Dead Matter Respiration

Farah Ahmed Mohamed, Rahma Shaban, Rawan Ramy

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Abstract

Climate change has been widely recognized to be a severely demanding, global challenge that affects almost all life aspects and, by far, is requiring immense effort to be tackled. Climate change resembles an infinite loop of numerous causes that include but are not limited to global warming, the highly increasing marsh gases, and CO_2 emission rates, overusing fossil fuels to generate power, and, most importantly, matter decomposition and anaerobic respiration. The Carbon Dioxide and Methane gas emissions released from decomposed matter affect temperature and humidity in addition to increasing CO_2 and CH_4 rates which significantly have dreadful long-time effects on climate change. With the assistance of the Internet of Things (IoT), a complete technical system consisting of two major digital and analog sensors: humidity and temperature sensor (DHT11) and CO_2 sensor (MQ135), connected to the internet using a Wi-fi ESP Arduino board, and eventually linked to a Graphic User Interface (GUI): a website that displays the collected data, graphs, and results. Implementing the prototype, the relations between the design requirements or variables showed a high trend or a directly proportional relation between the effects of CO_2 emissions on humidity and temperature and, in general, the effects of decomposition on climate change. In conclusion, decomposition represents a significant cause of climate change and without the right, proper guidance on how governments and countries should deal with and try to reduce the environmental impacts of climate change, horrendous consequences will occur.

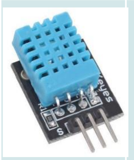
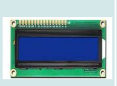
Introduction

According to NASA and many other scientific agencies, climate change has been apparently considered to be the most pressing challenge humanity encounters. Climate change affects all aspects of life, starting from economics, politics, education, and health to tourism, etc; its causes are countless and varied from using fossil fuels to natural phenomena such as matter decomposition and anaerobic respiration. Despite that decomposition provides essential nutrients and is considered mostly to be a beneficial, valuable phenomenon, Carbon Dioxide (CO_2), Methane (CH_4), and other gases released from the decomposed matter play a tremendous role in increasing air temperature and humidity, which, in turn, influences global warming and climate change. A handful of prior solutions regarding decomposition include but are not limited to measuring the impact of decomposed matter in swamps, canals, and even landfills. Two British researchers recognized, using traditional methods and low-tech measuring techniques, the direct relation between decomposition and CO_2 emissions but couldn't accurately identify the impact of decomposition on climate change using a completely accurate technical system. Thus, a demand for high-tech measuring methods was necessary to help establish an accurate relationship between decomposition and climate change.

This project fundamentally identifies the exact relation between decomposition and climate change using a complete IoT system by measuring three design requirements: temperature, humidity, and amount of Carbon Dioxide (CO_2) released. With the help of both digital and analog sensors such as DHT11, which is a digital temperature and humidity sensor, and MQ135, which is an analog CO_2 and CH_4 sensor, accurately-detailed results and relations were concluded to support our project hypothesis. As a result of this thoroughly comprehensive analysis, the design requirements were precisely addressed and displayed on a Graphic User Interface (GUI), an HTML, CSS, and JavaScript website designed from scratch to easily demonstrate data and tests for users.

Materials:

Table (1)

Item	ESP8255 NodeMCU	DHT11 sensor	MQ135 sensor	Bread board	LCD	container	Bread	Battery (9v)	Battery cap	MB102 Bread board
Usage	Connect the hardware part to WIFI	Measure temperature and humidity	Measure CO2 and CH4	Build temporary circuits	Display data	Package IoT system and decomposed bread	Decomposed matter	Power source	Connect the power source to the supply	Connect the power source to the breadboard
Image	 Fig (1)	 Fig (2)	 Fig (3)	 Fig (4)	 Fig (5)	 Fig (6)	 Fig (7)	 Fig (8)	 Fig (9)	 Fig (10)

Methods

Hardware:

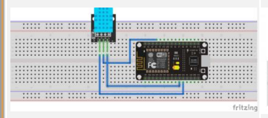
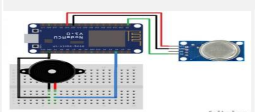
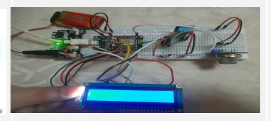
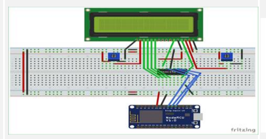
Table (2)

(1)	(2)	(3)	(4)	(5)
A container that is tightly closed to prevent any leakage of gases was brought	The MQ135 and DHT11 sensors are stuck on the cover of the container by silicon to be able to measure the emitted gases from the decomposition process.	Some slices of bread (organic matter) were put inside the container and were sprinkled with water	The bread was left in the container for about 7 days in a warm place until the bread mold fungus starts to appear.	The change in the reading of the two sensors was observed and analyzed .

