UNIVERSITI TEKNIKAL MALAYSIA MELAKA

PORTABLE ARTIFICIAL NOSE TO DETECT CHICKEN MEAT SPOILAGE USING AMMONIA SENSOR

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electrical Engineering Technology (Industrial Automation and Robotics) with Honours

by

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DECLARATION

I hereby, declared this report entitled “Portable Artificial Nose to Detect Chicken Meat Spoilage using Ammonia Sensor” is the results of my own research except as cited in references.

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Electrical Engineering Technology (Industrial Automation and Robotics) with Honours. The member of the supervisory is as follow:

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(Siti Nur Suhaila Binti Mirin)

ABSTRAK

Ammonia adalah gas yang tidak berwarna, larut air, dan reaktif bersama bau menyesakkan. Tambahan pula, ammonia juga dihasilkan secara semula jadi dari penguraian bahan organik, termasuk tumbuh-tumbuhan dan haiwan. Setelah daging ayam melalui proses kerosakan, kandungan ammonia akan dikeluarkan daripadanya. Ia bukan kandungan ammonia yang tinggi, ia hanya kandungan gas rendah ammonia dalam julat 0-10 bahagian per juta (ppm). Oleh kerana ia adalah kandungan rendah ammonia, pengguna sukar untuk membezakan dengan menghidu bau menyesakkan yang mana satu daging ayam itu sebenarnya dalam proses kerosakan. Projek ini keluar dengan hidung tiruan untuk mengesan kehadiran gas ammonia dibebaskan daripada kerosakan daging ayam. Peranti telah direka mengikut mesra dan mudah alih pengguna.

Untuk mengesan kandungan gas ammonia dibebaskan, peranti mengandungi MQ135 pengesan ammonia kerana masa tindak balas adalah pantas dan ammonia boleh dikesan antara 0 - 100 ppm. Selain itu, pemprosesan data untuk projek ini terdiri daripada papan Arduino UNO, yang terdiri daripada ATmega328 mikropengawal. Ia telah diprogramkan untuk mengesan kehadiran gas ammonia.

ABSTRACT

Ammonia is a colorless, water-soluble, and reactive gas with a pungent suffocating odor. Furthermore, ammonia is also produced naturally from decomposition of organic matter, including plants and animals. Once chicken meat going through spoilage process, the ammonia content will be released from it. It is not high content of ammonia, it just low content of ammonia within range at 0 to 10 part per million (ppm). Since it is low content of ammonia, the consumers difficult to differentiate by sniffing the pungent suffocating odor which one the chicken meat was actually in spoilage process. This project come out with a portable nose for detecting the presence of ammonia gas released from the spoilage of chicken meat. The device was designed according to user friendly and portable.

To detect the content of ammonia gas released, the device is embedded with MQ135 ammonia sensor because of its rapid response time and low ammonia content range between 0 – 100 ppm. Besides, data processing for this project comprised Arduino UNO board, which consists of ATmega328 microcontroller. It was programmed to sense the presence of ammonia gases.

DEDICATION

Special dedicated to my beloved parents, family, friends and lecturers, who had strongly encouraged, inspired and supported me in my entire journey of learning.

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TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

A	Ampere
AgCl	Silver Chloride
ANN	Artificial Neural Network
CHEMSENSOR	Chemical Sensor
CM	Centimeter
EC	Electro Chemical
FCM	Fuzzy C. Means
IPS	Intelligent Perception System
IrOx	Iridium
LCD	Liquid Crystal Display
LED	Light Emitter Diode
MOS	Metal Oxide Sensor
PCA	Principal Component Analysis
PPM	Part Per Million
RF	Radio Frequency
RGB	Red-Green-Blue
SAW	Surface Acoustic Wave

<	Less Than
>	More Than
°C	Degree Celcius
V	Volt
Ω	Ohm

CHAPTER 1

INTRODUCTION

1.0 Introduction

The chicken meat spoilage was detected by a portable artificial nose using ammonia sensor. This section consists of project briefing, problem statement, objective, work scope.

