

# Measurement System of Temperature, Humidity and Air Pressure over 433 MHz Radio Frequency

## An Application on Quadrotor

Budi Setiyono, Sumardi, Rafdito Harisuryo  
Departement of Electrical Engineering, Engineering Faculty  
Diponegoro University  
Semarang, Indonesia  
E-mail : budisty@undip.ac.id

**Abstract**—Gathering information of weather parameters such as temperature, humidity, and air pressure in a particular place and time as quickly and as possible are required to support other areas. However, sometimes geographical constraints such as the natural contours of the Indonesian archipelago with the ocean, mountains and hills can hamper collection this information. Therefore, we need a data collection system that can handle the problem without the influence of geographical constraints. One solution is the telemetry system. In this research, weather data acquisition system was designed with BMP180 sensor to collect air pressure data, DHT11 sensor to sense temperature and humidity data, and Arduino microcontroller used as data processing. Transmission system used 433 MHz RF module with 17 cm cable antenna as the sender and receiver of data. Data is displayed in a graph in server. So we get the data acquisition based on Graphical User Interface. Experiment results showed that the increase in temperature tends to be accompanied by a drop in air pressure, and vice versa. However, the air pressure data tend not affected to this changing the height of an area measured from sea level.

**Keywords**— *temperature, humidity, air pressure, weather, RF 433 MHz*

### I. INTRODUCTION

Driven by technological development of this era, the collections of accurate information is very needed. One of which is in the field of climatology. Weather parameters information gathering such as temperature, humidity, and air pressure in a certain time and place need to know quickly and accurately to support other areas of work.

Meteorology, Climamotologi and Geophysics Council (BMKG) is the government agency charged with overseeing the development of climate, weather and earthquake potential in the entire archipelago. Currently BMKG has 173 weather stations scattered in area from Medan, North Sumatra up to Wamena, Papua [1]. The weather station consists of instruments measuring weather variables such as temperature, humidity, and air pressure. BMKG provide information services regarding weather data, weather forecasts and climate in Indonesia, which can be accessed on the official BMKG website.

On the BMKG website, the level of accuracy, precision and updated speed of measured data needs to be improved in order to provide weather information quickly and accurate which is indispensable in weather-sensitive activities such as aviation, shipping and other important activities that require this information. The weather information on the BMKG website is the result of a program that is based on interpolation and extrapolation of weather data at multiple positions in Indonesia [2]. This condition can be overcome with the addition of a weather station to provide information and weather forecasts at some point in certain areas, however, sometimes geographical constraints such as the natural contours of the Indonesian archipelago with the sea, mountains and hills can hinder the collection of this information. A data collection system is required without influenced of obstacles geografis. Therefore, accurate and precise information regarding the current weather conditions at some point on a particular area or region and can be updated in real-time. One solution is telemetry system.

Telemetry system is a measurement process of variables data with a certain distance. Data are transmitted via cable or wireless media. Data will be processed or analyzed by the receiving station.

Temperature, humidity, and air pressure data measurement system used DHT11 sensor as air humidity and temperature sensor. BMP180 is used to sense air pressure. Arduino microcontroller is used as reader sensor data are then processed and transmitted over the air communication medium wave radio (Radio Frequency) or commonly abbreviated as RF of an area to be measured. In the receiving station, data are displayed in graphical form in real-time. This system is expected to be able to work representing the weather station instruments, but with a lower cost, lower power consumption, longer distance but remains accurate and precise with sensors that had been calibrated.

### II. METHODOLOGY

#### A. Hardware Design

Hardware design is divided into three parts, the first part is the the data sender that consist reader and data transmitter

shown in Fig. 1. Reader software designed as a weather parameter is the data of temperature and air pressure sensors obtained through BMP180 sensor, and moisture data obtained through DHT11 sensor readings. Then the data is sent via 433 MHz RF transmitter modules. The second part is the receiver shown in Fig. 2. The data measurement is received via 433 MHz RF receiver module then sent by the Arduino microcontroller serial port connected to a computer for displayed. On the programming software in the third part in the form of a graph of measurement data. The programming language used on the part of the sender (transmitter) and the receiving (receiver) is a C language Arduino. Programming into the microcontroller ATmega328P using the Arduino IDE (Integrated Development Environment). On the part of the measurement data viewer in the form of a graph on the computer.

