COMPARATIVE STUDY ON THE SERIES OF THE MQ SENSOR FOR PREDICTION OF CO_2, METHANE, PROPANE AND HYDROGEN PERCENTAGE INSIDE THE LIVING ROOM USING ARDUINO MEGA AND ARDUINO UNO

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ABSTRACT :Aim: In the Earth's atmosphere there is about 0.04% of CO_2 (about 400 ppm) and this index is still growing. To overcome this, a monitoring system for CO_2 , methane, propane, and hydrogen concentration has been implemented using MQ sensors by comparing them with Arduino Mega and Arduino UNO. **Materials and Methods:** Comparing the Arduino microcontrollers for the prediction of CO_2, methane, propane & hydrogen percentage using the series of MQ sensors by keeping alpha error-threshold value 0.05, enrollment ratio as 0.1, 95% confidence interval, power as 80%. The two groups in this research work are the control group, Arduino Mega (N = 20) and study group Arduino UNO (N = 20). **Results:** In Arduino UNO, there is a statistically significant difference ($P = .033$, $P < 0.05$) in hydrogen and there is a statistical insignificant in ($P = .983$, $P > 0.05$) propane, ($P = .889$, $P > 0.05$) in methane, ($P = .929$, $P > 0.05$) in CO_2 percentage. This shows the Arduino UNO showed better results than using Arduino MEGA. **Conclusion:** In this study of comparing the Arduino microcontrollers for the prediction of CO_2, methane, propane & hydrogen percentage using the series of MQ sensors, the Arduino UNO showed better results than using Arduino MEGA.

KEYWORDS: Arduino Mega, Novel configuration in arduinoUNo, CO_2, Methane, Propane, Hydrogen, Embedded system.

1. INTRODUCTION

This study is all about comparing two different Arduino microcontrollers (embedded system) between the Arduino Mega and Novel configuration in Arduino UNO for CO_2, methane, propane and hydrogen percentage monitoring systems with MQ sensors(Holovatyy et al. 2018). Air pollution is a rising issue these days. It is compulsory to monitor air quality and keep it under control for a healthier future and healthy living for all (Somansh Kumar and Jasuja 2017).Indoor air pollution (IAP) is a leading environmental risk closely related to the health, comfort, and well-being of building occupants. The impact of IAP can be up to 100 times higher as compared with outdoor pollutant levels(Saini, Dutta, and Marques 2020). At the high level of carbon monoxide concentrations, it can impair vision and coordination, such as headaches, dizziness, confusion, nausea and also can cause flu-like symptoms. To avoid the bad effects from the pollutants, accurate air quality monitoring systems and follow up actions are needed (Kim, Chu, and Shin 2014).
Approximately, 278 Science Direct and 426 IEEE papers were relevant to this work. With the increase of industrialization and urbanization, the environment has become polluted at an alarming rate even to the level of affecting the day to day life of people. In recent times indoor air quality has attracted the attention of the researchers as an important similarity to that of external air pollution. In a certain sense, indoor air quality must be paid more attention than outdoor air quality as people spend more time indoors than outdoors (Li and He 2018).Carbon dioxide is an insidious gas so that changes in its concentration are difficult for humans to recognize. The gas is safe in low concentrations but life-threatening in excessively large quantities (e.g., more than 30,000 ppm for a short term exposure of 15 minutes and more than 5000 ppm for 8 hour time weighted average) (Pandey and Kim 2007). The method of monitoring the air state is its continuous monitoring of the

content of harmful gases and vapours and the determination of their concentration. Therefore, the development of qualitatively new low-cost such devices is an urgent task (Holovatyy et al. 2018). The proposed system is to monitor harmful gases like Carbon Monoxide, Methane, Hydrogen using Arduino based monitoring systems with sensors (RajalakshmianVidhya 2019). The best study is monitoring systems using dedicated sensors by connecting them to an Arduino microcontroller to monitor the CO_2, methane, propane and hydrogen concentration that have been proposed (Acharyya et al. 2017). The entire setup is desired to be placed inside living rooms.Our team has extensive knowledge and research experience that has translate into high quality publications(Patturaja and Pradeep 2016; Ramesh Kumar et al. 2011; Krishnan, Pandian, and Kumar S 2015; Felicita 2017b, [a] 2017; Santhosh Kumar 2017; Sivamurthy and Sundari 2016; Sathivel et al. 2008; Sekar et al. 2019)

Many research works have been carried out regarding CO_2, methane, propane and hydrogen percentage monitoring systems for indoor air detection, they are not considered to be effective and cost too high. To overcome this, we proposed a prototype device for CO_2, methane, propane and hydrogen percentage monitoring with an Arduino based monitoring system. This prototype is better than those other studies and also it is affordable. The authors were expert in the field of sensors and were able to conduct studies of monitoring indoor CO_2 percentage, also methane, propane and hydrogen levels with Arduino Mega and Arduino UNO microcontroller (embedded system) and compare them in the biomedical aspect. The aim of this study is to compare two different Arduino microcontrollers between Arduino Mega and Novel configuration inArduino UNO for CO_2, methane, propane and hydrogen percentage monitoring systems with MQ sensors.

