Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF IOT BASED ON AIR QUALITY MONITORING FOR TOURISM

NUR HAFIZA HANIM BINTI JA'AFFAR

Bachelor of Electronics Engineering Technology (Telecommunications) with Honours

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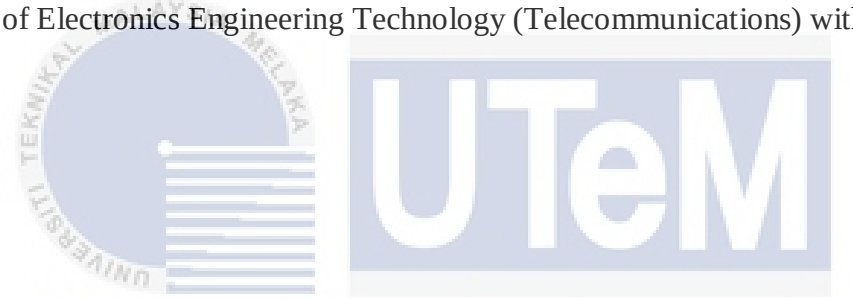
A project report submitted
in partial fulfillment of the requirements for the degree of
Bachelor of Electronics Engineering Technology (Telecommunications) with Honours



Faculty of Electrical and Electronic Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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DEDICATION

Alhamdullilah, with his abundance and permission this final year project was completed. To my beloved mother and family members who gave so much support and encouragement, "You always In My Memory". For my Supervisor as well who providing support toward this success greatly appreciated it. May Allah bless us with happiness and success.

ABSTRACT

The tourism industry in Malaysia is one of the major leading sectors in economic development. Malaysia was once ranked 9th most visited country in the world by tourists. Tourism sector and air pollution are interrelated. Polluted air can negatively affect the tourism sector in return, the development of tourism sector can reduce air quality. High number of transportation and vehicles due to tourism activity may produce harmful gases that affect human health. This project aims to develop an IoT-based air quality monitoring system that provides air quality information at specific tourism areas through mobile application. This project has developed an air quality monitoring system by using MQ135 sensor to detect harmful gases in the air and used NodeMCU ESP8266 to able data deliver through Wi-Fi connection to IoT server. This system used BLYNK platform to create an app in the Google play store to allow tourists to view information about air conditions in the area they want to visit by downloading the app. The air quality monitoring system hardware would put at tourist spots, and the output from the sensor would remotely display on the BLYNK interface. In short, this project development divides into two parts, which are hardware development and software development. For hardware development, it involves a sensor, a microcontroller and Wi-Fi module called a sensing circuit and software development involves an IoT platform to create a mobile application. This system performance was tested by comparing data from sensing circuit with data from AirVisual application. As a result, the performance shows the sensing circuit ability to read air quality data same as AirVisual application and has the potential to be used as outdoor air quality monitoring system This project can help tourists to take care of their health and plan a suitable place to visit in accordance with their health conditions. The development system has potential to be commercialized as quality monitoring device for tourism purposes.