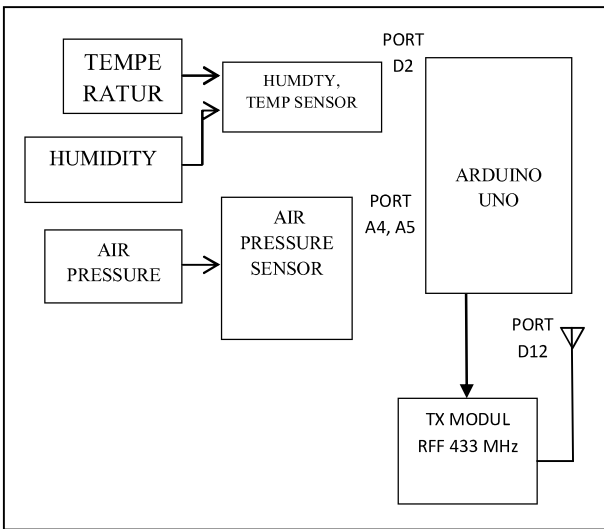


Fig. 1. Sensor element and transmitter part

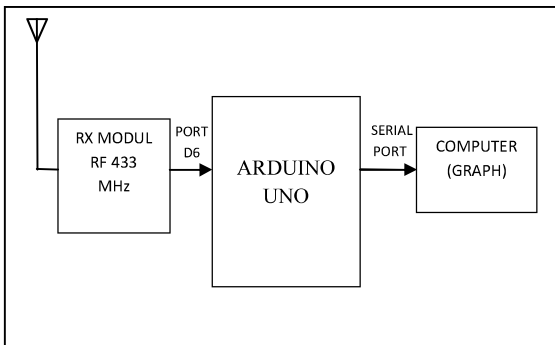


Fig. 2. Receiver part

**B. Software Design**

The flow of data transmission starting from the reading of the temperature, humidity, and air pressure parameters to the sensor. The data is then processed by a microcontroller. Data received by the microcontroller is stored in a temperature, humidity, and air pressure variable and then sent through the transmission of data using 433 MHz radio frequency module.

When the power supply is turned on, the microcontroller and 433 MHz RF modules are on standby condition and ready to accept data. When incoming, the received data is in a string format. The data is sent by the Arduino microcontroller via a serial port into the computer and then the data is broken down into three parts, which are included in the three variables: temperature, humidity, and air pressure. Then the data of three variables shown in the three graphs with each graph contains a description of variables and units of data displayed

