DESIGN AND ANALYSIS OF IOT BASED INTEGRATED AIR QUALITY MONITORING SYSTEM

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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This report is submitted in partial fulfilment of the requirements for the degree of Bachelor of Electronic Engineering with Honours

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DEDICATION

A special dedication to the almighty God who made this project a success despite facing a lot of challenges and fallbacks, and to my beloved parents, who are my source of encouragement. Also, to my gracious supervisor, Ts. Mohd Shahril Izuan bin Mohd Zin, he always taught and guided me when facing many challenges and problems.

ABSTRACT

Air pollution is one of the main problems faced by all countries worldwide. The increasing pollution level is due to industries, urbanization, and a rising population that affects human health. Whenever air pollution occurs, there is a likelihood of losing a life, the risk of respiratory infections increases, and extensive damage to nature, even the agricultural crop, and commercial forest yields. But indoor air pollution is worse than outdoor air pollution because the areas enable more potential pollutants to build up more than open spaces. For this reason, the project entitled 'Design and Analysis of IoT based Integrated Air Quality Monitoring System' is proposed. It aims to design and develop an air quality monitoring system with IoT technique and analyze its effectiveness in monitoring multiple air quality parameters such as dust and gas concentrations. In order to do this, the system needs information such as humidity, temperature, gas concentration, and dust concentration to determine the system's effectiveness. All the measured data values are represented in graphical form and analyzed. The significant parts of this project are sensor and data transmission. The data collected will be passed to the Thingspeak server via the Arduino NodeMCU ESP32 microcontroller. The data can be shared and monitored in real-time. Lastly, the system will notify the user if certain parameters exceed the optimum value through the Pushbullet application. In short, the designed system can monitor the air quality of the indoor environment.

ABSTRAK

Pencemaran udara merupakan salah satu masalah utama yang dihadapi oleh semua negara di seluruh dunia. Tahap pencemaran yang semakin meningkat adalah disebabkan oleh industri, pembandaran, peningkatan populasi yang menjejaskan kesihatan manusia. Setiap kali pencemaran udara berlaku, terdapat kemungkinan kehilangan nyawa, risiko jangkitan pernafasan meningkat, dan kerosakan yang meluas kepada alam semula jadi, malah tanaman pertanian, dan hasil hutan komersial. Tetapi pencemaran udara dalaman adalah lebih teruk daripada pencemaran udara luar kerana kawasan dalaman membolehkan bahan pencemar berpotensi terkumpul lebih banyak daripada kawasan lapang. Atas sebab ini, projek bertajuk 'Reka Bentuk dan Analisis Sistem Pemantauan Kualiti Udara Bersepadu berasaskan IoT' dicadangkan. Ia bertujuan untuk merekabentuk dan membangunkan sistem pemantauan kualiti udara dengan teknik IoT dan menganalisis keberkesanannya untuk memantau pelbagai parameter kualiti udara seperti kepekatan habuk dan kepekatan gas. Untuk melaksanakan fungsi ini, sistem memerlukan maklumat seperti kelembapan, suhu, kepekatan gas dan kepekatan habuk untuk menentukan keberkesanan sistem. Semua nilai data yang diukur diwakili dalam bentuk grafik dan akan digunakan untuk analisis. Bahagian penting projek ini ialah

sensor dan penghantaran data. Data yang dikumpul akan dihantar ke pelayan Thingspeak melalui mikropengawal Arduino NodeMCU ESP32. Data boleh dikongsi dan dipantau dalam masa nyata. Akhir sekali, sistem akan memberitahu pengguna jika parameter tertentu melebihi nilai optimum melalui aplikasi Pushbullet. Pendek kata, sistem yang direka boleh memantau kualiti udara persekitaran dalaman.