1.1 Project Briefing

The purpose of this project is to design portable artificial nose and detect the presence of ammonia gas release from raw spoilage chicken meat. The spoilage process of chicken meat could be verified by humidity, temperature, oxygen, carbon dioxide and ammonia gas. The project focus on detecting the ammonia gas presence by using MQ-135 ammonia sensor and microcontroller Arduino UNO R3 to do the programming. The value of ammonia gas will display on Liquid Crystal Display (LCD).

1.2 Problem Statement

Spoilage of chicken meat results the development of odor when the spoilage organisms present onto it (Mead 2004). Referring to (Tobergte & Curtis 2013), the odor had become ammoniacal and microbial population increased. Consumers are difficult to differentiate either fresh or not just sniffing odor came out from the raw chicken meat. Due to this problem, there is a must to create the portable artificial nose and the ammonia gas as a mechanism to check the condition of raw chicken meat either spoil or not by using ammonia sensor.

Previous project from (Timsorn et al. 2014) used TGS826 ammonia gas sensor. This sensor was capable to measure from 30 to 300 ppm. According to (Kozacinski et al. 2012), the ammonia content measured start at the value of 0.85 ppm. Therefore, the appropriate sensor for portable nose needs to achieve that value.

1.3 Objective

The overall project objective is the development of portable artificial nose to detect chicken meat spoilage using ammonia sensor. This project has the following specific objectives:

a) To construct the design of portable artificial nose which contain Arduino UNO as main controller and ammonia sensor as input.
b) To investigate the suitable sensor that can be use to detect concentration ammonia gas at low range.
c) To analyze the data of ammonia concentration released from raw chicken meat by using Microsoft Excel 2010 at 3 situation ; Room temperature, Inside refrigerator and freezer.

1.4 Work scope

To achieve the objectives, this project was based on the scopes below :

1.4.1 Sample Used

These projects focus on raw chicken meat only. It was cut into 12 pieces.

1.4.2 Main Component in Portable Artificial Nose

1. MQ-135 Electrochemical Ammonia Gas Sensor
2. Arduino UNO R3 board
3. ATmega328 Microcontroller
4. LCD Display (16 x 2)
5. Green LED
6. Push button

1.4.3 Experiment Method

A whole fresh chicken was cut into 18 pieces and was stored at 3 different places. The sample was stored at room temperature, in refrigerator and freezer. For each day until a week passed, the ammonia sensor will sense presence of ammonia gas in the chicken meat.

1.4.4 Analysis

The data that we collected are the content of ammonia gas released and physical changing of the chicken. The data from microcontroller was sent to the computer for make analysis by using Microsoft Excel 2010.

1.5 Summary

The project was carried out after identified the problem statement and come out with the objective to achieve. Furthermore, this project just based on the work scope that created only, so that to ensure the project was in a right track.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

Ammonia is produced naturally due to decomposition of organic matter including plants, animals, and animal wastes (New York State Department of Health 2004). The beginning of spoilage process, any animals including chicken meat will produced an ammonia gas. Due to this matter, there have several ammonia measurement method to detect the concentration of ammonia gas.

Human consumed food daily and the ingredient must be in fresh to avoid any circumstances. In order to avoid spoilage food enter into our body, many method to detect food spoilage was invented.

2.1 Ammonia Measurement Method

The concentration of ammonia gas could be detected by various methods. Every method has their advantages and disadvantages. It is referring to the type of ammonia that to be measure either in large or low concentration. In this section, several ammonia measurement methods had been research and briefly each of them including their

method, advantages and disadvantages. Therefore, the decision was made and chose only a method among them to suit for this project at the summary.

2.1.1 Filter Pack

According to Day et al. n.d., the filter consists an array design to collect various airborne species, related to decomposition. The ammonia gas was trap into the filter and analyzes it in the laboratory. The filter pack available at low cost and convenient logistic. The disadvantage is unsuitable for real-time monitoring and also cannot assemble into the microcontroller.

