Gas Detection and Classification Alcohol Using Neural Network-Based Gas Sensors

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Abstract—Alcoholic beverages, apart from being haram, also cause loss of consciousness. The influence of alcohol while driving is very dangerous and can result in an accident. For this reason, it is necessary to detect the alcohol content in beverages so that their halal status is known and to avoid the dangers of consuming alcohol. This research is to detect the aroma of alcohol using the MQ-3 gas sensor, which consists of an aroma sensor in general with an Artificial Neuron Network (ANN), such as the number of neurons, layers, and epoch. Most of the learning schemes require testing to optimize the model structure. For this experiment, ANN is used as a liquid classification in grouping alcoholic and non-alcoholic liquids. The MQ-3 gas sensor successfully reads liquid vapor in alcohol with levels of 30%, 50%, 70%, and other water-based liquids. An artificial neural network with 2 hidden layers, 10 neurons, and 1000 iterations with the sigmoid activation function can approach a regression score of 1.1545 and sq error score of 0.5781.

Keywords: alcohol gas, gas sensor, artificial neuron network

I. INTRODUCTION

Drinks that contain alcohol can cause people to get drunk if they drink too much. Alcoholic beverages that cause drunkenness are considered haram, besides that alcoholic drinks also cause loss of consciousness and are very dangerous when someone is driving a vehicle, this can cause traffic accidents. Many deaths from traffic accidents are caused by human error and the influence of alcohol [1], [2].

Research is needed to detect the alcohol content in drinks so that they avoid haram drinks because they do not know what they are drinking and are intoxicated by alcoholic beverages. Previous research has made an alcohol detection device for drinks using the MQ-3 sensor and the Arduino Uno microcontroller. The MQ-3 sensor will send a signal to read the alcohol content to the microcontroller, this analog signal is then converted into a 10-bit digital quantity to be displayed on the LCD in the form of alcohol content in percentage [3]. The MQ-3 sensor used in the previous studies was often functioned as an alcohol detection sensor because the sensor is accurate to be used as an alcohol detector [4]. The result of this study was a stand-alone alcohol level detector that was not yet connected to a cellular network or internet network.

Another research detected the driver’s alcohol level using Arduino and then programmed and processed the results using LabVIEW [5]. In this study, Arduino tools and sensors as a system hardware had been connected to a computer to read and process alcohol content readings through the LabVIEW software. The data sent by Arduino was obtained from direct readings of vehicle driver’s log sheet to analyze high and low alcohol levels using the LabVIEW software on the Arduino Compatible Compiler for LabVIEW (ACCL) software application. Alcohol level monitoring was performed on a computer with the LabVIEW application installed. This research was also not connected to the cellular network or internet network.

Another similar research used an internet network based on android application for internet monitoring where you could monitor vehicle drivers online, anytime and anywhere. Its working principle was like a GPS tracker which could be monitored from the android application. This research had been connected to the internet network but could only be monitored using an android smartphone, not for other types of smartphones [6].

The influence of alcohol is so extensive that it causes unconsciousness such as emotional and behavioral disturbances. Another study on real time monitoring of alcohol gases was carried out in the laboratory. One way to detect alcoholism is signal analysis, most of the research focuses on detecting alcoholism using deep learning machine classification and algorithms with EEG Signals [7].

This study uses a gas sensor consisting of a general aroma sensor that can be used for various sensitive aromas of biological or chemical substances. While pattern recognition in this system is for data reduction and data structure analysis in the form of supervised pattern recognition. The use of Artificial Neural Networks (ANN) is currently considered as one of the important tools in chemometrics [8]. In general, because ANN is a non-parametric device where parameters have adaptabilities (such as number of neurons, layers and epochs), most learning schemes require testing to optimize the model.
The artificial neural network resembles the human brain in 2 things, namely:

1. Knowledge is acquired by the network through the learning process.
2. The strength of the connections between nerve cells (neurons) known as synaptic weights are used to store the knowledge.

The artificial neural network is determined by 3 things:

1. The pattern of relationships between neurons (called network architecture).
2. The method for determining the weight of the link (called training/learning methods).
3. The activation function, which is the function used to determine the output of a neuron.

The backpropagation network model is the most used supervised coaching, learning, or training techniques. This method is an excellent method to deal with complex pattern recognition problems. In the backpropagation network, each unit in the input layer is associated with each unit in the hidden layer. Every unit that is in the hidden layer is connected to each unit in the output layer. This network consists of many layers (multiple layer network) [17]. When this network is given an input pattern as a training pattern, then the pattern goes into the hidden layer. The hidden layer unit is forwarded to the output layer unit. Then the output layer unit will respond as the output of the neural network imitation. When the output does not match with the expectation, the output will be propagated backward on the hidden layer, then goes to the input layer.