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LIST OF SYMBOLS AND ABBREVIATIONS

For examples:

AQI	:	Air Quality Index
CO	:	Carbon Monoxide
CO_2	:	Carbon Dioxide
DC	:	Direct Current
GSM	:	Global System for Mobile communication
GUI	:	Graphical User Interface
IDE	:	Integrated Development Environment
IoT	:	Internet of Things
LCD	:	Liquid Crystal Display
PCA		Principal Component Analysis
PM	:	Particulate Matter
PPM	:	Parts Per Million
SBC		Single Board Computers
SBS	:	Sick Building Syndrome
SO_2	:	Sulphur Dioxide
WHO	:	World Health Organization
WSN	:	Web Sensor Nodes

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CHAPTER 1

INTRODUCTION

This chapter will discuss the project background, problem statement, objective, and scope of work. The structure of the thesis will also be included in this section.

1.1 Project Background

Air quality monitoring system has become a part of the popular element in ensuring a healthy environment and lifestyle. The development of air quality monitoring systems is one of the crucial developments for civilizations of humans. It can be used in many places such as in the factory, outdoor, houses, rooms, workplaces, etc.

In recent years, the world's air quality has become poor year by year due to the development of industrialization. It has become a significant public health concern in all countries. In 2016, it was estimated that ambient or outdoor air pollution in both cities and rural areas causes nearly 4.2 million premature deaths per year worldwide [1]. Even though outdoor air pollution is one of the primary sources that cause air quality change, indoor air pollution cannot be ignored. Indoor air pollution is considered a dangerous element for one of the world's leading causes of death, including diabetes, heart disease, stroke, pneumonia, and other chronic diseases [2].

According to the Global Burden of Disease study, 1.6 million humans died prematurely because of indoor air pollution in 2017 [3]. 3% of global deaths accounted for 6% in low-income countries [3]. Therefore, an air quality monitoring system is essential because it is a remedial action to improve air quality and is always easy to implement once airborne pollutants are detected.

Besides that, previous work and research on air quality monitoring systems include using various types of sensors such as MQ2, MQ7, MQ135, BME280, DHT11, dust particle sensors, etc. The selection of the idea and components are then decided based on the requirements so that it is suitable to meet the needs.

1.2 Problem Statement

Currently, an air quality monitoring system is essential in assessing pollution in relation to the ambient air quality standards. Air pollution can be categorized into outdoor and indoor pollution. Based on the research, we spend most of the time, which is approximately 90% indoors compared to outdoor [4]. The indoor air can be up to five times more polluted than the outside air. Besides that, indoor pollution can cause health problem that is more serious than outdoor pollution, such as irritation of the eyes, headaches, fatigue, and respiratory diseases. Hence, it was in the top five environmental dangers.

Referring to [5] and [6], there is no data analysis for the developed system. It is vital to have data analysis to provide a trustful result from the system that has been designed so that the system's effectiveness can be ensured and give a reliable reading to the users.

Therefore, it is necessary to develop an affordable, community-based, real-time air quality monitoring system with IoT-based integrated to monitor the indoor environment's air quality so that humankind's health can be ensured. All the measured data will be analyzed to determine the system's effectiveness. Also, the selected sensors are one of the factors that will affect the system's effectiveness.

1.3 Objectives of the Research

The objectives of this research are:

1. To design and develop an affordable indoor air quality monitoring system.
2. To analyze the system's effectiveness by monitoring four air quality parameters: temperature, humidity, gas concentration, and dust concentration.
3. To develop an IoT-based data processing and transmitting unit.

1.4 Scope of Work

The design and development of this project's air quality monitoring system are based on the Internet of Things (IoT) to determine and analyze the system's effectiveness using Arduino NodeMCU ESP32 and multiple sensors. However, this system focuses more on monitoring the indoor environment's air quality. The effectiveness is highly dependent on the sensors being used; the more the related sensors are deployed, the higher the effectiveness [7]. The prototype of this system will be installed in a closed room environment for a few days. DHT22 sensor, MQ135 gas sensor, and PMS5003 dust sensor will sense the surrounding air to detect the increment or decrement of temperature, humidity, gas concentration, and dust concentration. ESP32 is then collected and reads the data from those sensors by uploading programming code (C Language) from Arduino IDE software to ESP32. Four air quality parameters are monitored in real-time, and the measured data will be sent to the cloud server for analysis. Meanwhile, there are some limitations: speed of received and updated data, capacity to receive data or send notifications for the use of ThingSpeak and Pushbullet applications. In this project, three different types of air quality sensors are used.