ABSTRAK

Industri pelancongan di Malaysia adalah salah satu sektor utama dalam pembangunan ekonomi. Malaysia pernah menjadi tempat ke-9 negara yang paling banyak dikunjungi di dunia oleh pelancong. Udara yang tercemar boleh mempengaruhi sektor pelancongan, tetapi peningkatan dalam pengembangan sektor pelancongan dapat mempengaruhi kualiti udara. Oleh itu, ia menyebabkan peningkatan dalam pengangkutan di mana kenderaan dapat menghasilkan gas berbahaya yang mempengaruhi kesihatan manusia. Projek ini telah membangunkan sistem pemantauan kualiti udara dengan menggunakan sensor MQ135 untuk mengesan gas berbahaya di dalam udara dan menggunakan NodeMCU ESP8266 untuk membolehkan data dihantar melalui sambungan Wi-Fi ke pelayan IoT. Sistem ini menggunakan platform BLYNK untuk membuat aplikasi di "Google Playstore" untuk membolehkan pelancong melihat maklumat mengenai keadaan udara di kawasan yang ingin mereka kunjungi dengan memuat turun aplikasinya. Sistem peranti pemantauan kualiti udara akan diletakkan di tempat-tempat pelancongan, dan bacaan dari sensor akan dipaparkan dari jarak jauh di aplikasi BLYNK. Ringkasnya, pembangunan projek ini terbahagi kepada dua bahagian, iaitu pembinaan peranti dan pengembangan perisian. Untuk pembinaan peranti, ia melibatkan sensor, mikrokontroler dan modul Wi-Fi yang disebut litar pengesan (sensing circuit) dan pengembangan perisian melibatkan platform IoT untuk membuat aplikasi mudah alih. Prestasi sistem ini telah diuji dengan membandingkan data daripada "sensing circuit" dengan data daripada aplikasi AirVisual. Hasilnya,ia menunjukkan keupayaan "sensing circuit" untuk membaca data kualiti udara sama seperti aplikasi AirVisual dan berpotensi untuk digunakan sebagai sistem peranti pemantauan kualiti udara luar. Projek ini dapat membantu pelancong menjaga kesihatan mereka dan merancang tempat yang sesuai untuk dikunjungi sesuai dengan keadaan kesihatan mereka. Sistem ini berpontensi untuk dikomersialkan sebagai alat pemantauan kualiti untuk tujuan pelancongan.

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LIST OF ABBREVIATIONS

API	-	*Air Pollution Index*
API	-	*Air Quality Index*
CO2	-	*Carbon Dioxide*
LPG	-	*Liquefied Petroleum Gas*
MCU	-	*Microcontroller Unit*
MCO	-	*Movement Control Order*
NO2	-	*Nitrogen Dioxide*
O3	-	*Ozone*
ppb	-	*Part per billion*
PPM	-	*Part per Million*
PM10	-	*Particular matter 10*
PM2.5		*Particular matter 2.5*
SO2	-	*Sulphur Dioxide*
SOC	-	*System on Chip*
V	-	*Voltage*
WSN	-	*Wireless sensor network*

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

In this chapter, the overview of the project would briefly discussed. This chapter would described the problem statement, objectives of the project, scope, and the report structure.

1.1 Research Background

Poor air quality because of polluted air. Polluted air is the presence of solid particles and gases in the atmosphere that can be harmful to human health. We are unable to control this situation because of these gases that come from car and truck exhaust, factories, dust, volcanoes and wildfires. Furthermore, bad air quality can affect the tourism industry because tourists will be suspicious of local service providers when they recognize the destination having poor air quality, which can result in a bad reputation for our country. Other than that, poor air quality can damage tourist development by inducing negative psychological states in tourists, damaging the tourist experience, decreasing tourism demand and reducing tourist arrival to our country.

To overcome this problem, the tourists need to be guided or get information about a good air presence to the place that they can visit without harm. Therefore, the aim of this project is to develop an IoT based on air quality monitoring system for tourism industry. We propose an improved method of traditional air quality monitoring by embedding the IoT concept into the system. This concept has been widely ventured in many recent related

works. Manyresearchers used the IoT concept to provide cloud information to ensure real-time data was monitored.

This project is implemented in two main phases, which are hardware development and software development. For hardware it will involve a sensor, a microcontroller with Wi-Fi module while software development will involves air quality measurement to IoT platform. The sensor will measure the level of fresh air and be controlled by microcontroller. Once data is collected, it will be sent to another app to display information about air quality index to tourists, and it is convenient for them to plan a safe journey. The development project will be tested by using real data to ensure that the system meets the functional requirement. The sensor will be tested to observe if the system can identify the command or not.

