CARBON DIOXIDE MEASUREMENT VIA INFRARED ABSORPTION WITH DISPLAY

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DEDICATION

Special dedication to my loving parents Mohd Said b. Senin and Puan Rohani bt Kardi, all my siblings, my kind hearted
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ABSTRACT

The development of this project is about the carbon dioxide measurement via infrared absorption with display. It is an upgrade project where the output of this measurement is display through the LED in form of voltage. Based to the phenomena which is carbon dioxide molecules absorb the infrared radiation, this project is important to identified the quantity of carbon dioxide in the air surrounding. The large quantity of the carbon dioxide can cause the greenhouse effect to the earth which is earth warming. The large quantity of the carbon dioxide in the air over the normal quantity also give negative impact to the human life such as tired, uncomfortable, and effect the body system. This is because the less quantity of the oxygen slows down the flow of the blood in the body system and affected the entire human limb. Via the identification of the quantity of the carbon dioxide through the development of this project, the method of avoid can be taken to control the contains of carbon dioxide from over the normal quantity especially in the closed area. Start from the development of the infrared transmitter and infrared receiver circuit, and also the display circuit, all this entire circuit is combined to identify the infrared absorption by the carbon dioxide. More carbon dioxide in the air, more infrared is absorbed. The receiver part will detect the unabsorb infrared to be process and displayed trough the LED in a form of voltage value.

ABSTRAK

Pembangunan projek ini adalah mengenai pengukuran karbon dioksida melalui serapan inframerah dengan paparan. Ia merupakan sebuah projek yang dinaiktaraf daripada prototaip asal di mana hasil daripada pengukuran karbon dioksida dipaparkan melalui LED dalam nilai voltan. Berdasarkan kepada fenomena serapan infrared oleh karbon dioksida, projek ini memainkan peranan yang penting untuk mengenalpasti kuantiti karbon dioksida dalam udara kerana lebihan kuantiti karbon dioksida dalam udara akan menyebabkan kesan rumah hijau terhadap bumi dan menjadikannya semakin panas akibat daripada peningkatan suhu. Kuantiti karbon dioksida yang melebihi paras biasa dalam udara juga memberikan impak yang negatif dalam kehidupan manusia seperti keletihan, ketidakselesaan, dan menjejaskan sistem tubuh badan. Ini kerana, kandungan oksigen yang kurang dalam udara akan menyebabkan peredaran darah yang perlahan dan melemahkan semua anggota badan. Melalui pengenalpastian kuantiti karbon dioksida ini menerusi projek yang dihasilkan, langkah-langkah mengatasi dapat diambil bagi mengawal kandungannya daripada melebihi paras normal terutamanya di kawasan yang tertutup. Bermula dari pembinaan litar pemancar dan penerima bagi cahaya infrared serta litar paparan, kesemua litar ini digabungkan untuk mengukur kadar penyerapan infrared oleh karbon dioksida. Semakin banyak karbon dioksida dalam udara, maka semakin banyak cahaya infrared yang diserap. Bahagian penerima akan menerima cahaya infrared yang tidak diserap dan nilai ini seterusnya akan dipaparkan menerusi paparan LED dalam nilai voltan.

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LED	Light Emitting Diode
PCB	Printed Circuit Board
CO_2	Carbon Dioxide
H_2CO_3	Acid Carbonate
$HCO3^-$	Bicarbonate
CO_3^{2-}	Carbonate
TLV	Threshold Limit Value
USDA	United State Department of Agriculture
NIOSH	National Institute for Occupational, Safety and Health
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning
OSHA	Occupational, Safety, and Health Administration
GWT	Global Warming Theory
RCRS	Regenerative Carbon Dioxide Removal System
IR	Infrared
UV	Ultraviolet
IrDA	Infrared Data Association
IC	Integrated Circuit
DC	Direct current
ADC	Analogue Digital Converter

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CHAPTER I

INTRODUCTION

1.1 Introduction

This project involves researching about the carbon dioxide measurement via infrared absorption with display. It is intended to upgrade Prototype 1 where circuit improvement will be done and display or indicator will be added to show the measurement's values of the air quality. From previous work, by adjusting the amount of carbon dioxide in containment, the absorption of these various amounts can be used to measure carbon dioxide content. And this is as to simulate either for open air or for a concealed room quality monitoring. The idea of this project comes from the phenomena of the infrared absorption by carbon dioxide. The effect of infrared radiation absorption causes the earth warming.