Software:

The following section demonstrates the software part of the prototype which can also be accessed through this link: https://github.com/Farahelsadany11/Dead-Matter-Respiration

Table (3)

DHT11 (3pins)	MQ135 (4 pins)	ESP8266 board NodMCU	LCD	Firebase (IoT platform)
Used to measure temperature and humidity.	the MQ135 is used to measure CO2 concentration	used to connect the sensors to the WIFI	Used to display data collected from the sensors	connect the ESP 8266 board with the GUI.
 Fig (11)	 Fig (12)	 Fig (13)	 Fig (14)	 Fig (15)

Graphic User Interface (GUI):

Our GUI is, in simple words, a interactive website developed using HTML, CSS, JavaScript, and PhP languages to display the collected data and the relations between variables in the form of graphs and charts.

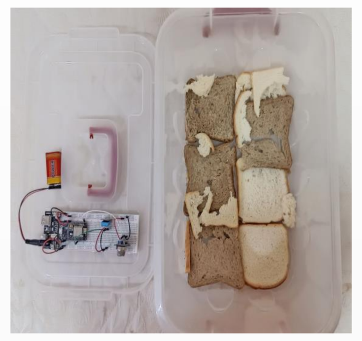


Fig (16)

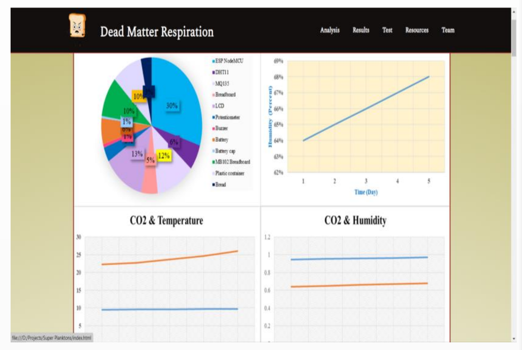


Fig (17)

Test plan :

The methods applied to test the prototype are putting the two sensors in the container, then measuring the temperature, humidity, and marsh gases every day for 5 days, and finally observing the change that will happen in the chosen data.

Trial 1: The Mq135 and DHT11 sensors were used to test the design requirements, the collected data was slightly close to each other; thus, some holes were observed in the container and decision was made to do another test with a plastic airtight container.

Trial 2: The data collected showed a direct relationship between the two variables and the temperature, but we observed that decomposition time takes a long time, so we added some drops of water to the bread to increase the decomposition rate.

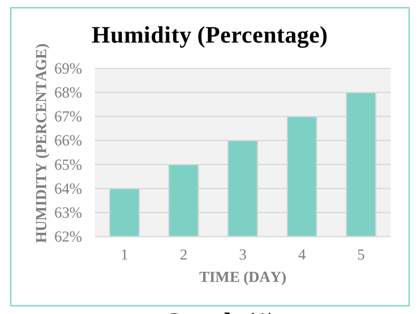
Trial 3: The results from the latest test were more accurate. The rate of temperature increase was noticeable, and it also demonstrated a direct relation between humidity and temperature as well as between marsh gases and humidity.

Results

2. Humidity

Table (4)

Time	Day 1	Day 2	Day 3	Day 4	Day 5
Trial 1	60.02 %	62.08 %	62.20 %	63.30 %	63.32%
Trial 2	65.05 %	66.04%	67.2%	69.6%	70.08%
Trial 3	66.01%	68.03%	68.06%	71.3%	72.04%
Average	64%±5.0%	65%±5.0%	66%±5.0%	67%±5.0%	68%±5.0%

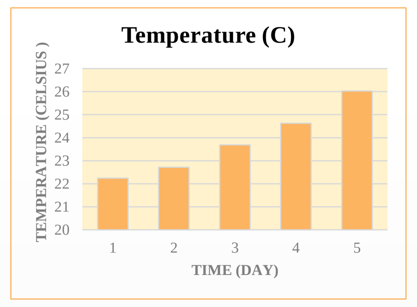


Graph (1)

1. Temperature

Table (5)

Time	Day 1	Day 2	Day 3	Day 4	Day 5
Trial 1	20.07 °C	20.09 °C	21.20 °C	21.28 °C	22.80 °C
Trial 2	23.01 °C	24.07 °C	24.80 °C	26.03 °C	27.30 °C
Trial 3	23.03 °C	24.00 °C	25.09 °C	26.80 °C	28.00 °C
Average	*22.24°C±2*	*22.72°C±2*	*23.69°C±2*	*24.63°C±2*	*26.03°C±2*

