Internet of Things (IoT) Based Temperature and Humidity Monitoring System for Library Rooms

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Abstract. To keep books stored in a library can last a long time, the temperature and humidity of the room need to be maintained according to the type of paper. Therefore, it is necessary to conduct regular observations to anticipate any abnormal condition of the room. On the other hand, data on room temperature and humidity can also be used to predict the age of the paper from a book can survive. Observation of that data manually is very inefficient. In this study, a system of monitoring the temperature and humidity of a library room was made automatically. The acquisition data can be accessed and displayed via local or internet network. Moreover, it can be downloaded as excel file for further analysis.

Keywords: Temperature · Humidity · Internet of Things

1 Introduction

Based on Library Law No. 43 of 2007, library materials are all works in the form of written works, print works, and record works (non-book library materials). Meanwhile, in the opinion of Sulistyo asuki [1], the types of library materials are divided into 6 (six) types, namely printed library materials or graphic works, non-printed library materials or recording works, micro-form library materials, library materials in electronic form, library materials associated with computers and e-books. For every library material in the public library, it must be in accordance with the needs of the community, so that the collection can be used to the maximum extent possible by all levels of society. Collection of library materials contained in libraries is known as library collections (Library Law No. 43 of 2007 concerning Libraries).

Most of the library collections are in the form of books. Damage problems that often occur in libraries are caused by physical damage to library materials, especially those made of paper. Large scale damage occurs in collections made of paper material, because it is influenced by the storage environment that does not meet the requirements, incorrect handling, and from the library material. In addition, Indonesia, which has a tropical climate, does not support paper library materials which can last a long time from damage, especially in the rainy season because the humidity becomes high. In such a situation, the water content in the paper will increase, causing the strength of the

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paper to be reduced and weak [2]. Library material made of paper is a material that is flammable, easily torn, easily damaged by insects, stains will arise due to dust and mold. Damage to library materials in addition to sourced from paper raw materials, damage is also influenced by physical factors.

Physical factors are the cause of damage to library materials caused by dust, temperature, humidity, and light. Pollutants can enter the building through air holes or vents that are not closed properly. Pollution produces sulfur oxides and nitrogen oxides which will be absorbed by paper, it makes the color turn into brown and brittle. According to RI Law No. 43 of 2007, the temperature of the library collection room should limit the temperature between 19–23 °C then the relative humidity is said to be ideal between 40–50% RH. If the room is humid, dust and moist water will cause mold on the collection. In order to be accessible to future generations efforts should be made to prevent damage to library materials, namely by preservation.

Temperature and humidity are factors that greatly affect the collection conditions. This is due to the large number of libraries in Indonesia in general not paying attention to the temperature and humidity conditions in the library materials storage so that the collection damage becomes faster. Especially in Indonesia, which has a tropical climate and changing weather conditions. During this time, the measurement of temperature and humidity of a library room is done manually using an instrument called a thermo-hygrometer. This tool can be used to read temperature and humidity conditions but the weakness is that the reading of this tool is done manually. With the manual reading, the data obtained depends on the human eye so it is not real time. In addition, by reading manually, it cannot represent the actual condition of the room so that in this study online monitoring system of temperature and humidity will be developed, so that it can be used as an effort to extend the public's collection in order to the value of the information can be used longer.

Indoor temperature and humidity monitoring system has been studied in prior researches. For instance, the monitoring system based on ZigBee wireless communication is the done in [3]. It doesn't have degree of flexibility to be accessed through common user computer device. A web-based monitoring system is studied in [4] based on MCU processor and serial communication protocol. The using of MCU as the main processing unit also demonstrated in [5] and [6]. Meanwhile, M. F. A. Samsudin *et al.* have shown utilizing raspberry pi as main processing unit [7]. Their developed system doesn't show the user interface of sensor calibration menu that might be useful for novice user. On the other hand, it doesn't have real time clock module to provide long live accurate time stamp accusation data. In this work, a humidity and temperature monitoring system has been developed based on raspberry pi hardware with accurate time stamp. It come up with user friendly interface for sensor configuration and data display both accessed via local network or internet.

