services and work together to achieve a common goal. With this capability, IoT has shifted the definition of the internet as computing anywhere, anytime, anything, anything for anyone and any service. (Ernita, 2015)

The Internet of Things (IoT) is infrastructure global for the information society, enabling sophisticated services, by connecting objects (things) both physical and virtual based on current information exchange technology and its developments and communication technology.

Remote temperature monitoring is very useful if carried out in large areas, dangerous areas or for speed of data collection because only sensor equipment and transmission systems are on site. Remote access can be via cable, wireless or fiber optic either point to point or network. . (Totok, 2016)

b. *the Internet of Things* (IoT) Works

The way the internet of things works is quite easy. Every object must have an IP Address. IP Address is an identity on a network that allows this object to be ordered from other objects on the same network. Next, the IP addresses of these objects will be connected to the internet network. Nowadays, it is very easy to get an internet connection. In this way, we can monitor these objects and even give orders to them.

After an object has an IP address and is connected to the internet, a sensor is also installed on the object. Sensors on objects allow the object to obtain the information it needs. After obtaining the information, the object can process the information itself, and even communicate with other objects that have an IP address and are connected to the internet as well. There will be an exchange of information in communication between objects the. After

information processing is complete, the object can work by itself, or even order other objects to also work. So, in the internet of things humans will act as kings and will be served by the objects around them. (Richard, 2014)

2.1.2 Temperature and Humidity

a. Understanding Temperature and Humidity

Temperature is a measure or degree of hotness or coldness of an object or system. Temperature is defined as a physical quantity that is shared between two or more objects that are in thermal equilibrium. An object that is hot is said to have a high temperature, and vice versa, an Objects that are cold are said to have a low temperature. (Christian, 2013)

Humidity is a measure of the amount of water vapor in the air. The amount of water vapor influences physical, chemical and biological processes in nature, therefore it will affect human comfort as well as the environment. If the amount of water vapor content exceeds or is less than the required requirements, it will cause interference and damage. For example, food and medicines stored in storage require certain humidity conditions so that they do not spoil quickly. Electronic equipment also rusts easily if the air around it has high enough humidity. Therefore, information about air humidity in a particular area is needed. This is an important thing to know because it involves the effects it causes. (Christian, 2013)

b. Temperature and humidity requirements in the drug production room (area).

The drug production room is a room/area for making drugs. The manufacture of medicines must follow CPOB (Good Medicine Manufacturing Practices) to ensure that the medicines made consistently meet the specified requirements and are in accordance with their intended use.

Production areas should be ventilated effectively using an air control system including air filters with a level of efficiency that can prevent contamination and cross-contamination, temperature control and, if necessary, air humidity control according to the needs of the product being processed and the activities carried out indoors and their impact on outside factory environment. The production area should be monitored regularly both during and when there is no production activity to ensure compliance with previously designed specifications. (CPOB p. 16 point 3.21, 2012)

According to CPOB, drug production rooms/areas are classified according to their cleanliness class, namely:

1. Classes A, B, C and D are room cleanliness classes for making sterile products.

2. Class E is a cleanliness class for the manufacture of non-sterile products.

The air in the processing room is an area with specific environmental conditions that are defined, controlled and monitored to prevent cross-contamination (in multi-product facilities) or degradation of starting materials and products. (POPP 2013 volume I point 3.21 p. 72).

It is made clear in POPP (Operational Instructions for Implementing CPOB Guidelines) the importance of monitoring temperature and humidity in production areas, in this case non-sterile production areas.

2.1.3 Arduino Uno R3

Arduino UNO is a microcontroller board based on the Atmega328 (datasheet). The Arduino UNO has 14 digital input/output pins (6 of which can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. The Arduino UNO contains everything needed to support the microcontroller, easily connecting it to a computer with a USB cable or supplying it with an AC to DC adapter or using a battery to start it up.

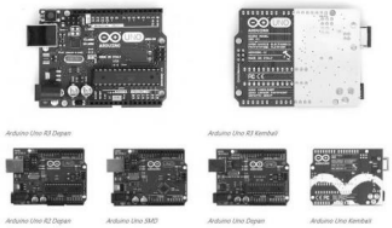


Figure 1 Arduino UNO R3

Source: Dany, 2014

The Arduino UNO is different from all previous Arduino boards, the Arduino UNO does not use an FTDI USB-to-serial driver chip. In contrast, the features of the Atmega16U2 (Atmega8U2 up to the R2 version) are programmed as a USB to serial converter. Revision 2 of the Arduino UNO board has a resistor that pulls the 8U2 HWB line to ground, which makes it easier to put into DFU mode. Revision 3 of the Arduino UNO board has the following new features:

1. Pinout 1.0: added SDA and SCL pins which are close to the AREF pin and two other new pins which are placed close to the RESET, IOREF pin which allows the shield to adjust

the voltage provided from the board. In the future, the shield will be made compatible/compatible with boards that use AVR which operates with a voltage of 5V and with Arduino Due which operates with a voltage of 3.3V. The second one is an unconnected pin, which is provided for future purposes.