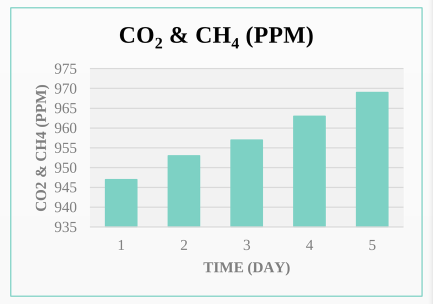


Graph (2)

3. Marsh gases (CO_2 & CH_4)

Table (6)

Time	Day 1	Day 2	Day 3	Day 4	Day 5
Trial 1	932 ppm	932 ppm	935 ppm	935ppm	937 ppm
Trial 2	950 ppm	960 ppm	966 ppm	976 ppm	980 ppm
Trial 3	960 ppm	967 ppm	972 ppm	980 ppm	990 ppm
Average	947 ppm ±50	953 ppm ±50	957 ppm ±50	963 ppm ±50	969 ppm ±50



Graph (3)

Analysis

Implementing the prototype, some positive and negative results were vividly gathered to determine both efficiency and effectiveness. Our designed prototype will come in handy with the process of detecting the natural, global phenomenon of decomposition and its effects on climate change which, in turn, will help overcome and precisely address Egypt's climate change-related grand challenges.

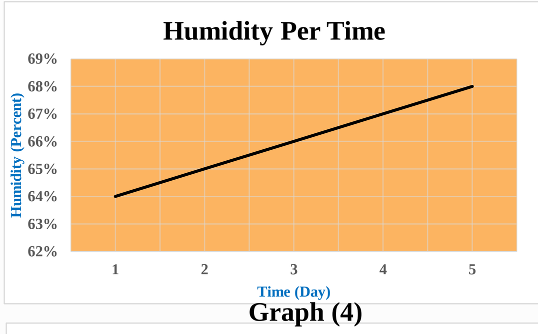
Testing analysis:

The following table depicts an analysis of all the tests performed along the testing journey:

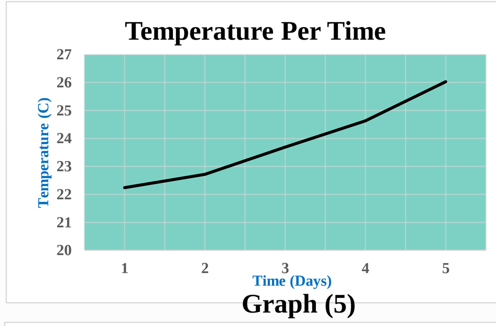
Table (7)

First trial	Second trial	Third trial
The observations conducted showed that all the results approximately remain constant, so we concluded that there is a leakage in the container, as a result of that we conducted a new test with the Airtight container to prevent any leak of gases. At first, we used an MQ2 air quality sensor that measures propane, methane, carbon monoxide, and some other gases. The tested gases didn't produce the desired relations between temperature, humidity, and CO2 and their effects on climate change. Thus, we replaced MQ2 with Mq135 which measures CO_2, methane, etc which have more effect on climate change.	We remarked that the duration of the decomposition process takes about 6 to 7 days, which is relatively more time than expected; hence, we added some drops of water to the bread to increase the decomposition rate. We used ThingSpeak cloud as an IoT analytics platform, but we discovered that ThingSpeak delays readings of the sensors; thus, we replaced it with Firebase Cloud, which just transfers the data from the sensors to the website.	In comparison to earlier tests, the results from the latest test were more accurate. The rate of temperature increase was noticeable, and it also demonstrates a direct relation between humidity and temperature as well as between marsh gases and humidity. Finally, we came to the conclusion that when the decomposition rate increases, the temperatures rise, and CO_2 and other marsh gases as well as humidity levels rise, the climate in Egypt would be significantly impacted in the far future, creating a major problem that needs to be solved right away.
Modifications:: •Using a plastic airtight container instead of a glass container. •Using air quality sensor Mq135 instead of Mq2.	• Add some drops of water to the bread to increase the decomposition rate. • Using Firebase cloud instead of ThingSpeak	

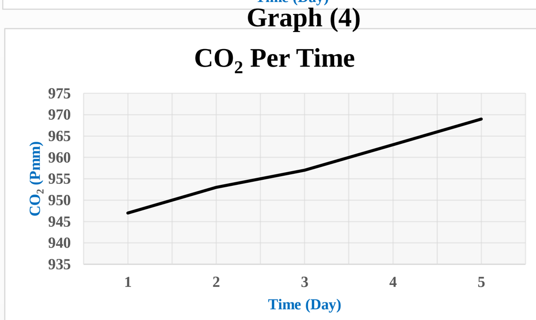
The following graphs represents the average results:



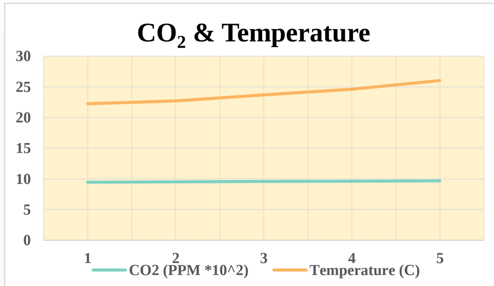
Graph (4)



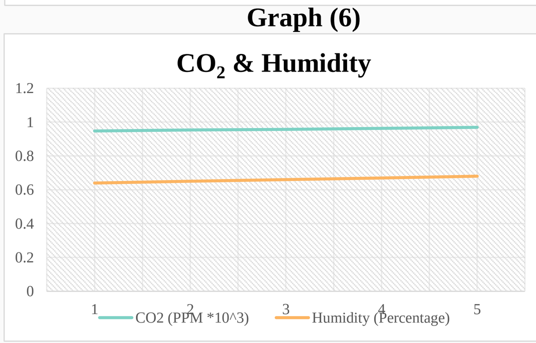
Graph (5)



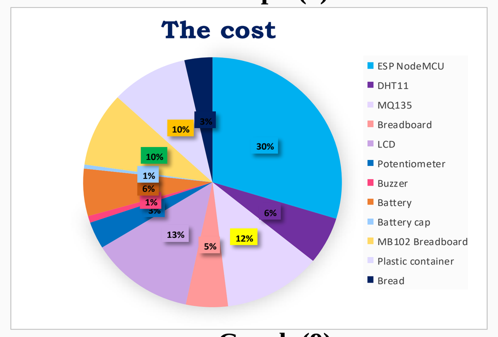
Graph (6)



Graph (7)



Graph (8)



Graph (9)

Scientific concepts & Learning transfer:

Biology*: Studying anaerobic respiration and matter decomposition was our project idea's initial spark. Biology significantly helped us understand the gases released from such a phenomenon which was the primary inspiration for this project.*

Chemistry: Studying the LO "Concentration" was undoubtedly fruitful in helping us deal with CO_2 and the MQ135 sensor.

Relative Humidity law:

$$RH = \left(\frac{\rho_w}{\rho_s}\right) x\ 100\%$$

RH : Relative Humidity
ρ_w : Density of water vapor
ρ_s : Density of water vapor at saturation

Fig (18)

Recommendation:

For the sake of applying the project on the large scale, some recommendations must be taken into consideration for stronger effectiveness and efficiency of the system. The following points summarize those recommendations:

- Using various organic matter to increase the amount of gases produced from the decomposition process, instead of depending on the decomposition of bread as a source of CO_2 only.
- Use the DHT22 sensor instead of DH11 as it has a better resolution and a wider temperature and humidity measurement range, and you can only request readings with 2 seconds intervals.
- Use ESP32 instead of ESP8266 NodMCU as ESP 32 has more than one analog pin that is needed for connecting more than one analog sensor with the ESP, while the ESP node MCU has only one analog pin that requires multiplexer to connect the sensors with the ESP.
- Using MG811 co2 sensor instead of MQ135, because it has a high sensitivity for CO_2 than MQ135.
- For better results and analysis, the system should be implemented in high-temperature conditions.

Conclusion:

In our investigation, we concluded that rising CO_2 will contribute to increasing humidity and will affect the climate by raising temperatures, which will subsequently enhance global warming and have a detrimental impact on the whole planet. Our project is an IoT system that offers several advantages, including cost savings, improved productivity and efficiency, control and automation, expanded data collecting, and predictive analysis. All these IoT benefits enable us to obtain precise data and analyze the resulting information. As it showed high accuracy of CO_2 concentration, temperature, and humidity results with a low percentage of error. Additionally, compared to the results of other solutions, our prototype showed the much higher efficiency. Owing to the ability of our prototype to establish direct relationships between the outcomes of data gathered and their effects on climate. What's more, it was concluded that in order to fight climate change, it's a must for governments and countries to initialize recycling systems. It's crucial to categorize garbage in landfills (ex. Liquid garbage should be kept far away from dry, solid garbage), Place landfills in less humid, cold areas instead of hot, humid environments, and finally, avoid single-use products.

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Further information:

Feel free to contact us at:
farah.1120591@stemmaadi.moe.edu.eg
rahma.1120543@stemmaadi.moe.edu.eg
rawan.1120554@stemmaadi.moe.edu.eg