2.1.2 Denuder

The denuder is an instrument for trapping and analyzing any concentration inorganic reactive gas. Referring to Roumeliotis et al. 2010, denuder consists of three concentric etched glass tube with different radii creating three separate flow annuli. For this type of measurement, it is suitable for in-house sampling. Even it is good for low concentration of ammonia gas but it cannot assemble with microcontroller.

2.1.3 Surface Acoustic Wave Sensor (SAW Sensor)

The basic detection principle is based upon the changes in SAW propagation characteristics due to adsorption of gas molecule on sorbent film surface deposited in the propagation path (Bhasker Raj et al. 2013). The advantages are fast response and recovery speeds, high sensitivity and wireless sensing in any area. The disadvantages is the sensor is not portable and high robust. Therefore, it is not suit to bring this sensor at any place.

2.1.4 Optical Fiber Sensor

According to Mhdi et al. 2013, the construction an optical fiber-based evanescent wave sensor for gaseous ammonia sensing, so that sol-gel film is used to encode bromo cresol purple on the surface of a bared fiber core, and evanescent absorption is measured through a spectrometer. Mhdi et al. 2013 also mentioned that optical fiber sensor are suitable for monitoring various environmental hazards, for the size is small and flexibility of design to make them ideal tool in analysis.

2.1.5 Metal Oxide Semi-Conductor Sensor (MOS)

It is highly desirable that metal oxide semiconductor sensors have a large surface area, so as to adsorb as much of the target analytic as possible on the surface, giving a stronger and more measurable response; especially at low concentrations (Fine et al. 2010). The sensor usually comprises a ceramic support tube containing a platinum heater coil onto which sintered SnO2 is coated onto the outside of the tube with any catalytic additives, so that gas samples are sensed by the change in the electrical resistance of the metal oxide semi-conductor (Berna 2010). The disadvantage is very sensitive to any moisture presence.

2.1.6 Electrochemical Sensor (EC Sensor)

Electrochemically electrodes based on noble metals like platinum, gold or palladium is normally used. Thereby, cross-sensitivities against ; e.g. sulfur-containing compounds have to be taken into consideration. Simultaneously it is possible that the metals themselves can react as catalysts and cause undesired reactions in the medium (Sachse et al. 2015). The advantages are Low cost, robust and portable which make them suitable for industrial monitoring.

2.1.7 Summary of Ammonia Measurement Method

There have six type of ammonia measurement that had been research and decide to choose electrochemical sensor as a main sensor for the portable artificial nose. The table below describe a summary for all the ammonia measurement method stated before which is the advantage and disadvantage.

Table 2 . 1: Summary of Ammonia Measurement Method

Ammonia Measurement Method	Advantage	Disadvantage
Filter Pack	- Low cost - Convenient logistics	- Cannot assemble into the microcontroller.
Denuder	- Can detect low concentration of ammonia	- Cannot assemble into the microcontroller.
Surface Acoustic Wave Sensor	- Fast response - High sensitivity	- Not portable - High robust
Optical Fiber Sensor	- Small size - Useful in any hazardous area	- It is not direct measurable tools because it must use spectrometer to give out the value. - Cannot assemble into the microcontroller.
Metal Oxide Semi-conductor Sensor	- Robust - Lightweight	- For detect low concentration, it

	- Quick response time	must be adjust the surface area. - Very sensitive to moisture. - Cannot assemble into the microcontroller.
Electrochemical Sensor	- Low cost - Portable sensor - Easy to handle - Can assemble to the microcontroller	- None

2.2 Method to Detect Food Spoilage

Daily food that we consumed everyday will undergo of spoilage process in a certain time. It is difficult for human to detect the early spoilage process of the food with only their naked eyes. Therefore, many methods to detect food spoilage were creating to overcome this problem. In this section, there have several methods to be briefly the method, advantage and disadvantage. To suit with this project, the decision was made to choose a method to detect food spoilage according to the objective in a summary.

2.2.1 Radio Frequency pH - Sensing Tag for Wireless Food Quality

The pH sensor embedded in a non-battery radio-frequency (RF) transponder. The IrOx / AgCl sensing electrodes were fabricated on a polymide substrate. The radio-frequency transponder will ensure the wireless monitoring food quality (Huang et al.