2. More powerful RESET circuit.
3. Atmega 16U2 replaces 8U2.

"Uno" means one in Italian and was named to signify the next release (product) Arduino 1.0. Arduino UNO and version 1.0 will be the reference for future Arduino versions. Arduino UNO is the final series of Arduino USB boards and a reference model for Arduino boards, for comparison with previous versions. (Dany, 2014)

2.1.4 LCD 2004 (20x4)

LCD is an abbreviation of the words liquid crystal display, namely a display panel made from liquid crystal material. Crystals with special properties that display complete colors originating from the reflection/transmission effect of light with wavelengths at certain viewing angles, are one of the important technologies that support the need for thin and light electronic equipment. (Saludin, 2013)

The LCD (*liquid crystal display*) used is an LCD that has a resolution of 20x4 and can be controlled in two modes, namely 4-bit and 8-bit. (Aziz, 2015)

Figure 2 LCD 20x4

Source: Aziz, 2015

2.1.5 I2C

I2C is an interface between two *bus lines*, namely SDA (*Serial Data Line*) and SCL (*Serial ClockLine*). Each connected device is addressed by software with a unique address. On this line there is *master-slave communication* between the two connected devices. The

data sent is a multiple of 8 beet. Transfer speeds are 100 Kbit/s in standard mode, 400Kbit/s in fast mode, and 3.4 Kbit/s in high-speed mode. (Andi, 2010)

Figure 3 I2C LCD 2004 backside view

Source: Abasi, 2017

2.1.6 LM35 sensors

LM35 is the temperature sensor most widely used in practice, because apart from being quite cheap, its linearity is quite good. The LM35 does not require external calibration providing accuracy of ±¼ºC at room temperature and ±¾ºC in the -55 to +150ºC range. The LM35 is intended to operate at -55 to +150ºC, while the LM35C is at -40ºC to +110ºC, and the LM35D is in the 0-100ºC range. The LM35D is also available in an 8-foot package and a TO-220 package. The LM35 sensor will generally increase by 10mV for every 1ºC increase (300mV at 30ºC). (Heri, 2016)

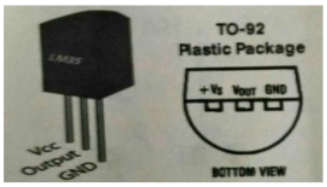


Figure 4 LM35 sensor

Source: Heri, 2016

2.1.7 DHT22 sensor

DHT-22 is a temperature and humidity sensor which is also known as the AM2302 sensor. This sensor is almost the same as the DHT11 and also has four legs. The legs of DHT22 can be seen in Figure 2.6.

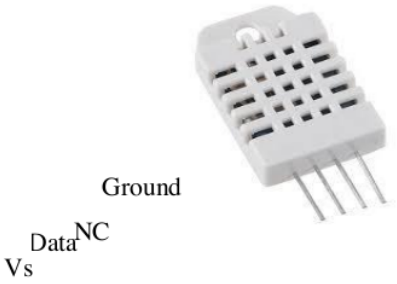


Figure 5 DHT22 sensor

Source: Yoga, 2016

Figure 2.6 shows the four legs of the DHT22 sensor, namely the Vs, Data, NC and Ground legs. The source voltage is connected to the Vs leg, where the source voltage used is generally 5V because it follows the working voltage of the microcontroller, which is also 5V. Then the Data leg is connected to a microcontroller which is used to retrieve the measured temperature and humidity data.

The NC leg, namely the Not Connected leg, is a leg that is not connected to anything. So in testing, this leg must not be connected to anything. Meanwhile, the ground leg is connected to the source voltage ground. This DHT22 sensor has several advantages, namely as follows:

1. Data from sensor measurements is in the form of digital signals with conversion and calculations carried out by an 8-bit MCU.
2. The sensor is accurately calibrated with temperature compensation in the adjustment chamber with calibration coefficient values stored in the integrated OTP memory.
3. The range of temperature and humidity measurement results from the DHT22 sensor is wider
4. The sensor is capable of transmitting measurement results signals via cables up to 20 meters long, making it suitable for placement anywhere. If using a cable longer than 2 meters, the sensor requires a 0.33µF buffer capacitor between the source voltage (Vs) leg and the ground leg (Ground).

2.1.8 WiFi ESP 8266

WiFi is a technology used in electronic equipment to exchange data wirelessly (using radio waves) over a computer network. Equipment can be connected to a computer network

through an *access point* . An *access point* has a range of approximately 20 meters indoors, and even wider outdoors.

