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Analysis System Design Smoke Monitoring And Temperature Based Arduino Nano

Bestari Putra Lase[1], Beni Satria[2], Solly Aryza[3]
[1,2,3]Universitas Pembangunan Pancabudi, Medan, North Sumatera, Indonesia

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ABSTRACT
This research aims to design and analyze a temperature and smoke monitoring system using Arduino Nano as the main microcontroller. This system is equipped with an LM35 temperature sensor and an MQ-2 smoke sensor to detect environmental changes in real-time. Data obtained from the sensor is processed by Arduino Nano and sent via the KYL1020U wireless communication module using radio frequency technology. Information regarding the temperature and smoke concentration is then displayed on the monitor via an application specifically designed for this purpose. System testing was carried out to evaluate sensor accuracy and wireless data transmission reliability. Test results show that the system is able to detect changes in temperature and smoke concentration with high accuracy and send data effectively without any significant delays. In conclusion, the Arduino Nano-based temperature and smoke monitoring system with the LM35, MQ-2 sensor and KYL1020U module is effective and reliable for environmental monitoring applications on various scales. It is hoped that the implementation of this system can increase awareness and response to potential fire hazards and maintain air quality in various environments.

Corresponding Author:
Ariyanto Gultom
Universitas Pembangunan Panca Budi, Medan
Bestarilase97@gmail.com

INTRODUCTION

A Fire is a serious threat that can result in major losses both in terms of material and life. One effort that can be made to prevent and reduce the impact of fires is to install a temperature and smoke monitoring system. This system functions to detect changes in temperature and smoke concentration in an area, so that early warning can be given and preventative action can be taken immediately.

Microcontroller technology such as the Arduino Nano is increasingly popular in various monitoring applications because of its small size, affordable price, and ability to be integrated with various sensors and communication modules. The LM35 temperature sensor and MQ-2 smoke sensor are two important components that can detect environmental parameters relevant to fire risk. In addition, the KYL1020U wireless communication module uses radio frequency technology which enables effective and efficient transmission of data over long distances.

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In this research, a temperature and smoke monitoring system was designed using Arduino Nano, LM35 sensor, MQ-2 sensor, and KYL1020U module. Data obtained from the sensor will be sent via radio frequency and displayed on the monitor via a special application. This system is expected to provide an effective solution for real-time environmental monitoring and increase awareness and response to potential fire hazards. The aim of this research is:

1. Design and develop a temperature and smoke monitoring system using Arduino Nano, LM35 sensor, and MQ-2 sensor.
2. Implements the KYL1020U communication module for wireless data transmission using radio frequency technology.
3. Developing an application to display temperature and smoke data received from the monitoring system in real-time on the monitor.

It is hoped that this research can focus on the design and analysis of an effective temperature and smoke monitoring system and provide results that can be implemented practically in real situations.

Literature Review

Temperature and Smoke Monitoring System

The temperature and smoke monitoring system functions to detect environmental changes that could indicate potential dangers such as fire. This system usually consists of sensors to detect environmental parameters, a microcontroller to process data, and a communication module to transmit information to a control center or monitoring device. Previous research shows that the use of temperature and smoke monitoring systems can improve fire safety and response (Smith et al., 2020).

Arduino Nano

Arduino Nano is a type of microcontroller that is widely used in electronics projects and embedded systems. Its small size and affordable price make it ideal for a variety of applications, including monitoring systems. Arduino Nano is equipped with various input/output pins that enable integration with various sensors and communication modules (Banzi & Shiloh, 2014).

Figure 1. Arduino Nano

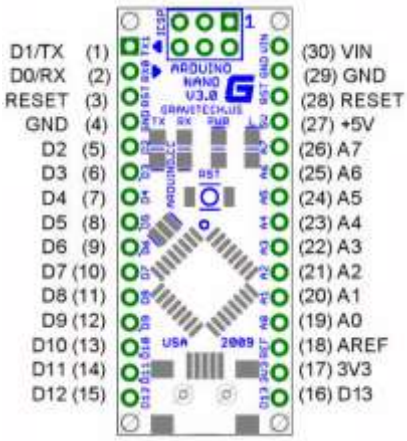

Figure 2. Arduino Nano pinout

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Arduino Nano Pins Description

