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Continuous Onboard Vehicle Emission Monitoring through IOT

Soumyadeep Das Adhikary[1], Suman Dutta[2], Sohini Mondal[3], Sarbojit Ghosh[4], Souvik Dhar[5], Sourav Mallick[6], Partha Das[7]

[1, 2, 3, 4, 5, 6Student, [7]Assistant Professor, Department Of Electrical Engineering, JIS College Of Engineering, Block- A, Phase -III Kalyani, Nadia-741235, West Bengal

Abstract: ***From the very beginning of the civilization, human adopted new technologies to make simple their life, it leads them to the urbanization & industrialization. The result of that is the increasement of pollution in the air. After twentieth century, transportation sector became the major contributor to this pollution. This sector produces harmful gases like CO, HC, NOx etc. This has the harmful effects on the human being, more precisely asthma, eye iteration, lung disorder & consequences of fertility etc. To control the effect of that gases continuous monitoring of that gases is one of the way. Our system can be used to do this process properly.***

The application of IOT make this system more advance in order to control the car emission. It consist of MQ2, MQ7, MQ135 sensors. The system will implemente nearer to the tailpipe of the vehicle to monitor the emission, the result would be sent to the server as well as in the android application from which the concerned authority can check the result, will help to take the necessary step.

Keyword: Continuous Monitoring Of Gases, MQ 2 Sensor, MQ135 Sensor, MQ7 Sensor, Android Application

I. INTRODUCTION

From the beginning of the civilization, human adopted new technologies to make their life simpler. Industrialization is one of the biggest result of that. Automobile is one of the outcome of industrialization. As the industry grows a new term introduced as a curse on the environment is pollution. After twentieth century transportation sector became the major contributor of the air pollution. Almost 70% of total pollution occurred due to the vehicle or transportation sector in INDIA. Vehicle produced harmful pollutant gases like CO, HC, NOx in the exhaust.

This gases are responsible for different type of health hazards in human being. Commonly known as asthma, eye irritation, lung disorder. Emission come from vehicle exhaust pipes are responsible of increasement of global warming. It destroys the ground level ozone.

Vehicle emission is largest contributor of total green house gas generation. It leads to the change of climate of that particular country causing sea level rise, flooding, drought, acid rain, rise in temperature etc. This emission is cause of death of a 361,000 people in 2010 & 385,000 people in 2015. The main three gases produced in car emission is CO, HC, NOx. CO produced due to the incomplete burning of fuel. Hydrocarbon is produced due to unburnt fuel. When the emission reacts with the oxygen and nitrogen of air it produced Nitrogen Oxides. To reduce the amount of gases from the exhaust it is needed to do continuous monitoring. To do this thing in a proper manner our device is adapted with IOT, by which it send the data to the server for the ease of monitoring from all over the world.

II. PROBLEM DEFINITION

The environmental pollution has the long & severe effect in INDIA as well as in the whole world. Among the all types of environmental pollution Air pollution has the major effect in the environment as well as in the human being. Many cities of our country is enlisted in top polluted cities of the world.

The metro cities Delhi, Kolkata, Mumbai are the most polluted cities of the country. The main contributor of air pollution in urban areas of the country is Transportation sector, nearly 27% of total air pollution. The number of vehicle increased rapidly in road of this country & it is expected to increase in the same rate as increased in past 10 years. This will effect directly or indirectly the economy, public health, global warming, and environment.