The ESP 8266 module is a SoC *(System on Chip)* with an integrated TCP/IP protocol *stack , making it easy to access using a microcontroller via 802.11 b/ g/ n Wi-Fi Direct* (P2P) serial communication. The Esp8266 WiFi module can function as a host or as a data transfer module in a WiFi network. This module has good data processing and storage capabilities, making it possible to integrate with sensors and other special devices via GPIO.

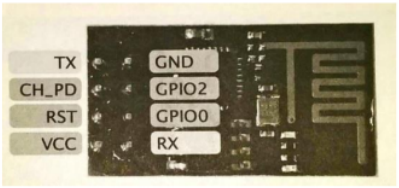


Figure 6 Esp 8266

Source: Quick Learning and Programming Arduino Book

a. (WEMOS D1 R1 Mini)

Wemos is a board module that can function with Arduino, especially for projects that use the IoT concept. Wemos can *run stand-alone* without needing to be connected to a microcontroller, unlike other WiFi modules which still need a microcontroller as the controller or brain of the circuit, Wemos can *run stand-alone* because it already has a CPU that can program via serial port or via OTA and transfer programs *wirelessly* . (Dian, 2017).

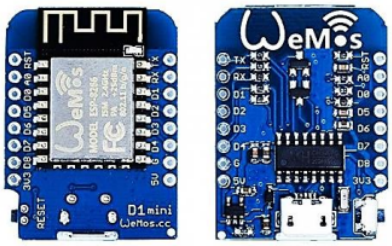


Figure 7 Wemos D1 R1 Mini

(Source: https://www.instructables.com/id/Wemos-to-Wio-Adapter/)

2.1.9 DC *Cooling Fan*

The DC fan or DC *Cooling Fan* functions to regulate the air flow speed. The main part that makes up a DC fan is a DC motor. The working principle of the motor in a DC fan is basically the same as the working principle of a DC motor in general. (Fajri, 2013)

Figure 8 DC *Fan*

Source: Aziz, 2015

2.1.10 Relays

A relay is an electrical switch that uses an electromagnet to move the switch from the OFF position to the ON position. The power required to activate *the relay* is relatively small. However, *relays* can control something that requires more power.

There are several types of relay configurations, for example SPST and SPDT which are shown in Figure 11. *Single Pole Single Throw* (SPST) is the simplest configuration, where the relay with this configuration only has two contacts. *Single Pole Double Throw* (SPDT) has three contacts. The contacts are usually labeled *Common* (COM), *Normally Open* (NO), and *Normally Close* (NC), the NC contact will connect to the COM contact when *the coil* is not powered. In *Normally Open* (NO), the contact will be disconnected when no power is provided to *the coil* . When power is applied, the *Common* (COM) will be connected to the NO contact and the NC contact is left *floating* . (Mochamad, 2017)

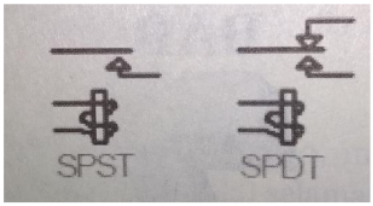


Figure 9 SPST Relay and SPDT Relay Configuration

Source: Mochamad, 2017

2.1.11 Arduino IDE

open-source single *-board* micro controller , derived from *the Wiring platform,* designed to facilitate the use of electronics in various fields, the *hardware* uses an Atmel AVR processor and *the software* has a simple C++ programming language and functions. complete, so Arduino is easy for beginners to learn. (Heri, 2015)

2.1.12 C Based Arduino Programming Language

The basic structure in Arduino programming is very simple and consists of two parts, consisting of two functions, namely the preparation function (*setup())* and the main function *(loop()).*

setup() is preparation before program execution. loop() is the place to write the main program that will be executed.

The setup() function is used to define the variables used in the program. This function runs the first time when the program is run, then there is loop() which is the core/main program of the Arduino which is run continuously, both reading input and activating output. This program is the core of all programs in Arduino.

2.1.13 PHP

PHP *Hypertext Preprocessor* or abbreviated as PHP is a *scripting language* especially used for *web development* . Due to its *server side scripting nature,* to run PHP you must use *a web server.*

PHP can also be integrated with HTML, Javascript, JQuery, Ajax. However, in general PHP is mostly used in conjunction with HTML type *files* . By using PHP you can create *powerful, dynamic websites* with *database management.*

2.1.14 MySQL

Database Management System (DBMS) is an application used to manage databases. DBMS usually offers several integrated capabilities such as:

1. Create, delete, add and modify databases.
2. In some DBMS the management is windows based (in the form of windows) so it is easier to use.
3. Not everyone can access existing databases so as to provide security for data.
4. Ability to communicate with other application programs. For example it is possible to access a MySQL database using an application created using PHP.
5. Access capability via intercomputer communication (client server).

