Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF AIR QUALITY MONITORING SYSTEM

MUHAMAD FARIS NAQIB BIN MOHD JASMIN

Bachelor of Electrical Engineering Technology (Industrial Automation & Robotics) with Honours

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A project report submitted
in partial fulfilment of the requirements for the degree of
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I hereby declare that I have checked this project report and, in my opinion, this project report is adequate in terms of scope and quality for the award of the degree of Bachelor of Electrical Engineering Technology (Industrial Automation & Robotics) with Honours.

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DEDICATION

This report is dedicated to my beloved parents and family member, thank you for showering me with your continuous love and devotion. It will always be remembered and kept in my heart. They always support me through thick and thin throughout the process of completing this report. Next, to my Supervisor, thank you for all the knowledge and support. Your patience, support and words of encouragement gave me enormous strength throughout the whole project. Then, to my seniors, my bestfriends and fellow friends, thank you for offering guidance and directions when I am at also lost the advice, support and motivations for the start of this project until the end of the project

ABSTRACT

Today, air pollution is the world's most serious environmental health problem. Air pollution has a detrimental effect on human health, the environment, and ecosystems. The air is contaminated by toxic gases released by industry, vehicle emissions, and an increase in harmful gas and particulate matter concentrations. Air pollution can result in a variety of serious health problems in humans, including respiratory, cardiovascular, and skin diseases. Air pollution has developed into the most serious environmental health hazard, and monitoring of air quality has increased. In an attempt to contribute technological instruments, this work proposes an IoT-based system for monitoring the most novice health pollutants using low-sensor systems, as proposed in the World Health Organization recommendations. The proposal presents the development in the hardware layer of a device able to measure the concentrations of the following pollutants: Particulate Material (PM 2.5), Carbon Dioxide, Carbon Monoxide, Temperature, humidity and utilizing three sensors, respectively, DHT11, Dust Sensor and MQ-135. Recently, mobile technologies, especially the Internet of Things, data and machine learning technologies, positively impact the way we manage our health and lifestyle. With the production of IoT-based portable air quality measuring devices and their widespread use, people can instantly monitor the air quality in their living areas. In this study, a real-time mobile air quality monitoring system with air parameters such as Particulate Matter (PM 2.5), CO, CO2, humidity and temperature is proposed. The device will be equipped with a WeMos D1 Wi-Fi R3 microcontroller, which includes a Wi-Fi interface that enables data to be sent to a cloud-based server, such as the ThingSpeak webpage. It is important to note that what differentiates the proposal from others is implementing periodic notifications and sending alerts for cases in which a given pollutant has reached the maximum acceptable concentration.

ABSTRAK

Hari ini, pencemaran udara adalah masalah kesihatan alam sekitar yang paling serius di dunia. Pencemaran udara mempunyai kesan buruk terhadap kesihatan manusia, alam sekitar dan ekosistem. Udara dicemari oleh gas toksik yang dikeluarkan oleh industri, pelepasan kenderaan, dan peningkatan kepekatan gas berbahaya dan zarah. Pencemaran udara boleh mengakibatkan pelbagai masalah kesihatan yang serius pada manusia, termasuk penyakit pernafasan, kardiovaskular dan kulit. Pencemaran udara telah berkembang menjadi bahaya kesihatan alam sekitar yang paling serius, dan pemantauan kualiti udara telah meningkat. Dalam usaha untuk menyumbang instrumen teknologi, kerja ini mencadangkan sistem berasaskan IoT untuk memantau pencemar kesihatan yang paling baru menggunakan sistem sensor rendah, seperti yang dicadangkan dalam cadangan Pertubuhan Kesihatan Sedunia. Cadangan itu membentangkan pembangunan dalam lapisan perkakasan peranti yang dapat mengukur kepekatan bahan pencemar berikut: Bahan Zarah (PM 2.5), Karbon Dioksida, Karbon Monoksida, Suhu, kelembapan dan menggunakan tiga penderia, masing-masing, DHT11, Penderia Habuk dan MQ-135. Baru-baru ini, teknologi mudah alih, terutamanya Internet Perkara, data dan teknologi pembelajaran mesin, memberi kesan positif kepada cara kami mengurus kesihatan dan gaya hidup kami. Dengan pengeluaran peranti pengukur kualiti udara mudah alih berasaskan IoT dan penggunaannya yang meluas, orang ramai boleh memantau kualiti udara di kawasan kediaman mereka dengan serta-merta. Dalam kajian ini, sistem pemantauan kualiti udara mudah alih masa nyata dengan parameter udara seperti Zarah (PM 2.5), CO, CO2, kelembapan dan suhu dicadangkan. Peranti ini akan dilengkapi dengan mikropengawal WeMos D1 Wi-Fi R3, yang termasuk antara muka Wi-Fi yang membolehkan data dihantar ke pelayan berasaskan awan, seperti halaman web ThingSpeak. Adalah penting untuk ambil perhatian bahawa perkara yang membezakan cadangan daripada yang lain ialah melaksanakan pemberitahuan berkala dan menghantar amaran untuk kes di mana bahan pencemar tertentu telah mencapai kepekatan maksimum yang boleh diterima.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

In this chapter, details regarding the whole project are explained. This includes the issues, which the research is concerned, the problem statement of issue being studied, the aims and objectives of the study and the rationale and significance of the study. Moreover, this section also explained the scope, research questions and organization of the study. Therefore, this section consists of overview, background of study, problem statement, objective and scope of the study. Other than that, this section also provided extra information that are related to the project such as the definition of air quality monitoring using IoT and the table of air quality index in Malaysia.