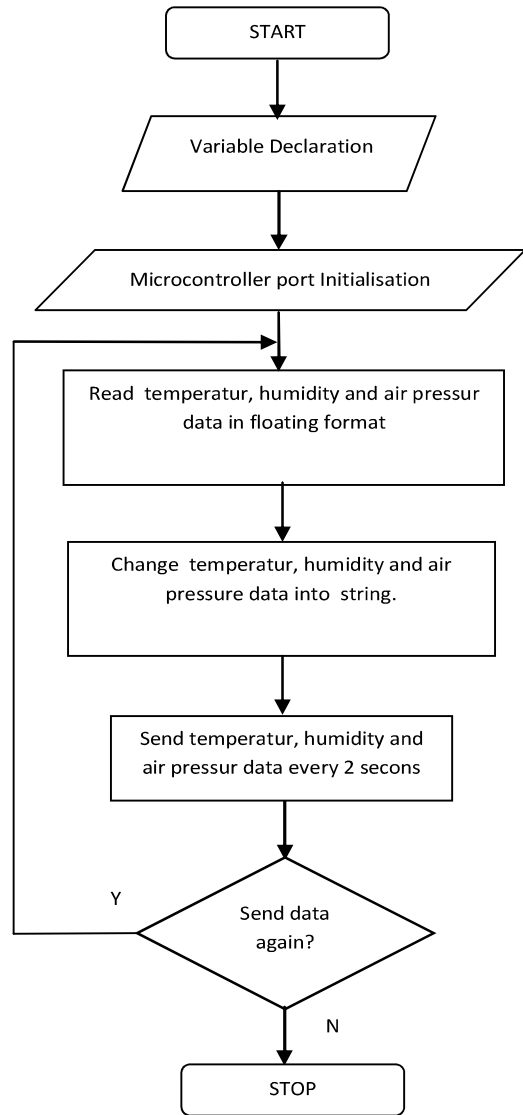


Fig.3. Flowchart of data transmitting

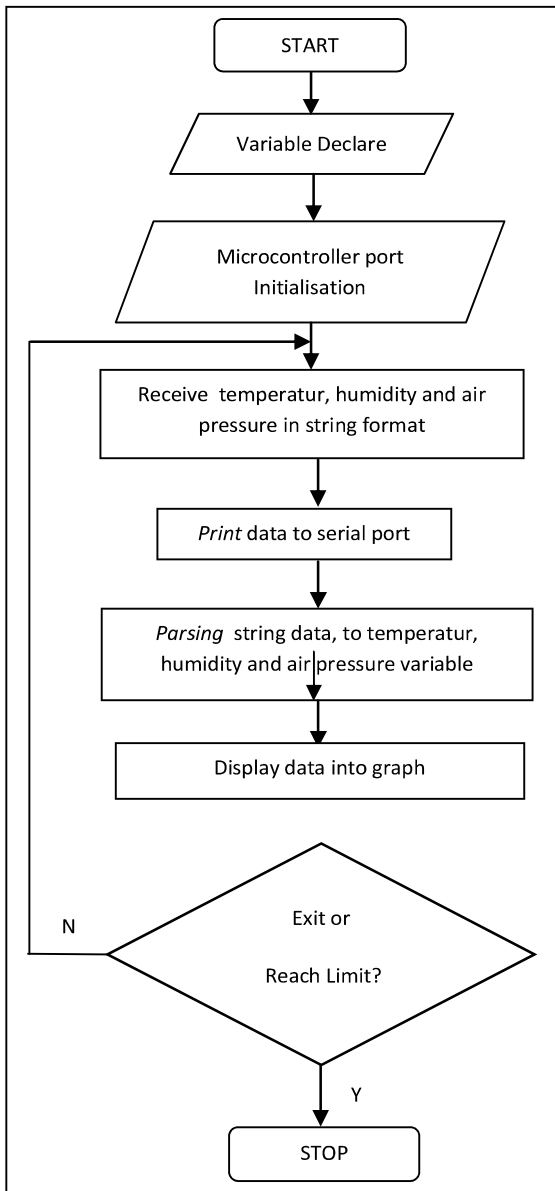


Fig. 4. Flowchart of data receiving and display

### III. IMPLEMENTATION AND RESULTS

First experiment is done by testing the temperature, humidity, and air pressure sensors. The next testing to determine the maximum distance of data transmission with 433 MHz RF modules either without a obstacle or line of sight condition. To simulate variations in temperature, humidity, and air pressure is done by providing different treatment on the sensor using a hair dryer and a spray. To determine the data transmission maximum distance used by give variations of the power supply (5, 9, and 12 Volt) and baudrate (2400, 1200, and 500bps) in the 433 MHz RF modules. Measurement results of the sensor is compared with instruments available on the market , the analog hygrometer and digital barometer.

#### A. Sensor Testing

To rise variations value in temperature and humidity, it is used a hair dryer as a heater around the sensor. To lower it, use a sprayer that contains water. Whereas to simulate variations in air pressure , sensor inserted into a confined space, then air is inserted into the space to increase pressure. Tests carried out indoors, at night local time. The average of difference in temperature sensor readings with reference measuring devices is 0.2°C or is 0.51%. The average of difference in humidity sensor readings with reference measuring devices is 0.2% RH or 0.58%. The average of difference in air pressure sensor readings with reference barometer is 0:43 kPa or 0.43%

#### B. Data Transmission Testings

The successfully of data transmissions is tested by giving the variation distance between the point of transmitting and the receiving point. Furthermore, given the variations in data transmission speed (baudrate) written on program. Data measurement in float format is then converted into char format and transmitted in binary code. This is to summarize the transmission is by combining three pieces of data and still maintain measurement data precision into two decimal places . Then, software is changing the data received from the char format into a format that the actual number. The format of received data is shown in Fig. 5. Measurement data is displayed in graphical form as shown in Fig. 6.