2 Materials and Method

In general, the library room temperature and humidity monitoring system as shown in Figure 1. The sensor module is placed in a location where temperature and humidity will be monitored. The module will be read by a data processing device while storing it

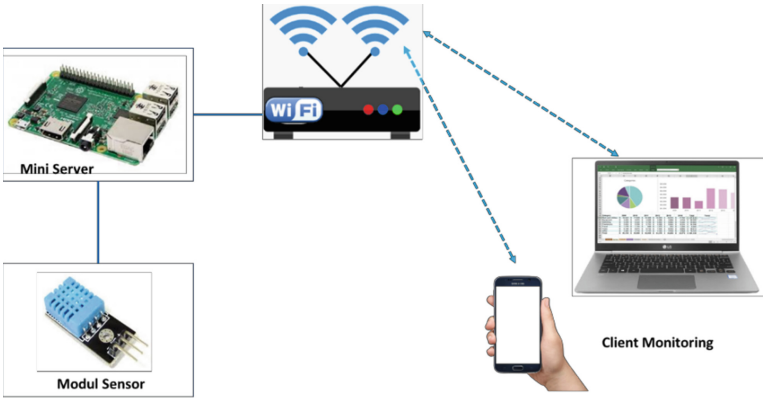

Fig. 1. Temperature and Monitoring System Diagram

(Mini Server). This device is connected to a Wi-Fi transmitter so that data that has been stored can be accessed using a laptop or smartphone device. The Wi-Fi transmitter also can be configured to connect to public internet Wi-Fi.

To facilitate the reading of data by users, the data stored in a database needs to be processed so that it can be displayed in tabular form. Therefore, a web-based application is developed for processing the data. The selection of web-based applications aims to facilitate the access of applications through a computer network. Furthermore, the stored data can be downloaded in the form of Excel for further data analysis. To be able to access the monitoring application, a laptop, smartphone, tablet or PC computer that is equipped with a Wi-Fi dongle can be used as client device. The client device must be connected to the same Wi-Fi network as the mini server, then access the application to the server's IP address using a browser. If it is intended to be accessed via internet, raspberry pi is configured as VPN client using third party VPN provider that is Hamachi VPN [8].

3 Result and Discussion

A hardware device has been developed that is used as a sensor data acquisition device while also functioning as a mini server that can be accessed online through a network. Figure 2 is a photo of the device that has been created based on the block diagram as shown in Figure 3. The temperature and humidity monitoring hardware has been completed and the data stored can be accessed using a smartphone or laptop over the Wifi network.

In this paper, each part of the device system will be discussed first and then the overall system discussion will be discussed.

3.1 Sensor Module

In this study, DHT11 sensor module is utilized [9]. This module has the ability to read temperature and humidity. On the other hand, this module has a data output with serial communication protocol so that it can be read by data processing devices such as Arduino or Raspberry Pi.

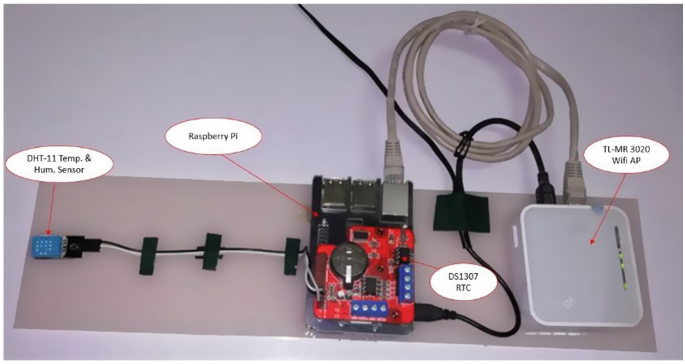

Fig. 2. Hardware Implementation of Monitoring System

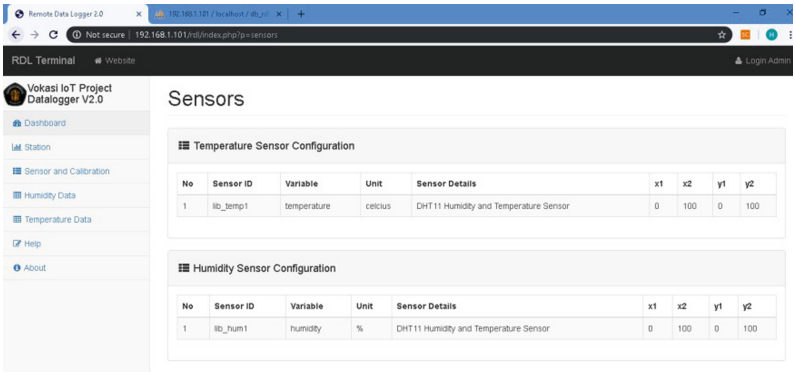

Fig. 3. Sensor and Calibration Menu

3.2 Raspberry Pi Based Mini Server Devices

The mini server device used is raspberry pi [10]. This device is a mini computer that functions as the main data processor. So that this device has the ability to run the main processing functions in the monitoring system, software is developed that functions to read data from the DHT11 sensor and then store it in a database in the Raspberry Pi. The connection from the sensor to the Raspberry Pi utilizes the One Wire pin which has a serial communication feature. On the other hand, created software that aims to display data in the form of web pages. Therefore, before the implementation of the data acquisition and data viewer program, the database server and also the web server are configured first in the Raspberry Pi.