a. digital I/O: D0-D13.
b. Analog input/output: A0-A7 (10-bit ADC).
c. PWM: Pins 3, 5, 6, 9, 10, 11.
d. UART: D0 and D1 (TX and RX, accordingly).
e. I2C: SDA – A4, SCL -A5.
f. SPI: MOSI – 11, MISO – 12, SCK – 13, SS (10).
g. 0 – TX(UART data transmission), D0.
h. 1 – RX(UART data reception), D1. RX and TX can be used for serial communications or as regular data ports.
i. 3, 29– reset.
j. 4, 29– grounded.
k. 5 – D2, interrupt INT0.
l. 6 – D3, interrupt INT1 / PWM / AIN0.
m. 7 – A4, counters T0 / I2C SDA / AIN1. AIN0 and AIN1 are inputs for the fast analog comparator.
n. 8 – A5, T1 / I2C SCL / PWM bus counters.
o. 9 – 16– D6-D13 ports, where D6 (9), D9 (12), D10 (13) and D11 (14) are used as PWM outputs. D13 (16 pin) is an LED. D10 – SS, D11 – MOSI, D12 – MISO, D13 – SCK are also used for SPI communications.
p. 18 – AREFis the reference voltage for the ADC microcontroller.
q. 19 – 26: analog inputs A0 ... A7. The ADC capacity is 10 bits. A4 (SDA), A5 (SCL) – used for communication via I2C bus. To create use a special library Wire.

LM35 Temperature Sensor

The LM35 temperature sensor is a linear temperature sensor that provides an output voltage proportional to the temperature in degrees Celsius. This sensor has high accuracy and is easy to use with microcontrollers such as Arduino Nano. Research by Wang et al. (2018) shows that LM35 has good performance in temperature monitoring applications with minimal error.

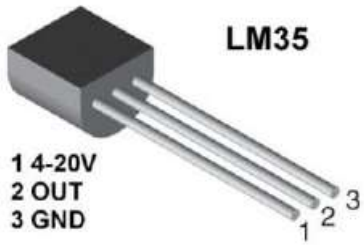

Figure 3. LM35 Temperature Sensor

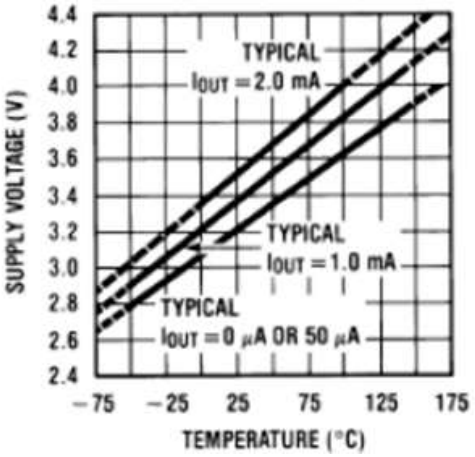

Figure 4. LM35 characteristic curve

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The LM 35 IC does not require external calibration or adjustment because its accuracy is up to approximately a quarter of a degree Celsius at room temperature. The sensor range starts from – 55°C to 150°C, the LM35 IC is very easy to use, it functions as a control for the split power supply display indicator. The LM 35 IC can be supplied with a current of 60 µA from the supply so that the heat generated itself is very low, less than 0 °C at room temperature.

To detect temperature, an LM35 temperature sensor is used which can be calibrated directly in C (Celsius), this LM35 functions as a basic temperature sensor. The special features of IC LM 35 are: Calibration in degrees Celsius. Linearity +10 mV/ ° C. Accuracy 0.5 ° C at room temperature. Range +2 ° C – 150 ° C. Operated on a 4 V – 30 V. Flowing current is less than 60 µA.

MQ-2 Smoke Sensor

The MQ-2 sensor is a gas sensor that can detect various gases such as LPG, smoke, methane and hydrogen. This sensor works by measuring the change in resistance in a sensitive material when a gas is detected. The MQ-2 is often used in security applications to detect gas leaks and the presence of smoke. According to research by Lee et al. (2019), the MQ-2 sensor has good sensitivity and fast response to changes in gas concentration.