2.1.15 ISIS Proteus Professional 7

Proteus professional 7 is a group of electronic software that is used to assist designers in designing and simulating electronic circuits. This software has two functions at once in one package, package one is software for schematic drawing and can be simulated which is named ISIS[4]. The second package is used to design *Printed Circuits Board (PCB*) images

called ARES. As an electronic circuit designer, I first use ISIS as a medium that makes design and simulation easier. (Alfan, 2017)

2.1.16 Notepad++

Notepad++ is a developer application program that is useful for editing text and programming code scripts. The latest version of this program is Notepad++ v5.9, which was released on April 6 2012. Notepad++ software was created and developed by the Notepad++ Team. This computer software has the advantage of increasing the capabilities of a text editor program, more than just the Windows default Notepad program. Notepad++ can recognize tags and code in various programming languages. The advanced search and text editing features available are also quite powerful, really helping a programmer or developer in completing their program code scripts. The Notepad++ program is widely applied and used by computer users in the field of desktop and web application programming. Notepad++ is free software (opensource). Notepad++ can be run on the Win2K, Windows XP, Vista, and Windows 7 operating systems. (Irvan, 2015)

2.1.17 Xammp Web Server

Whether a web application runs well or not requires what is called a web server. This web server is a place where web applications are stored and then accessed via the internet. Apart from that, the need for this web server is because for server side scripts such as PHP, new checks will appear if you use a web server. That's the difference with client side scripts such as HTML, CSS and Javascript, which is enough for the browser to know whether the script is as desired.

2.1.18 UML (*Unified Modeling Language*)

Unified Modeling Language (UML) is a "language" that has become the industry standard for visualizing, designing and documenting software systems. UML offers a standard for designing models of a system. By using UML, models can be created for all types of software applications, where these applications can run on any hardware, operating system and network, and be written in any programming language. But because UML also uses *classes* and *operations* in its basic concepts, it is more suitable for writing software in object-oriented languages such as C++, Java, or VB.NET.

2.1.18.1 UML (Unified Modeling Language) Diagrams

1. Class Diagram

   Class diagrams are static. This diagram shows the set of classes, interfaces, collaborations and relationships.

2. Object Diagram

   Object diagrams are static. This diagram shows objects and the relationships between objects. Object diagrams show static instantiations of everything found in a class diagram.

3. Use case diagram

   This diagram is static. This diagram shows a set of use cases and actors (a special type of class). This diagram is especially important for organizing and modeling the behavior of a system that users need and expect.

4. Sequence Diagram (Sequence diagram)

   This diagram is dynamic. A sequence diagram is an interaction diagram that emphasizes sending messages at a certain time.

5. Collaboration Diagrams

   This diagram is dynamic. Collaboration diagrams are interaction diagrams that emphasize the structural organization of objects that receive and send messages.

6. Statechart Diagram

   This diagram is dynamic. This diagram shows the states of the system, containing states, transitions, events and activities. These diagrams are especially important for showing the dynamic nature of interfaces, classes, collaboration and are especially important in modeling reactive systems.

7. Activity Diagrams

   This diagram is dynamic. This diagram is a special type of state diagram that shows the flow from one activity to another of a system. These diagrams are especially important in modeling the functions in a system and emphasize the flow of control between objects.

8. Component Diagrams

   This diagram is static. This diagram shows the organization and dependencies on pre-existing components. This diagram is related to a class diagram where components are typically mapped into more than one class, interfaces and collaborations.

9. Deployment Diagrams

   This diagram is static. This diagram shows the configuration when the application is run (at run time). This contains the nodes and the components they contain. Deployment diagrams are closely related to component diagrams where the deployment diagram

contains one or more components. This diagram is very useful when the application acts as an application that runs on many machines (distributed computing).

These 9 (nine) diagrams do not absolutely have to be used in software development, they are all made according to needs. (Prastuti, 2009)

2.1.18.2 *Use case diagrams*

Use case diagrams are modeling for the behavior *of* the information system that will be created. *Use cases* are used to find out what functions are in the information system and who has the right to use these functions. (Ade, 2016) The symbols used in *the Use case* Diagram are:

Table 1 *Use case diagram*

Gambar	Keterangan
	*Use case* menggambarkan fungsionalitas yang disediakan sistem sebagai unit-unit yang bertukar pesan antar unit dengan aktor, yang dinyatakan dengan menggunakan kata kerja
	*Actor* atau Aktor adalah *Abstraction* dari orang atau sistem yang lain yang mengaktifkan fungsi dari target sistem. Untuk mengidentifikasikan aktir, harus ditentukan pembagian tenaga kerja dan tugas tugas yang berkaitan dengan peran pada konteks tanpel sistem. Orang atau sistem bisa muncul dalam beberapa peran. Perlu dicatat bahwa aktor berinteraksi dengan *Use Case*, tetapi tidak memiliki kontrol terhadap *use case*.
	Asosiasi antara aktor dan *use case*, digambarkan dengan garis tanpa panah yang mengindikasikan siapa atau apa yang meminta interaksi secara langsung dan bukannya mengindikasikan data. Asosiasi antara aktor dan *use case* yang menggunakan panah terbuka untuk mengindikasikan bila aktor berinteraksi secara pasif dengan sistem
«include»	*Include*, merupakan di dalam *use case* lain (*required*) atau penanggilan *use case* oleh *use case* lain, contohnya adalah pemanggilan sebuah fungsi

2.1.19 Flow Chart (*Flowchart*)

Flowcharts are a way of writing algorithms using graphic notation. A flowchart is a picture or chart that shows the sequence or steps of a program and the relationships between processes and their statements. This description is expressed by symbols. Thus, each symbol describes a certain process. Meanwhile, the processes are depicted with connecting lines. Using a flowchart will make it easier for us to check parts that were forgotten in the problem

analysis. Besides that, flowcharts are also useful as a facility for communication between programmers working in a project team. Flowcharts help analysts and programmers to break down problems into smaller segments and help in analyzing other alternatives in operations.

Basically there are various kinds of flowcharts, including System Flowcharts, Paperwork Flowcharts / Document Flowcharts, Schematic Flowcharts, Program Flowcharts, Process Flowcharts. For program creation purposes, a Program Flowchart is used.

A program flowchart describes a sequence of instructions depicted with certain symbols to solve problems in a program. A program flowchart contains more detailed information about how each step of the program or procedure should be implemented. This flowchart shows each step of a program or procedure in the exact order they occur. Programmers use program flowcharts to describe the sequence of instructions of a computer program. Systems Analysts use program flowcharts to describe the sequence of work tasks in a procedure or operation.

III. RESEARCH METHODS

3.1 Development style

3.1.1 Types of research

A method is defined as an orderly method used to carry out work so that it is achieved as desired or a systematic way of working to facilitate the implementation of an activity to achieve the specified goals. Research is a careful examination, investigation or activity of collecting, processing, analyzing and presenting data carried out systematically and objectively to solve a problem or test a hypothesis for the development of general principles.

The research method is a systematic, orderly and orderly work procedure, which can be scientifically justified to solve a problem in order to obtain objective truth.

The elements in compiling research methods are as follows:

a) Subject and object of research.
b) Data and data sources.
c) Data collection techniques.
d) Data analysis techniques.
e) Data validity checking techniques.

Apart from research methods, the tools used in this research are flowcharts. A flowchart is a series of parts that describe the flow of a program. A flowchart is also a picture or chart that shows the sequence and relationship between processes and their instructions. This

description is expressed by symbols. Thus, each symbol describes a particular process, while the relationships between processes are depicted with connecting lines.

3.1.2 The scope of research

The scope of this research is that the author conducted research at PT. Ciubros Farma Semarang City in the production area related to environmental monitoring.

3.1.3 Related Variables

The variables related to this research are related to how the temperature and humidity monitoring system in the production area can monitor the entire production space easily with the sensors used in the system.

3.1.4 How to Collect Data and How to Process Data

In conducting research, the author uses several research methods so that it runs neatly, orderly and organized.

a. Object of research

The research was carried out at PT. Ciubros Farma Semarang City.

b. Data Type

There are 2 types of data collection used to obtain information about this research, including:

1. Primary Data

1) Observation

Direct observation of the object used as research.

2) Interviews

Namely by conducting questions and answers or consultations carried out directly with one of the PT staff. Ciubros Farma Semarang regarding information related to research.

3) Literature Study

Data collection is done by taking it from library materials or reading books related to the research theme.

2. Secondary Data

Data originating from outside the research object includes collecting books and literature related to the research object.

c. Data collection technique

The power collection methods used to obtain information about this research include:

1. Observation

Direct observation of the object used as research.

2. Interviews

Namely by conducting questions and answers or consultations carried out directly with one of the PT staff. Ciubros Farma Semarang regarding information related to research.

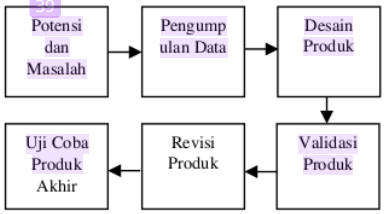
3. Literature Study

Data collection is done by taking it from library materials or reading books related to the research theme.