Carbon dioxide is known as a chemical compound, colorless, odorless and tasteless gas that is about one and one-half times as dense as air under ordinary conditions of temperature and pressure. It does not burn, and under normal conditions it is stable, inert and nontoxic. It will however support combustion of magnesium to give magnesium oxide and carbon. Although it is not a poison, it can cause death by suffocation if inhaled in large amount. It is a fairly stable compound but decomposes at very high temperature into carbon and oxygen.

Electromagnetic radiation having a wavelength in the range from 75×10^{-6} cm to $100,000 \times 10^{-6}$ cm. Infrared rays thus occupy that part of the electromagnetic spectrum with a frequency less than that of visible light and greater than that of most radio waves, although there is some overlap. The name infrared means beyond the red, or lower-frequency which is longer wavelength, and end of the visible spectrum. Infrared radiation is thermal, or heat radiation. Infrared radiation has the same properties as visible light, being reflected, refracted, and capable of forming an interference pattern. Infrared radiation is typically produced by objects whose temperature is above 10°K.

The development of this project is very important as it focuses to the carbon dioxide's measurement of close area such as lecture hall, office, library and anymore. By applying the infrared radiation, the quantity of carbon dioxide can be observed. The more infrared is being transmitted; the more carbon dioxide will be absorbed. The receiver will receive the low infrared light to be analysed and then it will display the observed measurement value. Further action is needed if the quantity of carbon dioxide is in large amounts.

1.2 Problem Statement

Large amount of carbon dioxide's quantity can effected human being. As have been told earlier, it can cause a death for inhaled by suffocation. The main reason and purpose of developing this project is to measure and observe the quantity of carbon dioxide in the close area such as hall, meeting room, lecture hall and many more by using the infrared absorption.

The previous Prototype shows it ability to measure and observe the quantity of carbon dioxide by using various sample of carbon dioxide which consist various quantities. Square wave signal is chosen by the Prototype as the infrared signal

transmitting between the transmitter and receiver since any change occur during the measurement is much easier to be detected than other wave. Through the analysis, it is improved that there is change occur to the wave during the measurement of carbon dioxide's sample where it shows that the carbon dioxide is reacted to the infrared signal via absorption. However, there is certain problem faced by the previous Prototype where the transmitting signal is unsmooth square wave signal for both transmitter and receiver. This is because of the noise that affected the wave. Even the filter circuit have been added to the receiver part to reduce the noise, the display showed by the oscilloscope is still the unsmooth square wave signal.

1.3 Objective

The objectives of this project are:

- Learned and study the specifications of infrared light and carbon dioxide.
- Construct and analyse the suitable infrared transmitter, infrared receiver and display.
- Improving the circuit of previous Prototype.
- Learned the function of infrared transmitter, infrared receiver and display.
- Apply the theory of infrared absorption to carbon dioxide in the project
- Make analyze and compare the ratio of infrared absorption to carbon dioxide.

1.4 Scope of the Project

The scope of this project is only involved the measurement of carbon dioxide's gas by infrared, even it maybe can detect other gases in the air. So, the suitable infrared wave is required for this purpose.

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As the improvement of the previous project, this project is able to provide the smooth square wave signal of the infrared transmitter and the infrared receiver. The circuit is also more simple and uncomplicated. Beside, it does not need any filter since there is no noise observed to the signal. So, the measurement can be done much easier through the oscilloscope. However, the additional of the display allow the measurement's values to be observed and any action to improve the quality of the air surrounding can be taken if the value shows large amount of carbon dioxide in the area.

This project started with the research about the related information via the books and internet. Beside that, the lecturer's guidance is also important for the project development. Sketches about the project will be done based on the information gathered. Then, the circuit will be constructed for simulation purposes which then will be tested whether it will give the required output or not. Any troubleshooting works will be done during the simulations. After that, the circuit will be constructing on the PCB. The circuit will be tested and observed together with display unit. Analysis will be done with oscilloscope to check whether the display shows the same result as measured.