2. MATERIALS AND METHOD

This study was done in a Sensors lab in Saveetha School of Engineering. The sample size calculation was calculated by using previous study results (Carrara et al. 2008) using clinicalc.com by keeping alpha error-threshold value 0.05, enrollment ratio as 0.1, 95% confidence interval, power as 80%. The two groups in this research work are the control group, Arduino Mega (N = 20) and study group Arduino UNO (N = 20).

The testing setup used in this study was made up of the hardware consisting of Arduino microcontroller, transducer, transformer, capacitor, LCD, regulator, rectifier, MQ sensors and DHT11 sensor. This hardware is worked by software such as Arduino IDE and MATLAB 2015. The ATmega328 microcontroller of the Arduino Mega board processes the received data from the sensors and outputs the result to the LCD module. In the circuit, the MQ gas sensors are connected to the digital pins of the Arduino UNO328 board. The temperature and humidity sensor have 4 outputs connected to ground (GND), output for sensor supply (VCC), the third pin is used to read the information from the sensor by the controller and the fourth output of the sensor is not used. Resistor (R1) of 10 kΩ must be added to the circuit between the power supply and the signal to prevent an emergency condition of the sensor. Two LEDs for indicating the operation mode (green LED) and alarm mode (red LED) are connected to the LED pins of the Arduino MC. The virtual terminal of the serial port monitor for transferring data to PC is connected to the TXD and RXD pins of the UART. The LCD module is connected to the controller via the I2C bus contacts. The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them. It is an open source software and easy to use, MATLAB combines a desktop environment tuned for iterative analysis and design processes with a programming language that expresses matrix and array mathematics directly. It includes the Live Editor for creating scripts that combine code, output, and formatted text in an executable notebook. MATLAB toolboxes are professionally developed, rigorously tested, and fully documented. To start the process the first step is to enter the coding in Arduino IDE and MATLAB 2015 programming software. After the coding is completed connect the UART which acts as a bridge to connect both hardware and software. Through the UART flash the coding into the novel configuration in Arduino UNO microcontroller(embedded system). Then click "run" to start the microcontroller for receiving data from the MQ sensors which are connected to the microcontroller. After the data received from the sensors, the microcontroller transfers the data to the LCD display that shows the CO_2 percentage, temperature (in Celsius) and Humidity percentage. Finally, the overall result was shown in a graphical representation in the MATLAB program.

Statistical Analysis

Statistical analysis is done by using SPSS software. In the analysis CO_2, methane, propane & hydrogenis considered as an independent variable with respect to time which is a dependent variable. The comparison is done using an independent sample t test.

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3. RESULTS

In this study different Arduino microcontrollers for the prediction of CO_2, methane, propane & hydrogen percentage using a series of MQ sensors. Table 1. represents the output ofthe series of the MQ sensor for prediction of CO_2, methane, propane and hydrogen percentage inside the living roomusing Novel configuration inArduino UNO and ArduinoMega.Table 2. represent the mean of Arduino UNO and Arduino Mega. The mean value of Arduino UNO had a highest accuracy (18.6000) in hydrogen when compared to ArduinoMega which had a lowest accuracy (16.0500) in hydrogen. Table 3 represents the independent sample T- test in predicting the CO2, methane, propane and hydrogen. There is a statistical significant difference between ($P = .033$, $P < 0.05$) in hydrogen and there is a statistical insignificant in ($P = .983$, $P > 0.05$) propane, ($P = .889$, $P > 0.05$) in methane, ($P = .929$, $P > 0.05$) in CO_2 percentage. This shows the Arduino UNO showed better results than using Arduino MEGA. Fig. 1. depicts the comparison of themean accuracy of Arduino UNO is higher than ArduinoMega. The standard deviation of Arduino UNO is higher than the Arduino Mega.

4. DISCUSSION

In Arduino, there is a statistical significant difference between ($P = .033$, $P < 0.05$) in hydrogen and there is a statistical insignificant in ($P = .983$, $P > 0.05$) propane, ($P = .889$, $P > 0.05$) in methane, ($P = .929$, $P > 0.05$) in CO_2 percentagethan the Arduino Mega. This shows the Arduino UNO is comparatively better than Arduino Mega.