3.3 Real Time Clock

Raspberry Pi by default does not have a real time clock (RTC) module as a computer in general. The RTC functions as a digital clock that will continue to run with its own battery power supply.

Therefore, this research adds an RTC module so that the time configuration continues to run even though the rapberry pi power supply is turned off. The RTC hardware used uses the PiShield EMS Logger model, which hardware is a module with Analog to Digital Converter (ADC) components. The RTC is based on the type DS1307 IC [11]. This module is mounted directly to the GPIO raspberry pi pin. This RTC module must be configured first in rapberry pi so that it reads at the same time setting the clock in accordance with local time. In addition, raspberry pi will also use the RTC clock as the main reference.

3.4 Wifi Transmitter

This tool is connected to the Raspberry Pi and serves to provide a local Wifi network so that the server can be accessed using a laptop, smartphone or other computer device that has Wifi connectivity. The device used is the Wifi output TPLINK device with the TL-MR3020 model as shown in the figure below. Therefore, the Wi-Fi module as possible to be configured as Wi-Fi client if intended to connected to public internet Wi-Fi connection.

3.5 Development of Data Reader, Storage and Viewer Software

Data reader and storage software was developed using the Python Programming Language. Temperature and humidity data readings are made periodically and can be set to the fastest time span every second. As for this study, data readings are made once every minute. The data is stored in a database server that is in Raspberry Pi along with time reading sensor data (time stamp).

To display data, web-based software is created using the PHP Programming Language. This software has the ability to display temperature and humidity data that has been stored in a mini server database. To facilitate further analysis, excel download feature is created, a feature that allows users to download data in the form of Excel. In addition to displaying data, in this software there is a calibration menu that serves to help calibrate the sensor module reading process. The following pictures are a web-based application display for configuration and data appearance (Figs. 4 and 5).

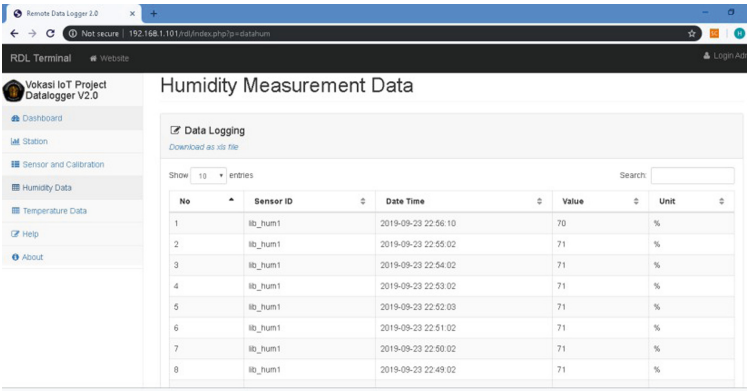

Fig. 4. Measurement Data Display

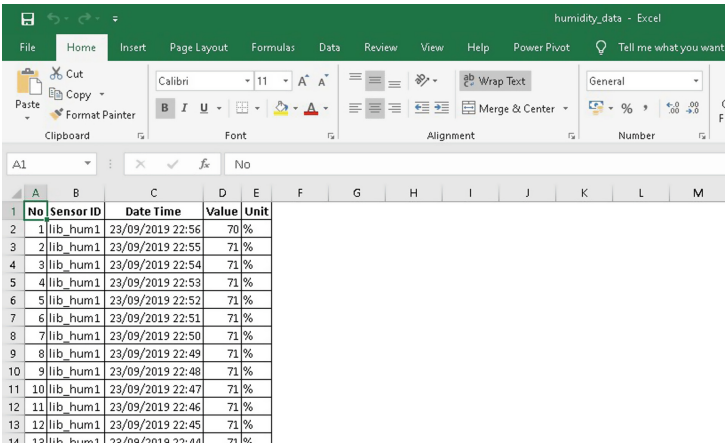

Fig. 5. Downloaded Data as An Excel Document

4 Conclusion

A platform for monitoring the temperature and humidity of the library has been made based on a mini- Raspberry Pi computer. The system can be used to monitor temperature and humidity damage in real time. Using this system, temperature and humidity data can be obtained which are useful in preservation of book collections in the library.

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