1.2 Problem Statement

The Ministry of tourism admits that polluted air due to haze in some areas has recently affected tourist arrival to Malaysia to some extent based on the m-star newspaper clipping on 5 October 2015 [33]. This shows that air quality must be taken into account as an important factor in the taking care of potential tourists, as it can give the competitiveness for tourism destinations. According to "A survey on air quality monitoring using internet of things" from [1] due to the increase in the emission of smoke from vehicles and industries, it increases the air density of polluted day by day in the environment, which can create health issues. Moreover, Malaysia is the 9th most visited country in the world by tourists based on the star newspaper clipping on 17 February 2012 [32]. The increased development of tourism sector also one of the factor lead to poor air quality where it has led to the increases in transportation which vehicle produce harmful gases such as CO2 that can affect human health.

Therefore, to avoid harmful gases that can affect tourist health, the tourist spot needs a system that can read the AQI level in the air. To solve this problem, tourist places need an air quality monitoring system to give tourists awareness of where they can prepare for or plan their journey.

1.3 Project Objective

The aim of this project is to develop an IoT-based air quality monitoring system for tourism industry. There are three objectives as listed below;

a) To develop an air quality sensing circuit by using NodeMCU and MQ135 sensor.

b) To develop a mobile application for air quality monitoring system using Blynk.

c) To analyse the performance of the air quality monitoring system through real testing.

1.4 Scope of Project

The scope of work for the project are as follows:

a) MQ135 will be mounted together NodeMCU to make a sensing circuit to read the AQI level in the particular area.

b) Create a mobile application with Blynk and publish it in the Google play store or shared with multiple user.

c) Sensing circuit being tested in an outdoor environment to get the real-time data. This data was collected in two different areas to assess their performance.

d) The sensing circuit will be placed at a high building to make it easier for the sensor to detect if there have any contamination in the air, this is because the mixture of harmful gases in the air spreads quickly and evenly. In this report, the sensing circuit is put at 1.47 metres high.

e) Tourist spots just need one sensing circuit to read the level of fresh air because we assume there is enough movement of air due to convection, the gas sensor works on the place it is mounted.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The level of fresh air is very important to humans, by which it benefits to the respiration of living creatures. To prevent humans from harmful chemicals released from polluted air, there are many development IoT-based air pollution monitoring systems found in the literature. However, to the best of our knowledge, there is no air monitoring system specifically designed and develop for tourism industry purposes. This chapter reviews articles and related works on IoT based on air quality monitoring systems from previous works

2.2 Overview of IOT-based Air Quality Monitoring Systems for tourism

World health organization (WHO) in 2014 has estimated that polluted air can kill seven million people worldwide every year according to [2]. It is stated in [3] that the earth's atmosphere is full of air which contains gases such as Nitrogen, Oxygen, Carbon Monoxide and traces of some rare elements. The presence of these contaminants in the atmosphere at certain level can harm human, animals and plant. Tourism is evidently one of critical contributors to polluted air in Taiwan [4]. Ironically, polluted air seems to drive tourists away due to poor air quality. This phenomenon is likely to decline the demand for outdoor leisure activities. According to the authors in [4] and [5], PM2.5 concentrations and SO2 emissions are the culprits of poor air quality in Chinese cities where PM2.5 caused by tourism development while SO2 emissions caused by urban industrial. The development of tourism sector affected the air quality in the tourism by transportation as well as the residential area.

However tourism area needs to have an air AQI indicates the level of air quality in the region stated in [6] and surprisingly the pandemic of COVID-19 helps decreasing the CO2 and NO2 levels due to vehicles traffic reduction during movement control order (MCO). In addition, a study conducted in Kuala Lumpur during MCO period [6] the implement of MCO helps reducing polluted air in the country by 1 to 68%. "Haze hurting Malaysia's tourism" made headline in the newspaper on September 25th 2019 and a study made in [7], the haze is a common phenomenon afflicting Southeast Asia (SEA), including Malaysia, and has occurred almost every year also the concentration caused air pollution in Malaysia is quite similar to what happen in China such as PM10, CO, NO2 and SO2.