3.2 Development Procedure

The research and development method used in this research is the Research and Development Method (R&D). To be able to produce certain products, research is used to analyze needs and to test the effectiveness of the product. (Sugiyono, 2014) Some of the stages are as follows:

The research and development steps are as follows:



Structure of R&D Development Procedures

Steps for Using R&D Methods

a. Potential and Problems

The main problem that is sought for a solution is that temperature and humidity monitoring activities can be carried out every day by QA staff, all production rooms have their temperature and humidity monitored, the data is field appropriate, there is no need to enter the production room to make observations of temperature and humidity, and there is action if the temperature exceeds the specified limit, namely 20-27ºC.

b. Data collection

In collecting data here the author conducts interviews, collects information and makes study observations.

c. Product Design

The product design uses LM35, DHT22, Esp 8266 (ESP-01), Sketch, PHP and MySQL database sensors, the system uses the IoT (Internet of Thing) concept for temperature and humidity, based on Arduino Uno R3.

In research at PT. Ciubros Farma Semarang, the author prepared a detailed system design such as a flowchart. A flowchart is a description in the form of a flow diagram of an algorithm in a program that states the direction of the program's flow in solving a problem.

d. Product Validation

Product validation is one of the development processes carried out to determine the level of effectiveness of the new product. The validity test aims to ask for assessments from experts or experts.

e. Product Revision

In this stage, an expert validates the product produced. If it is not in accordance with the initial objectives, the researcher will make improvements or revise it as requested by the expert.

f. Product Trial

The data from the test results of the Internet of Things (IoT) temperature and humidity monitoring system is then analyzed to find out whether the model is suitable for use or not. If the evaluation model and instruments do not meet the model fit requirements, it is then revised and tested again. These trials and revisions are carried out repeatedly until a final prototype is obtained that meets the requirements.

3.3 Research design

3.3.1 Trial Design

The products produced in *Research and Development* (R&D) research are varied. In the field of technology, technological products that can be used for human life are products that are quality, economical, attractive, low price, light weight, economical and have multiple benefits.

In research at PT. Ciubros Farma Semarang, the author prepared a detailed system design such as *a flowchart* . *A flowchart* is a description in the form of a flow diagram of an algorithm in a program that states the direction of the program's flow in solving a problem.

3.3.2 Object of research

PT. Ciubros Farma is one of the pharmaceutical industries in Semarang. PT. Ciubros Farma was originally a Cito drugstore which developed into *Cito Drogistery* . In 1944, drug production was only a *home industry* .

Mr. Sucipto Adi is the founder of *Drogistery Cito* . He has a strong determination to make it into the pharmaceutical industry. In 1976, the pharmaceutical industry PT. Ciubros Farma is right on Jalan Raden Patah 141 Semarang. This industry developed very rapidly and in 1979 it moved to Jalan Oerip Soemohardjo Km. 16 Mangkang Kulon Subdistrict. At this time PT. Ciubros Farma has a land area of 8,183 m². Initially PT. Ciubros Farma had one main building, but over time it has now grown to four main buildings. The name Ciubros is taken from the name of a family.

In 1944 PT. Ciubros Farma was able to establish a production site and laboratory that met the criteria and obtained a CPOB (Good Medicine Manufacturing Method) certificate from the Directorate General of Drug and Food Control, Ministry of Health of the Republic of Indonesia.

PT. Ciubros Farma always fixes every deficiency in the factory, including production, building facilities, equipment and management. On January 15 2007 PT. Ciubros Farma received ISO 9001:2000 certificate. In 2009 implemented Renewal XX ISO 9001:2008.

PT. Ciubros Farma continues to make improvements to fulfill ISO commitments. That is a review of the brief history of PT. Ciubros Farma, it is hoped that this review can increase our insight and knowledge regarding the pharmaceutical industry. In 2009, it carried out Renewal XX ISO 9001:2008.

3.3.2.1 *Flow of Documents* Old System for Monitoring Temperature and Humidity

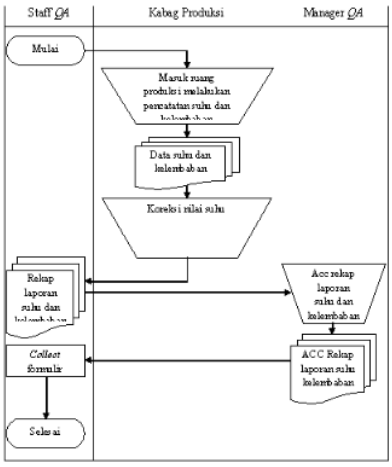


Figure 10 *Flow of Documents for* the Old Temperature and Humidity Monitoring System

Information :

QA staff enter the production room to record temperature and humidity, then the recording results are corrected by the Head of Production. The QA staff summarizes the temperature and humidity report and then submits it to the QA Manager for analysis. The QA Manager provides ACC on the temperature and humidity recording report, then the form is collected by the QA staff.