Figure 5. MQ-2 sensor

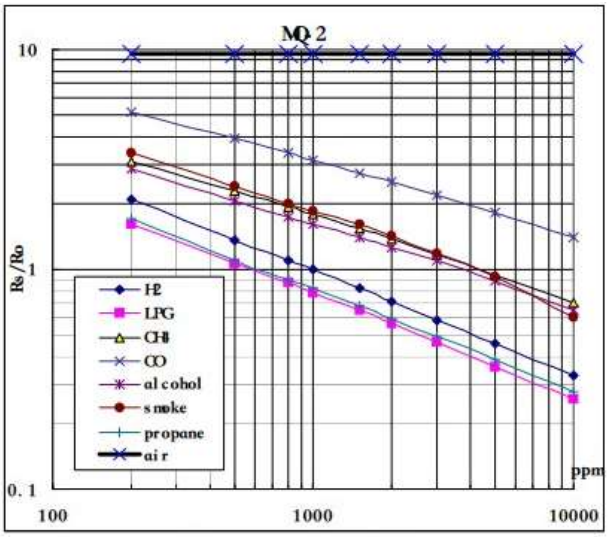

Figure 6. Characteristic curve of the MQ-2 sensor

KYL1020U Wireless Communication Module

The KYL1020U module is a wireless communication module that uses radio frequency technology to transmit data over long distances. This module is often used in remote monitoring and control applications due to its wide range and reliability. The study by Zhang et al. (2020) shows that the KYL1020U is effective in transmitting data with minimal interference.

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Figure 7. KYL 1020U Module

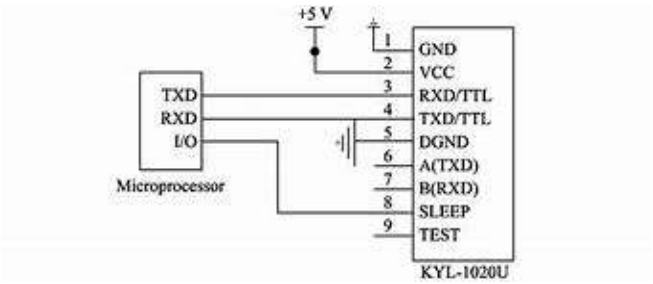

Figure 8. KYL 1020U Module Pinout

Radio Frequency Technology

Radio frequency (RF) is a wireless communications technology that utilizes electromagnetic waves to transmit data. RF is widely used in various wireless communication applications such as Wi-Fi, Bluetooth, and other RF systems. The advantages of RF technology include wide transmission range and high data rates. According to Brown (2017), RF is one of the most efficient wireless communication technologies for environmental monitoring applications.

Monitoring Applications

The monitoring application functions to receive, display and analyze data sent by the monitoring system. These applications are usually equipped with a user interface that makes monitoring and making decisions based on real-time data easier. Research by Kim et al. (2019) show that good monitoring applications can increase the effectiveness of safety systems and responses to emergencies. Integration of various components in a temperature and smoke monitoring system is the key to success in detecting and responding to potential hazards. Previous research shows that good integration between sensors, microcontrollers, communication modules, and monitoring applications can produce reliable and efficient systems. The study by Johnson et al. (2018) underscore the importance of proper testing and calibration in ensuring the accuracy and reliability of monitoring systems.

By reviewing relevant literature, this research aims to develop a temperature and smoke monitoring system that utilizes the advantages of the Arduino Nano, LM35 sensor, MQ-2 sensor, and KYL1020U module, and integrates them all in a reliable monitoring application.

METHOD

This research uses an experimental approach to design, develop and test an Arduino Nano-based temperature and smoke monitoring system. The research process involves several main stages, namely system design, data collection, data analysis, and system performance evaluation. The temperature and smoke monitoring system designed in this research consists of several main components:

a. Microcontroller: Arduino Nano
b. Temperature Sensor: LM35
c. Smoke Sensor: MQ-2

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d. Wireless Communication Module: KYL1020U
e. Monitoring Application: Developed using a programming language that supports real-time data display

The system block diagram depicts the relationships between the main components:

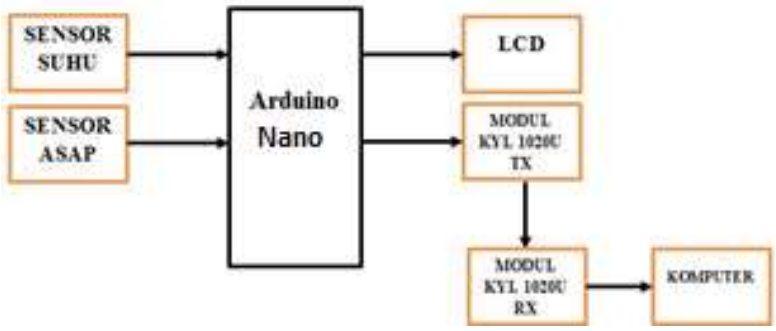

Figure 9. Block diagram

Data is collected via the LM35 temperature sensor and MQ-2 smoke sensor. The data generated by this sensor is then sent to the Arduino Nano for processing. After processing, the data is sent wirelessly using the KYL1020U module to the monitoring application. This application displays real-time temperature and smoke data.