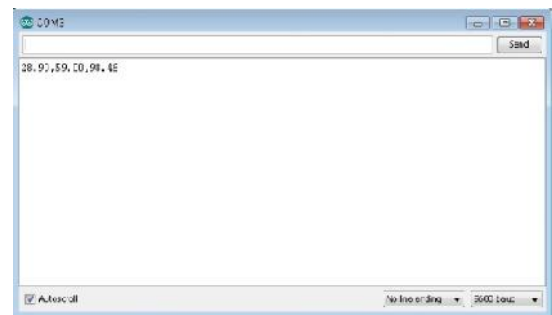


Fig.5. Format of the received data

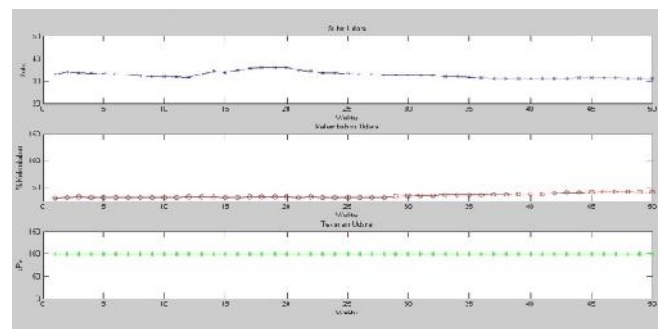


Fig. 6. The data is displayed in graphical form

From testing result shown in Table 1, obtained optimal transmission distances as far as 97 meters without obstacle condition, 12 Volt the transmitter power supply and data

transmission speeds of 500 bps. In successful transmission, the amount of data received will be exactly the same as the number of data sent. Conversely, when the optimal distance is exceeded, no data is received by the receiver section.

TABLE I. TRANSMISSION DISTANCE TESTING

Power Supply	Baudrate	Transmission Distance	Status	Transmitted Byte	Received Byte
5 Volt	2400	31 meter	Success	17	17
5 Volt	2400	32 meter	Success	17	17
5 Volt	2400	33 meter	Failed	17	-
9 Volt	2400	66 meter	Success	17	17
9 Volt	2400	67 meter	Success	17	17
9 Volt	2400	68 meter	Failed	17	-
12 Volt	2400	77 meter	Success	17	17
12 Volt	2400	78 meter	Success	17	17
12 Volt	2400	79 meter	Failed	17	-
5 Volt	1200	34 meter	Success	17	17
5 Volt	1200	35 meter	Success	17	17
5 Volt	1200	36 meter	Failed	17	-
9 Volt	1200	68 meter	Success	17	17
9 Volt	1200	69 meter	Success	17	17
9 Volt	1200	70 meter	Failed	17	-
5 Volt	500	40 meter	Success	17	17
5 Volt	500	50 meter	Success	17	17
5 Volt	500	60 meter	Failed	17	-
9 Volt	500	67 meter	Success	17	17
9 Volt	500	68 meter	Success	17	17
9 Volt	500	69 meter	Failed	17	-
12 Volt	500	95 meter	Success	17	17
12 Volt	500	96 meter	Success	17	17
12 Volt	500	97 meter	Failed	17	-

#### IV. CONCLUSION

The increase in temperature to be followed by a drop in humidity, and vice versa. Meanwhile, air pressure tends not to be influence, because the air pressure sensor can measure the absolute air pressure in the area . Data transmission distance with 433 MHz RF modules can extended by add power transmitter at the maximum specification is 12 Volt and reduce baudrate to 500 bps. In indoor testing condition, the wall thickness is very influential in the arrival succes of data transmission signals from the transmitter to the receiver. The more, more density and thicker the obstacle material , more difficult the transmission signal to be accepted by receiver.

Because radio waves are transmitted through the air medium. Then the little gap would be able to skip the data transmission to the receiver.

Air humidity sensor reader with a digital interface and faster data readout are required in sensing changes of air humidity with the accuracy of two decimal digits after the decimal point.

Module and the RF transmission antenna type with better gain is required so that data transmission can reach longer distances. Special configuration such as the addition of unique addressing also required for sender and receiver module, so they can recognize each other immediately to eliminate noise, Then, re-transmit function of data packets will be needed at a certain time span in case the part of the receiver does not receive data. RTC (Real Time Clock) is required so that the data and time data retrieval becomes more valid..

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