1.2 Background of Study

According to Institute for Medical Research and Occupational Health, Zagreb, Croatia, air is the inevitable transfer medium of environmental pollution to people while polluted food or water can be avoided, the air is inevitably breathed in any environmental in which people stay or through which they pass. They claimed that pollution comes from both indoor and outdoor sources. Indoor pollution is caused by human behavior such as cooking, cleaning, and smoking, while outdoor pollution is caused by pollutants produced by industrial areas, buildings, and furnishing materials.

In the middle of century, air quality research at work was a natural part of the job. Smog episodes in large cities and industrial areas demonstrated that not only workers were exposed to polluted air, but that all citizens, including small children, pregnant women, sick and elderly people, and others, were constantly polluted by heating, industry, traffic, and natural disasters. Because every living organism requires air every second, no living creature can exist without it, and that air must be fresh and clean.

Air pollution can harm us when it accumulates in the air in high enough concentrations. Millions of people live in areas where urban smog, particle pollution and toxic pollutants pose serious health concerns. People exposed to high enough levels of certain air pollutant may experience:

- Irritation of the eyes, nose and throat.
- Wheezing, coughing, chest tightness and breathing difficulties.
- Worsening of existing lung and heart problems such as asthma.
- Increased risk of heart attack.

Additionally, chronic exposure to air pollution can result in the development of cancer and damage to the immune, neurological, reproductive, and respiratory systems. In severe cases, it may even result in death. Air pollution is a problem that affects everyone. However, certain groups of people, particularly those who are sensitive to common air pollutants such as particulates and ground level ozone, may experience adverse effects. Sensitive populations include children, the

elderly, those who engage in physical activity outdoors, and those who suffer from heart or lung diseases such as asthma.

The earth's atmosphere is made of a delicate balance of naturally occurring gases that trap a portion of the sun's heat near the surface. This greenhouse effect contributes to the stability of the earth's temperature. Unfortunately, mounting evidence indicates that humans have disrupted this natural equilibrium by producing large amounts of several of these greenhouse gases, including carbon dioxide and methane. As a result, the earth's atmosphere appears to be trapping more of the sun's heat, increasing the planet's average temperature, a phenomenon known as global warming. Global warming, scientists believe, will significantly affect human health, agriculture, water resources, forests, wildlife, and coastal areas.

Haze is created when sunlight comes into contact with microscopic pollution particles in the air. Haze obscures our vision's clarity, colour, texture, and form. Certain pollutants that contribute to haze are released into the atmosphere directly by power plants, industrial facilities, trucks, automobiles, and construction activities. Others are formed when gases emitted into the air, such as sulphur dioxide and nitrogen oxide, collide with one another and form particles as they travel downwind.

The rapid advancement of The Internet of Things (IoT) and sensor techniques has sparked renewed interest in air quality measurements. Cities face interesting challenges and problems in meeting socioeconomic development and quality of life goals today, and the concept of "smart cities" addresses these issues. The smart city is inextricably linked to a strategy for addressing the problems that come with rapid urbanization. The Internet of Things (IoT) is a network in which physical objects are linked to one another or to larger systems. This network gathers large amounts of data from various devices we use in our daily lives and transforms it into usable information.

The Internet of Things (IoT) is a rapidly evolving concept that supports a wide range of areas and applications, including health, education, agriculture, industry, and environmental monitoring.

1.3 Problem statement

Currently, air pollution is the world's most significant environmental issue. Air pollution has a detrimental effect on human health, the environment, and ecosystems. Air pollution is caused by toxic gases released by industry, vehicle emissions, and increased concentration of harmful gases and particulate matter in the atmosphere. The air pollution that contain in our ecosystem is Carbon monoxide, Particulate Matter, Sulphur Dioxide, humidity and temperature. Air pollution can result in various serious health problems in humans, including respiratory, cardiovascular, and skin diseases.

Today, where air pollution has become the most significant health risk for the environment, the interest in air quality monitoring is increasing. Mobile technologies recently positively impact how we manage our health, particularly on the Internet of Things, data technologies, and machine learning. With the production and widespread application of portable air quality devices based on IoT, air quality can be instantly monitored by people in their living areas.

1.4 Objectives

The objective is to build an air quality monitoring based on IOT to ease people in an area. In order to complete this project, the following objectives have been considered.

1. To simulate an air quality monitoring system in indoor and outdoor environment.
2. To detect gases and particle dust that have in air using the air quality sensors.
3. To analyze data and readings of gases found in air using IoT platform monitoring.