a. Location: Experiments are carried out in a laboratory with controlled environmental conditions.
b. Procedure:
    1. Installing the LM35 and MQ-2 sensors on the Arduino Nano.
    2. Configuring the KYL1020U module for wireless communications.
    3. Develop monitoring applications to display data.
    4. Collect data under various conditions of temperature and smoke concentration.

The collected data is analyzed to evaluate the performance of the monitoring system. Some of the aspects analyzed include:

a. Sensor Accuracy: Compare sensor data with standard measuring instruments.
b. System Responsiveness: Measures the response time from changes in temperature and smoke concentration to display in the application.
c. Wireless Communications Reliability: Evaluation of consistency and data transmission range by the KYL1020U module.

System performance is evaluated based on several criteria:

a. Accuracy: The average error (mean error) between sensor data and standard measuring instrument data.
b. Reliability: Stability of data sent and received under various conditions.
c. Response Time: The time it takes for the system to detect changes and display data in the application.

Monitoring applications are developed using programming languages that support real-time data display, such as Python or JavaScript. This application has features:

a. Real-time Data Display: Displays live temperature and smoke data.

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b. Warning Notification: Provides a warning if the temperature or smoke concentration exceeds the specified threshold.
c. Data Storage: Saves the received data for further analysis.

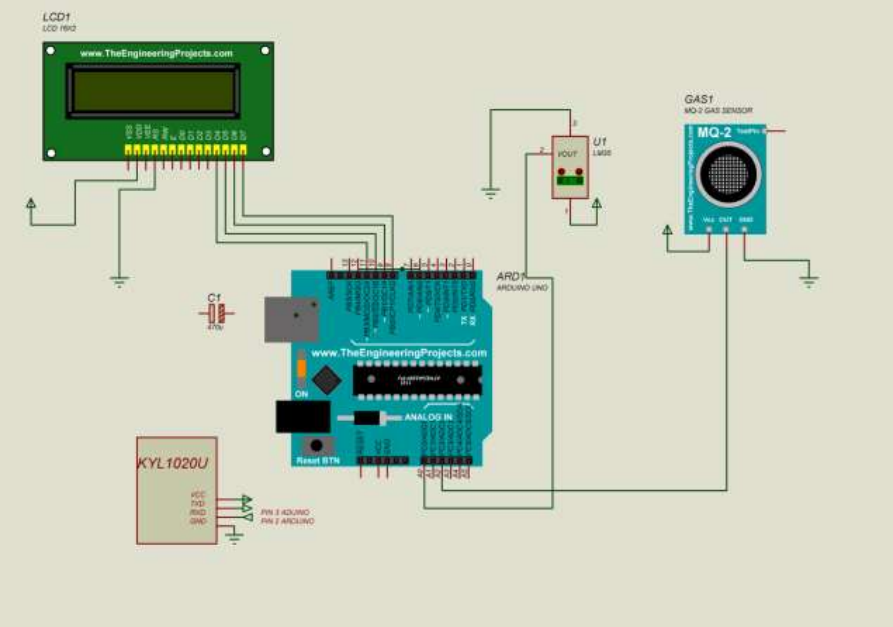

Figure 10. Complete circuit

System testing is carried out in two stages:

1. Individual Component Testing: Test each component (sensor, microcontroller, communication module) separately to ensure it functions properly.
2. System Integration Testing: Testing the entire system as a whole under controlled conditions to ensure all components work synergistically.

The individual testing steps are as follows:

1. Check Cable Connection:
   a. Make sure all cable connections are connected correctly according to the circuit schematic.
   b. Double check the polarity and connection of VCC, GND, and signals between each component.
2. Software Installation:
   a. Install Arduino IDE on your computer.
   b. Make sure the libraries for the LCD, communication module (if required), and MQ-2 sensor are installed in the Arduino IDE.
3. Program Code:
   a. Prepare the Arduino program code to read data from the MQ-2 sensor and display the results on the LCD.
   b. Add code to send data via the KYL1020U module if necessary.