3.3.2.2 *Flow of Documents* New Temperature and Humidity Monitoring System

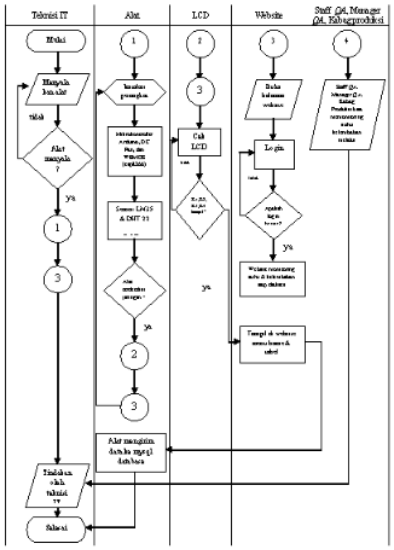


Figure 11 *Flow of Documents* for New Temperature and Humidity Monitoring System

Information :

The IT technician turns on the tool, the tool will carry out the installation process on the existing device, then the tool detects the internet network and checks whether the temperature and humidity values in the room appear on the LCD display. Open the website page and log in using the registered username and password. QA staff, QA Manager, and Head of Production can monitor temperature and humidity via the website. Temperature and humidity data is stored in the MySQL database. IT technicians control the tool for the process of turning the tool on and off.

3.3.3 Data Type

There are 2 types of data collection used to obtain information about this research, including:

a. Primary data

1. Observation

Direct observation of the object used as research.

2. Interviews

Namely by conducting questions and answers or consultations carried out directly with one of the PT staff. Ciubros Farma Semarang regarding information related to research.

3. Literature Study

Data collection is done by taking it from library materials or reading books related to the research theme.

b. Secondary Data

Data originating from outside the research object, including collecting books and literature related to the research object.

3.3.4 Data Collection Instrument

In this research, the data collection instruments are as follows:

1) Questionnaire or Questionnaire

A questionnaire is a research instrument in the form of a list of questions to obtain information from a number of respondents. A questionnaire or questionnaire can be called a written interview, because the contents of the questionnaire are a series of written questions addressed to the respondent and filled in by the respondent himself.

2) Interview

An interview is a form of verbal communication or a kind of conversation, which aims to obtain information. Interviews are a more systematic research instrument.

3) Observation

Observation is a researcher's activity through the process of observing using the five senses. This activity is carried out to obtain information about human behavior, circumstances or situations of the object being studied and to record every situation observed.

3.4.1 Block System Circuit Diagram

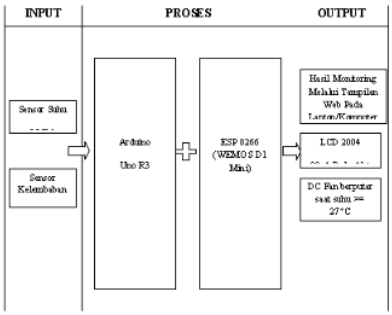


Figure 12 Block Circuit Diagram

From the block diagram above, it can be seen that the system configuration of the Internet of Things system consists of input, process and output.

From the input side, it consists of the LM35 Temperature Sensor, DHT22 Humidity Sensor. The controllers used are Arduino Uno R3 and ESP 8266 (ESP-01). Meanwhile, from the output side there is a web display, LCD 2004 20x4 and DC Fan rotates when the temperature is >= 27°C. The web display functions for the monitoring system, the 2004 20x4 LCD for display on the internet of things system and the DC Fan as a space cooler.

3.4 System Flowchart

A flowchart is a description in the form of a flow diagram of an algorithm in a program that states the direction of the program flow in solving a problem. The following is *a flowchart* of the implementation of *the Internet of Things* (IoT) on temperature and humidity simulations in non-sterile medicine production rooms using temperature sensors (LM 35) and humidity sensors (DHT 22) based on Arduino and the web:

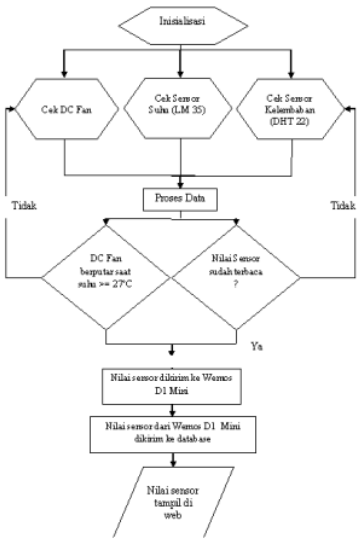


Figure 13 *Flowchart of Internet of Things (IoT)* Implementation of Temperature and Humidity Simulation in a Non-Sterile Medicine Production Room Using an Arduino and Web Based Temperature Sensor (LM35) and Humidity Sensor (DHT22).