This training stage is a step to train artificial neural network, namely by doing weight change, while solving the problem will be carried out if the training process has been completed, this phase called the testing phase [18], [19].

Figure 1 is a backpropagation algorithm where each unit of the input layer on the network backpropagation is always connected to every unit that is in the hidden layer, so every unit in the hidden layer is always connected to the unit in the output layer. The backpropagation network consists of many layers (multiple layer network), namely:

1. Input layer $X_i$ (1 piece), consisting of 1 to n input units.
2. Hidden layer $Z_j$ (at least 1 piece), consisting of 1 to p hidden units.
3. Output layer $Y_k$ (1 piece), consisting of 1 to m output units.

Each input unit ($X_i$, $i=1, 2, 3, ..., n$) receives a signal $X_i$ and forwards that signal to all layers above it (hidden layers). Each hidden unit ($Z_j$, $j=1, 2, 3, ..., p$) sums up the weighted input signal. output unit ($Y_k$, $k=1, 2, 3, ..., m$) sums the weighted input signals.

### III. MATERIALS AND METHODS

#### A. Research Stages

The design of an alcohol detection system based on data acquisition using an artificial neural network method consists of a series of hardware and software applications. The block diagram of the alcohol detection system using the MQ-3 sensor consists of several parts as shown in Figure 2.

The following are sections of the Web-based alcohol level detection block diagram:

- MQ-3 sensor that functions as a detection of alcohol levels.
- ESP-8266EX microcontroller which functions as the control center of the system that will read the MQ-3 sensor and process it, then display it on the LCD screen and send it to the web server via WEMOS module.
- LCD 16x2 display is an on-site screen display on
the alcohol content detection device which can be read directly on the information printed on the measuring instrument.

- WEMOS module is a wireless hardware connection component used to connect to the internet network.

B. Hardware

The MQ-3 sensor is used to detect alcohol levels directly, for example when breathing. The driver circuit uses 1 variable resistor. The output of the MQ-3 sensor is an analog voltage which is proportional to the alcohol received. Using the ADC function to be able to communicate with the microcontroller, ADC can respond to voltages 0–5 volts. The image of the MQ-3 sensor can be seen in Figure 3.

The LCD module functions as a medium for displaying information in the form of letters/numbers, which can accommodate 16 letters or numbers in each line [10]. The image of LCD module can be seen in Figure 4.

WEMOS D1 Wi-Fi Arduino ESP8266 is a microcontroller board made by WEMOS and designed similar to the Arduino Uno board. The uniqueness of WEMOS D1 Wi-Fi Arduino ESP8266 board is its compatibility with Arduino IDE, so you can use the Arduino IDE to create/compile programs and download them to this board. ESP8266EX Wi-Fi module has processor of 32bit/80-160MHZ [11], flash program memory of 4MB, 32KB SRAM & 80KB DRAM, with 2.4GHZ Wi-Fi feature makes WEMOS D1 Wi-Fi Arduino ESP8266 a very powerful board and suitable for the internet of things (IoT). This embedded ESP8266 Wi-Fi wireless module is an ESP8266 transceiver series Wi-Fi module [12].

The image in Figure 4 is a form of WEMOS D1 mini Wi-Fi is a microcontroller board with additional functions to be connected to a Wifi network, which has the following specifications:

- ESP-8266EX Microcontroller.
- IO voltage 3.3 Volts.
- Digital IO: 11 with IO/PWM/I2C/one cable.
- Analog input: Maximum input voltage of 3.2 Volts.
- Micro USB.
- Compatible with Arduino.
- Compatible with NodeMCU.
- Clock Speed of 80 MHz/160 MHz.
- Flash memory of 4MB.

C. Experimental Set-Up

This research consists of hardware functioned as a reading level of experimental materials in the form of alcohol and non-alcohol liquids. The hardware displays the results of alcohol content reading in the computer and analyzes experimental data using the ANN method. The medical standard of alcohol levels used consists of 30%, 50% and 70%. Non-alcoholic ingredients in the form of mineral water, orange juice and syrup water are determined as liquid ingredients. The experiment was carried out by measuring the voltage on the MQ-3 sensor with different liquid reading materials. Besides, the experiment also measured the analog-to-digital converter (ADC) value from gas vapor sensor readings of different liquids. The readings are taken from the LCD display prototype and the measurement is displayed on the computer screen. The ANN method is used for liming some of the liquids used in the experiment to classify whether the liquid contains alcohol or not.
IV. RESULTS AND DISCUSSION

This research consists of hardware and software. The hardware consists of WEMOS as the controller, namely ESP-8266EX Microcontroller, and an MQ-3 gas sensor as the sensor to read gas vapor from the liquid being tested. The software used is an application that functions as a computer for data acquisition of gas sensor readings. Other software used is MS Excel and the Matlab application to process data using ANN method.