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ANALYSIS AND DISCUSSION

Temperature Sensor Testing

The test results for the LM35 temperature sensor circuit are carried out by calculating the reading value of the LM35 temperature sensor which has been calibrated with the internal reference voltage value provided by the Arduino Uno board. The temperature value measurement results are displayed on the 16x2 LCD.

Figure 11. Temperature sensor test results

Smoke Sensor Testing

a. Function:The MQ-2 sensor detects the concentration of certain gases (such as LPG gas, methane and smoke) in the air and converts them into analog signals.
b. Connection:This sensor is connected to the Arduino analog pin (for example A0). The sensor leg is connected to VCC, GND, and the analog output (AO) to the Arduino analog pin.

Figure 12. Smoke sensor test results

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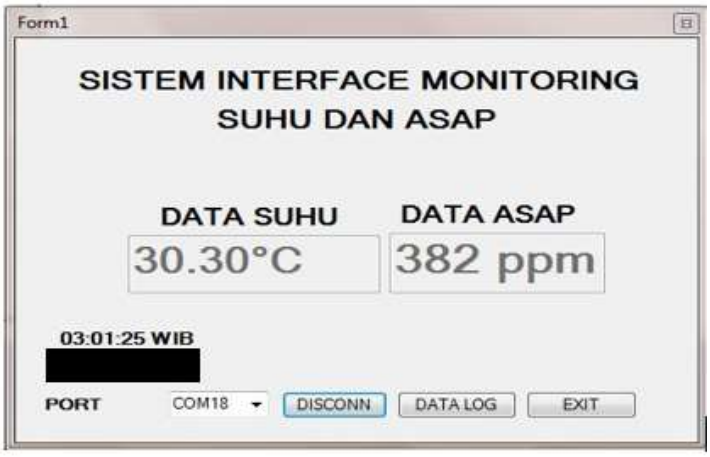

Figure 13. Display of Main Form Test Results

From the picture above you can see the initial system form where the application is able to display temperature sensor and smoke sensor data. Just by selecting the appropriate KYL 1020U receiver module hardware port and then pressing the connect button, temperature sensor data and smoke sensor data can be displayed in this form. Every change in temperature sensor data and smoke sensor data will be input into the database.

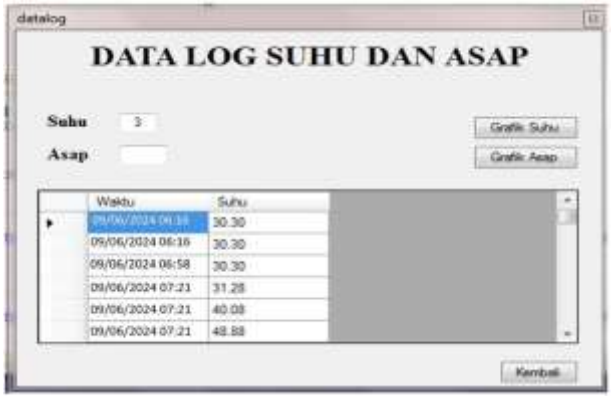

Figure 14. Display of temperature and smoke data in the database

From figure 14 it can be seen that:

a. The sensor records temperatures from several different points at almost the same time.
b. There may be drastic changes in temperature in a very short period of time.
c. There may be errors in data recording or systems that allow data to be collected several times at one time.

Temperature Fluctuation:

There was a significant temperature fluctuation from 30.30°C to 48.88°C in approximately one minute. This happened because the temperature sensor was tested by holding the sensor close to a flame for 2 seconds, and the sensor immediately responded by displaying the temperature increase in the database.

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CONCLUSION

Based on the results of research that has been carried out. The following conclusions can be drawn: The temperature and smoke detection and measuring device has been successfully designed by implementing Arduino Uno and several supporting devices, namely the LM35 sensor, MQ-2 sensor, LCD, KYL1020U. Data transmission between temperature and smoke detection devices and monitoring applications uses 433 MHz radio communication. The transferred data will be read via serial communication. The Temperature and Smoke Monitoring Interface System has been successfully designed using Microsoft Visual Studio 2010 to assist humans in monitoring several environmental objects.

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