Information :

Starting from initializing the Arduino Uno R3 then checking the temperature sensor, humidity sensor and DC fan on the internet of things system, are the temperature and humidity read on the device and the DC fan rotates when the temperature is >= 27°C? if "yes" the sensor value is stored in the database and appears on the website then the DC Fan rotates if the temperature is >= 27°C, if "no" the data is only sent directly to the database without appearing on the website.

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3.4.3 *Use case diagram*

Use case diagram will explain how the system runs starting from the IT technician turning on the tool then the tool turns on, the Arduino microcontroller carries out the process of installing the temperature, humidity and DC Fan sensors then the temperature and humidity sensors carry out the reading process, the temperature and humidity values are stored in the database and DC The fan rotates when the temperature = >27 c. IT Technician, *QA Staff, QA* Manager , Production Head log in. The web displays temperature and humidity values as shown in the following image:

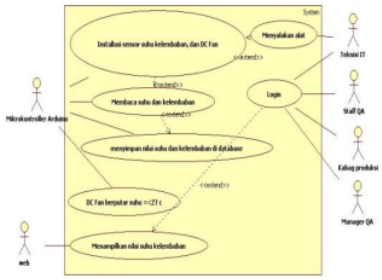

Figure 14 *Use case* temperature and humidity monitoring diagram

IV. RESEARCH RESULT

Based on *Research and Development (R&D)* , the results of this research can be developed into a new discovery that will be used in real life. The product design created by the author is included in *the Mechatronics* (Mechanics and Electronics) series. Mechanical consists of plywood wood and acrylic design. Electronics consist of LM35 sensor, DHT 22 sensor, ESP8266, DC Fan, Relay, Arduino Uno R3 module. Developed on a web programming system (php), with MySQL as *the database* .

Figure 15 LCD display of Room 1 and thermohygro

Figure 16 LCD display of Room 2 and Termohygro

Figure 17 LCD display of Room 3 and Termohygro

Figure 18 LCD display of Room 4 and Termohygro

Table 2 LM35 Sensor Measurements

Ruang	Suhu Sensor (LM35) (°C)	Suhu Termometer (°C)	Error (%)
1	27	27	0
2	28	27	3,70
3	28	27	3,70
4	28	27	3,70
Rata-rata			3,70

From the percentage error results for each room in table 4.7, the average error in LM35 temperature readings is 3.70%.

V. CONCLUSIONS, PRODUCT LIMITATIONS AND RECOMMENDATIONS

5.1 Conclusion

Based on the results of this research, several things can be concluded regarding the simulation performance of implementing the Internet of Things on Temperature and Humidity Simulations in Non-Sterile Medicine Production Rooms Using Temperature Sensors (LM35) and Humidity Sensors (DHT22) Based on Arduino and Web:

1. Temperature readings using the LM35 sensor compared to using a thermohygro that has been calibrated by KAN (National Accreditation Committee) obtained an error percentage of 3.70%.
2. DC Fan rotates when the indoor temperature is >=27°C.
3. Sending temperature and humidity values from the tool to the website requires a delay of 30 seconds.
4. The temperature and humidity display on the LCD corresponds to the temperature and humidity displayed on the website.
5. After carrying out expert and user validation trials, it produces a score of 40, which means this system is Very Valid, the comparison lies with the old PT system. Ciubros Farma where staff always monitors temperature and humidity by going around each room, whereas in the new system they only need to look at the website which is connected to the Internet of Things Temperature and Humidity system (Tool).

5.2 Product Limitations

The implementation of the Internet of Things still finds shortcomings, namely as follows:

1. On the web, the temperature monitoring system cannot automatically update without having to refresh the web page.
2. The tool cannot work when the power goes out.
3. The tool can only read the temperature and humidity in four rooms.
4. To reduce the temperature, use ice cubes .

5.3 Suggestion

From the conclusions above and the system that has been created, several suggestions can be put forward for consideration for further development, namely as follows:

1. There are still shortcomings in the implementation of the Internet of Things that has been designed, so it can be developed by adding applications that support Android/iPhone cellphones.
2. Because the existing internet is still unstable, it is recommended that the tool be able to detect another SSID (Hotspot) which will change automatically if the internet cannot be connected.

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IMPLEMENTATION OF INTERNET OF THINGS (IOT) TO SIMULATE TEMPERATURE AND HUMIDITY IN NON STERILE MEDICINE PRODUCTION ROOMS USING TEMPERATURE SENSORS (LM 35) AND HUMIDITY SENSORS (DHT 22) BASED ON ARDUIN

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