1.5 Scope of the study

The scope of this project are as follows:

a) Develop and design a monitoring system project prototype for gas concentration, particle dust in the air, Temperature and humidity.

b) This project will be carried out at the TAMAN TASIK UTAMA, located in Durian Tunggal, Malacca.

c) The main controller used is Arduino WeMos D1 Wi-Fi R3.

d) At the end of this research project, a prototype and hardware of a project that can monitor the concentration of gases and particle dust found in air is developed.

1.6 Significant of the Study

This project aims to create a prototype that uses an Arduino Wemos D1 Wifi as a controller to monitor the gas concentration in the air in the environment. Normally, the government will alert people about the air quality. However, this monitoring of air quality will save time and sooner alert people about air quality level.

There are numerous other implications of the study for this prototype. The MQ-135 Air Quality Gas Sensor Module on the control unit is a significant element. This will help to reduce the time constraint.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this chapter, past researches that are related to the research project research such as journals, articles, news, books and websites that are related to the research are discussed. There are few sections in this chapter explaining about air pollution, effects of air pollution and case of air pollution in Malaysia.

2.2 What is Air Pollution

Air pollution is the presence of substances in the atmosphere that are harmful to humans and other living things, as well as causing chaos on the climate and natural resources. Air pollutants come in various forms, including gases (ammonia, carbon monoxide, Sulphur dioxide, nitrous oxides, methane, and chlorofluorocarbons), particulates (both organic and inorganic), and biological molecules (Comunian *et al.*, 2020)(Sun, Hong and Wold, 2010). Air pollution can cause disease, allergies, and even death in humans; it can also harm other living organisms such as animals and food crops, and it can inflict damage on the natural and built environments (for example, climate change, ozone depletion, and habitat degradation) (for example, acid rain). Air pollution can be caused by both human activity and natural processes.

Air pollution is a significant risk factor for various pollution-related diseases, including respiratory infections, heart disease, chronic obstructive pulmonary disease (COPD), stroke, and lung cancer. The effects of low air quality on human health are far-reaching and mainly affect the breathing and cardiovascular systems. Individual responses to air pollutants vary depending on the type of pollutant, the degree of exposure, and the individual's health status and genetics. In 2008, the Blacksmith Institute's World's Worst Polluted Places reported identified "indoor air pollution and poor urban air quality as two of the world's most serious toxic pollution problems"(Blacksmith Institute, 2008). Outdoor air pollution alone is responsible for 2.1 to 4.21 million deaths each year. Globally, air pollution kills approximately 7 million people each year and is the world's single most significant environmental health risk. The scale of the air pollution crisis is staggering: 90% of the world's population breathes polluted air to some extent. Although the health consequences are severe, the issue is frequently handled haphazardly.

The global economy is estimated to lose $5 trillion annually as a result of lost productivity and lowered quality of life caused by air pollution. There are numerous technologies and strategies for reducing air pollution (Quarmby, Santos and Mathias, 2019). International and national legislation and regulations have been implemented to control air pollution and mitigate its effects. In cities, strict enforcement of local laws has resulted in significant improvements in public health. At the international level, some of these efforts have been successful, such as the Montreal Protocol, which limited the release of harmful ozone-depleting chemicals, or the 1985 Helsinki Protocol, which limited sulphur emissions, while others, such as international action on climate change, have been less successful.

Table 2.1 comparison of pollutant concentration and sub-indices

Air Quality Index (AQI)							
AQI index	NO_2 (ppb)	SO_2 (ppb)	O_3 (ppm)	O_3 (ppm)[1]	PM_{10} (ug/m^3)	$PM_{2.5}$ (ug/m^3)	CO (PPM)
Good (0~50)	0-53	0-35	0-0.054	-	0-54	0.0-15.4	0-4.4
Normal (51~100)	54-100	36-75	0.055-0.07	-	55-125	15.6-35.4	4.5-9.4
Unhealthy for sensitive groups (101~150)	101-360	76-185	0.071-0.085	0.125-0.164	126-254	35.5-54.4	9.5-12.4
Unhealthy for all groups (151~200)	361-649	186-304	0.086-0.105	0.165-0.204	255-354	54.5-15.4	12.5-15.4
Very unhealthy (201~300)	650-1249	305-604	0.106-0.2	0.205-0.404	355-424	150.5-250.4	15.5-30.4
Harmful (301~400)	1250-1649	605-804	[2]	0.405-0.504	425-504	250.5-350.4	30.5-40.4
Harmful (401~500)	1650-2049	805-1004	[2]	0.505-0.604	505-604	350.5-500.4	40.5-50.4

2.2.1 Carbon Dioxide in daily life

Carbon dioxide is a chemical compound made up of a single carbon atom and two oxygen atoms. It is a colourless gas with a faint, sharp hue and a slightly sour flavor (Lighting, Poisoning and Alloys, 2004). It is a trace element in the earth's atmosphere formed during the combustion of carbon-containing materials, fermentation, and respiration of animals and is utilized by plants during carbohydrate photosynthesis. Photosynthesis is necessary for the survival of life on earth because humans and animals rely on plants for food.

Hypercapnia is a medical term for CO2 poisoning. This occurs when the blood contains an abnormally high concentration of CO2. Early signs of hypercapnia include skin flushed, muscle