CHAPTER II

LITERATURE REVIEW

2.1 Carbon Dioxide

Carbon dioxide is a chemical compound which is colorless, odorless and tasteless gas that is about one and one-half times as dense as air under ordinary conditions of temperature and pressure. Under normal conditions it is stable, inert, non-toxic and does not burn. However, it will support combustion of magnesium to give magnesium oxide and carbon. The composition of carbon dioxide is one carbon and two oxygen atoms. It is often referred to by its formula CO_2. It is present in the Earth's atmosphere at a low concentration and acts as a greenhouse gas. In its solid state, it is called dry ice. It is a major component of the carbon cycle. Although it is not a poison, it can cause death by suffocation if inhaled in large amount. Carbon dioxide is a fairly stable compound but decomposes at very high temperature into carbon and oxygen.

Atmospheric carbon dioxide derives from multiple natural sources including volcanic out gassing, the combustion of organic matter, and the respiration processes of living aerobic organisms. Man-made sources of carbon dioxide come mainly from the burning of various fossil fuels for power generation and transport use. It is also produced by various micro organisms from fermentation and cellular respiration.

During the photosynthesis, carbon dioxide is utilized where both the carbon and the oxygen is used to construct carbohydrates. In addition, plants also release oxygen to the atmosphere, which is subsequently used for respiration by heterotrophic organisms, forming a cycle.

2.1.1 Chemical and Physical Properties of Carbon Dioxide

Carbon dioxide is a colourless gas which, when inhaled at high concentrations, a sour taste is produced in the mouth and a stinging sensation in the nose and throat. High concentrations here mean a dangerous activity because of the associated asphyxiation risk. These effects result from the gas dissolving in the mucous membranes and saliva, forming a weak solution of carbonic acid.

Its density at 25 °C is 1.98 kg m^{-3}, about 1.65 times that of air. The carbon dioxide molecule (O=C=O) contains two double bonds and has a linear shape. It has no electrical dipole. As it is fully oxidized, it is not very reactive and, in particular, not flammable.

At temperatures below −78 °C, carbon dioxide changes directly from a gas to a white solid called dry ice through a process called deposition. Liquid carbon dioxide forms only at pressures above 5.1 atm at atmospheric pressure, it passes directly between the solid phase and the gaseous phase in a process called sublimation [13].

All aerobic organisms produce CO_2 when they burn carbohydrates, fatty acids and proteins where it is the prime energy source and the main metabolic pathway in heterotrophy organisms such as animals, and also a secondary energy source in prototroph organisms such as plants when not enough light is available for photosynthesis. The large amount of reactions involved is exceedingly complex and not described easily. Another modus operandi utilized by the Photoautotroph via the

absorption of CO_2 from the air, and, together with water, react it to form carbohydrates [5].

Carbon dioxide is soluble in water, in which it spontaneously interconverts between CO_2 and carbonic acid, H_2CO_3. The relative concentrations of CO_2, H_2CO_3, and the deprotonated forms bicarbonate, HCO_3^- and carbonate, CO_3^{2-} depend on pH. In neutral or slightly alkaline water (pH > 6.5), the bicarbonate form predominates (>50%) becoming the most prevalent (>95%) at the pH of seawater, while in very alkaline water (pH > 10.4) the predominant (>50%) form is carbonate. The bicarbonate and carbonate forms are very soluble, such that air-equilibrated ocean water where mildly alkaline with typical pH from 8.2 to 8.5 which contains about 120 mg of bicarbonate per litre [5].

2.1.2 Application of Carbon Dioxide

Carbon dioxide is often used as an inexpensive, nonflammable pressurized gas. Life jackets often contain canisters of pressured carbon dioxide for quick inflation. Steel capsules are also sold as supplies of compressed gas for airguns, paintball markers, for inflating bicycle tires, and for making seltzer. Rapid vaporization of liquid CO_2 is used for blasting in coal mines.

Carbon dioxide is the most commonly used compressed gas for pneumatic systems in Combat Robots. Carbon dioxide is ideal for this application because at room temperature it becomes a liquid at a pressure of 60 bars. A tank of liquid carbon dioxide provides a constant 60 bar pressure until the tank is close to being empty. A tank of compressed air would gradually reduce in pressure as it was used.

Carbon dioxide extinguishes flames, and some fire extinguishers, especially those designed for electrical fires; contain liquid carbon dioxide under pressure. Carbon dioxide also finds use as an atmosphere for welding, although in the welding