In [8], the author explains the important of parameters that are considered in the proposed framework such as CO2, SO2, NO2, smoke and LPG. CO2 is colourless, odourless gas and non-combustible gas and have capabilities in interfering the availability of oxygen also CO2 is a gas essential to life in the planet because it is one of the most important elements evolving photosynthesis but the concentration of CO2 has increased due mainly to massive fossil fuels burning as stated in [8]. SO2 is a colourless gas, detectable by the distinct odour and taste, high concentration of these gas may cause respiratory problems, especially in sensitive groups, like asthmatics [8]. The NO2 is a brownish gas, easily detectable for its odour, very corrosive and highly oxidant [8]. NO2 produced by fossil fuels burning plants whereby the gas is released freely to the atmosphere, concentrations of NO2 may lead to respiratory problems.

This matter increase the awareness of safety level of air, thus enhancing the development of air pollution monitor systems which several countries have started implementing IOT for the purpose of monitoring air pollution according to [1]. IOT plays a

vital role to find application in integrating interrelated computing devices by bringing the mechanical and digital aspects together because the present monitoring systems for air quality involve equipment's are difficult to install, heavy and expensive with IoT tools it can deliver a system to quantify, report air quality with devices that are efficient and deliver accurate data constantly based on [1]. Most of the system use ESP8266 Wi-Fi module to monitor the air quality over a web server using internet [8], [3], [9] and [10], The gas sensor will interact with the microcontroller to process the data and send it over the application. In [11], [12], [13] and [14], the authors proposed to monitor the level of pollution using Raspberry-Pi and 3 different types of gas sensor. In [15], [16] and [17], the authors proposed a monitoring system by utilizing ESP8266 module, as a result user can monitor the air quality using smartphone connected through ESP82266 Wi-Fi module so that air condition being monitored every time. Authors in [18] proposed to monitor air over a local host using internet and activate alarm when quality goes down with PIC16F877A.

According the authors in [19] and [9], the measurement of dangerous gas will based on API where it focus on four pollutant index component which is atmospheric aerosol particles, CO2, O3, NO2 and SO2, as shown in Figure 2.1. In [20], the authors developed a software named Air Excellence Guide to determine AQI based on $PM_{2.5}$ and PM_{10} as shown in Table 2.2. The authors in [17] calculated AQI based on the amount of 5 types of gases which are O3, NO2,CO,SO2 and particulate matter(PM_{10} and $PM_{2.5}$). Furthermore, in [3] there are 2 type pollutants which is primary and secondary pollutants, as for primary pollutants mean released directly into atmosphere and secondary pollutants produced when the primary pollutant reacts with other atmospheric chemicals. Table 2.1 illustrates the effect of exposure to carbon monoxide from author in [21]. In addition, [6] show a table of AQI

measurement for PM concentration that can be useful as reference since PM10 is one of the cause of air pollution in Malaysia illustrate at figure 2.2.

API	Air Pollution Level
0 - 50	Good
51 - 100	Moderate
101 - 200	Unhealthy
201 - 300	Very unhealthy
301 - 500	Hazardous
500+	Emergency

Figure2.1: The Air Pollution Index precautious level

Table 2.1: Effects of Exposure to Carbon Monoxide in Various Concentrations

PPM	Time	Information
35-50	8 hours	The maximum concentration permitted for continuous exposure for 8 hours according to OSHA
200	2-3 hours	Headache
400	1-2 hours	Headache
800	10 – 15 minute	Dizziness, vomiting
1600	20 minutes	Headache, dizziness, death within 1 hour
3200	5-10 minutes	Headache, dizziness, death within 1 hour
6400	1-2 minutes	Headache, dizziness, death within 1 hour
6000-8000	5 minutes	Incapacitation
12800	2-3 sniff	Unconscious
12800	1-3 minute	Death