People spend more than 90% of their time in indoor environments, a wide number of non-specific symptoms which characterizes the Sick Building Syndrome, involving the skin, the upper and lower respiratory tract, the eyes and the nervous system, as well as many building related diseases (Pitarma, Marques, and Ferreira 2017). The device used here is an Novel Configuration in Arduino UNO development board powered by the ATmega328p microcontroller. The Arduino code was written in script according to an algorithm based on a simple analog signal receive and store mechanism. The stored analog signal values in a queue were then sent to the LCD driver function and the digital data pins drove the screen of the LCD to our desired output (Ibrahim 2018). In (Lapshina, Kurilova, and Belitsky 2019) an experiment was conducted to achieve practical results. The research proved that when the window is closed, the concentration of carbon dioxide rises in this case to the value of 850-970 ppm. The value did not rise higher due to the good work of the ventilation system.

In (Lobur et al. 2020), The system uses an Arduino Mega 2560 board, a circuit has been designed in a manner that it tends to be exceptionally smaller in size. In this research, 5 types of sensor modules were installed. All five of the sensors are able to determine air environment parameters, which are the key factors of indoor environment. The circuit has been configured with the Megamicrocontroller which is the ArduinoMega microcontroller(Bakri et al. 2015). According to (Koedoes et al. 2020). The output of the Arduino Mega is shown in LCD. This LCD function displays information about the room temperature and air quality levels of CO and CO_2 in the form of a value from the sensor reading of results. The ability of the system to monitor air quality is highly dependent on the performance of the sensor.

The limitations of this study are the time duration in monitoring carbon dioxide percentage inside living rooms, environmental temperature, air, humidity which could be overcome by using standard environmental conditions and time parameters.

This study provides important futuristic scope to make many low cost and user-friendly CO_2 monitoring systems with this open source code programming software which make the device affordable and easy to program without need of additional knowledge. In near future, this device will be upgraded to a custom designed contemporary single printed circuit board in order to fabricate it into minimal size.

5. CONCLUSION

In this study of comparing two different Arduino microcontrollers for the prediction of CO_2, methane, propane & hydrogen percentage using the series of MQ sensors, the Arduino UNO showed better results than Arduino Mega microcontroller.

DECLARATION

Conflict of interest
No conflict of interest in this manuscript

Authors contribution

Authors KS involved in data collection, data analysis, manuscript writing, Author DJR involved in conceptualization, data validation and critical review of manuscript.

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Tables and Figures

Table 1. Output of the series of the MQ sensor for prediction of CO_2, methane, propane and hydrogen percentage inside the living roomusing a. ArduinoMega(Control group) and b. Arduino UNO (Study group)

a. ArduinoMega - Control group

Sample	CO2	Methane	Propane	Hydrogen
1	20.00	31.00	11.00	26.00
2	18.00	31.00	8.00	25.00
3	18.00	26.00	7.00	24.00
4	17.00	24.00	7.00	20.00
5	16.00	21.00	6.00	20.00
6	15.00	19.00	6.00	19.00
7	15.00	16.00	5.00	17.00
8	13.00	16.00	5.00	17.00

9	13.00	15.00	4.00	17.00
10	13.00	14.00	4.00	14.00
11	13.00	14.00	4.00	14.00
12	12.00	11.00	4.00	14.00
13	12.00	11.00	4.00	13.00
14	12.00	11.00	4.00	13.00
15	11.00	11.00	3.00	12.00
16	11.00	10.00	3.00	12.00
17	11.00	10.00	3.00	12.00
18	9.00	8.00	3.00	11.00
19	9.00	8.00	3.00	11.00
20	9.00	8.00	3.00	10.00

b. Arduino UNO - Study Group

Sample	CO_2	Methane	Propane	Hydrogen
1	22.00	33.00	12.00	27.00
2	19.00	33.00	8.00	24.00
3	18.00	26.00	7.00	23.00
4	17.00	24.00	6.00	22.00
5	16.00	23.00	5.00	20.00
6	15.00	21.00	5.00	20.00
7	15.00	19.00	4.00	19.00
8	13.00	18.00	4.00	18.00
9	13.00	15.00	4.00	18.00
10	13.00	14.00	4.00	18.00
11	12.00	14.00	3.00	17.00
12	12.00	14.00	3.00	17.00
13	12.00	13.00	3.00	17.00
14	12.00	13.00	3.00	16.00
15	12.00	13.00	3.00	16.00
16	12.00	12.00	3.00	16.00

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17	11.00	12.00	3.00	16.00
18	11.00	12.00	3.00	16.00
19	11.00	11.00	3.00	16.00
20	11.00	11.00	3.00	16.00

Table 2. Comparison and analysis of MQ sensors for CO_2 methane, propane and hydrogen, detection using Arduino Mega and Arduino UNO.