Figure 5 pictures a series of alcohol level detectors, namely WEMOS ESP-8266EX Microcontroller and a Wi-Fi network connection that will send the gas reading value of the liquid being tested into the computer.

The gas sensor reads the vapors of the liquid being tested by placing alcoholic or non-alcoholic liquids in an enclosed space to measure the alcohol content using the MQ-3 gas sensor. The MQ-3 sensor output is the conversion result of alcohol content detection. The voltage is passed to the WEMOS analog input pin A0 and the alcohol content reading is displayed to the 16x2 LCD screen via D1 and D2 pins. Measurements were made by pouring the liquid into a round container with a diameter of 12 cm and a height of 4 cm. The MQ-3 sensor is drilled into the alcohol reservoir cap to read the alcohol content being tested.

Table 1 is the measurement results are data training and used to determine the type or classification of fluids that are not yet known. The 70% alcohol test liquid measures a voltage of 2.31 Volts and the ADC value is 473. The voltage and ADC values for other alcoholic and non-alcoholic liquids are recorded in this table as x1 and x2.

<table>
<thead>
<tr>
<th>Liquid</th>
<th>Voltage (Volt)</th>
<th>ADC Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alcohol 70%</td>
<td>2.31</td>
<td>473</td>
</tr>
<tr>
<td>Alcohol 50%</td>
<td>1.88</td>
<td>385</td>
</tr>
<tr>
<td>Alcohol 30%</td>
<td>1.51</td>
<td>309</td>
</tr>
<tr>
<td>Mineral water</td>
<td>0.47</td>
<td>096</td>
</tr>
<tr>
<td>Orange water</td>
<td>0.50</td>
<td>102</td>
</tr>
<tr>
<td>Mystery Liquid</td>
<td>0.67</td>
<td>137</td>
</tr>
</tbody>
</table>

The first stage of ANN method in the classification process is to calculate the hidden layer, estimate the score, predict probability and error.

As shown in Table 2, the mystery liquid can be included in the category of non-alcoholic liquid according to the value of mineral water and orange juice both from the probability prediction and the sq error is close to the group. h1 and h2 are hidden layers of input linear combinations with weights to be calculated. h1 and h2 are hidden layers of input linear combinations with weights to be calculated, where the weights are small random numbers. After calculating everything, we get the predicted probability value of liquid mystery is 0.760348 and the squared error is 0.578129.

The analysis calculated using the Matlab application also shows results that support calculation tables by showing 100% accuracy as shown in Figure 6.

Figure 7 shows the position of mystery liquid in the activation function. The mystery liquid being tested is syrup water. Experiment using the ANN method will test whether it can classify the mystery liquid, whether it is in the category of liquid containing alcohol or non-alcohol. From the test, the MQ-3 sensor has been able to read the vapor from alcoholic and non-alcoholic liquids by showing
the voltage value and ADC value for each liquid being tested. ANN method with 2 input values, 2 input layers, 2 hidden layers and 1 output layer successfully made a mystery classification of the liquid tested by grouping it into a non-alcoholic group. The mystery liquid itself is this syrup water, which shows that ANN has successfully functioned to classify.

By using ANN it succeeded in classifying mystery liquid as a non-alcoholic liquid from the training data grouping table and activation function diagram, the test also succeeded in sending gas sensor reading data via the internet network.

V. CONCLUSIONS

Based on the research results, it can be stated that some conclusions: the MQ-3 gas sensor successfully reads liquid vapor in the form of alcohol with levels of 30%, 50%, 70% and other water-based liquids. An artificial neural network with 2 hidden layers, 10 neurons, and 1000 iterations with sigmoid activation function is able to approach regression score of 1.1545 and sq error score of 0.5781. The Artificial Neural Network (ANN) is a classification technique that is quite reliable due to its ability to predict the type of gas vapor from the liquid being tested.

For future research, suggestions that can be given are research is still possible to develop backpropagation neural network architecture up to the prediction stage by adding other variables such as ppm value of the tested liquid vapor.

REFERENCE