	Group	N	Mean	Std.Deviation	Std.Error Mean
CO_2	**Arduino Mega**	20	13.3500	3.18343	.71184
	Arduino UNO	20	13.8500	3.09966	.69311
Methane	**Arduino Mega**	20	15.7000	7.34202	1.64173
	Arduino UNO	20	17.5500	6.95455	1.55509
Propane	**Arduino Mega**	20	4.8500	2.10950	.47170
	Arduino UNO	20	4.4500	2.30503	.51542
Hydrogen	**Arduino Mega**	20	16.0500	4.88257	1.09178
	Arduino UNO	20	18.6000	3.16893	.70859

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Table 3 : Independent sample t-test of CO_2, methane, propane, hydrogen, there is a statistical insignificant difference between ArduinoMegaand Arduino UNO

Independent sample t test					
		f	**sig**	**t**	**dt**
CO_2	**Equal variances assumed**	.008	.929	-.503	38
	Equal variances not assumed			-.503	37.973
Methane	**Equal variances assumed**	.020	.889	-.818	38
	Equal variances not assumed			-.818	37.889
Propane	**Equal variances assumed**	.000	.983	.573	38
	Equal variances not assumed			.573	37.705
Hydrogen	**Equal variances assumed**	4.913	.033	-1.959	38

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	Equal variances not assumed			-1.959	32.595

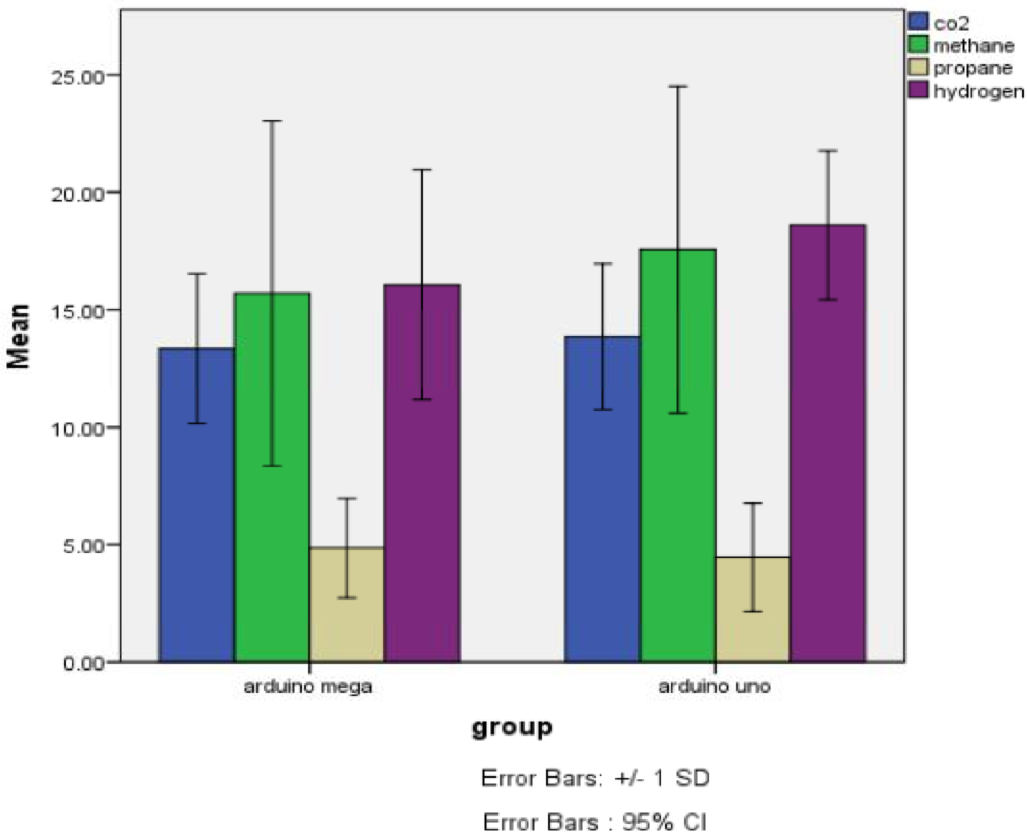

Fig. 1. Comparison the MQ sensor for prediction of CO_2, methane, propane and hydrogen percentage using Arduino Mega and Arduino UNO of mean accuracy .The mean accuracy of Arduino UNO is better than Arduino Mega. The standard deviation of Arduino UNO is slightly better than the Arduino Mega. Now x axis Arduino UNO vsArduinoMEGA then y axis : mean accuracy of detection +/- 1 SD.

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