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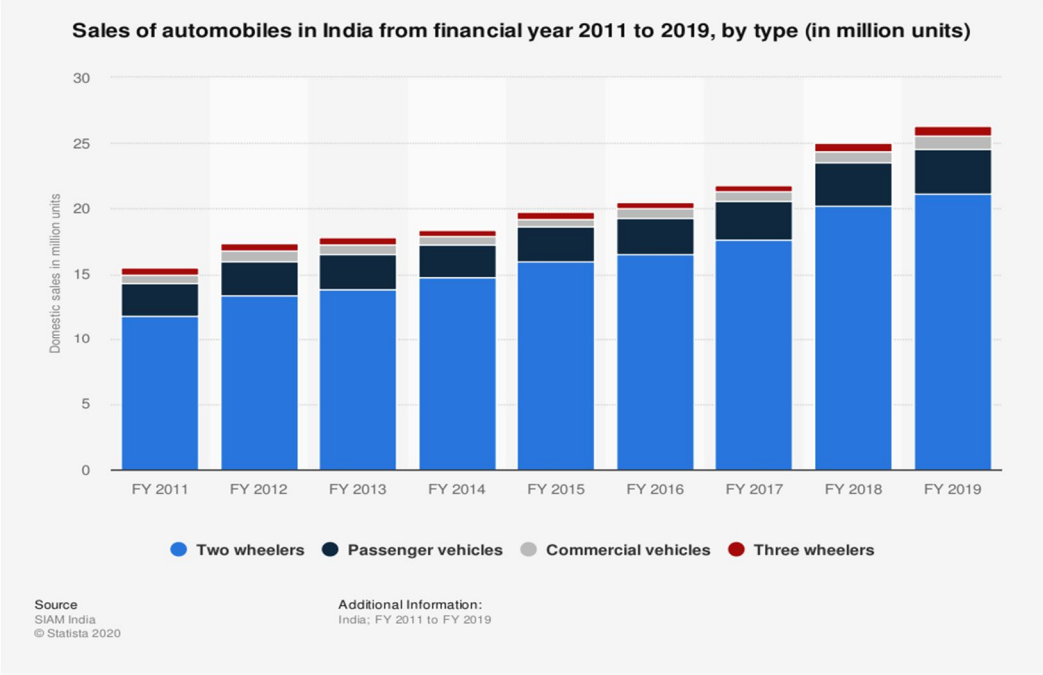


Fig 1: Growth Of Automobiles On The Indian Road
Source: https://www.statista.com/statistics/608392/automobile-industry-domestic-sales-trends-india/

Vehicle emission can have adverse impact such as high death rate, premature mortality, lower crop yields, environmental damages and so on CO ,HC, NOx are the most toxic gases produce deu to burning of fuel & has several effects.CO causes headache, dizziness, vomiting & nausea. HC some times acts as carcinogens & also effects heart kidney etc. NOx causes some severe respiratory problems. The rise of pollution is one of the concerned matter of the central government. Government issued Pollution Under Control Certificate (PUC) and Fit Certificate (FC) for all types of vehicle & an order of Supreme Court in the year 2017, had directed insurance companies not to insure a vehicle without a valid PUC certificate. So that it is mandatory to make a valid PUC certificate for all types of vehicles. State & Central government made a number of pollution testing centre all over the country. But it is not enough to do all the process in a good manner. In another order Supreme Court had directed that from april 2020 onwards a new emission standards will be introduce in market that is BSVI (Bharat Stage 6), this is more advance & stricter than previously present in market BSIV (Bharat Stage 4). It is not possible to stop the pollution but it can be reduce. Continuous Monitoring is the process by which we can monitor the vehicular emission in a regular interval so that it will help us to know the actual emission status of the vehicle in the regular basis which will be more helpfull for remote monitoring.

III. PROPOSED METHODOLOGY

As per the government rule PUC & FC is mandatory for all type of vehicle , but in practical scenario some situation may occur that the vehicle can emit the toxic period though it is in certification period due to rush driving, inappropriate combustion of fuel, degradation of fluidity of engine mobile, degradation of break oil, chemical composition of fuel etc. So reduce the emission of toxic gasses cannot be eliminated completely but through continuous & accurate monitoring it can be checked to a safe value. Continuous emission monitoring system (CEMS) is a real time air pollution monitoring system which consists of sampling , conditioning , analytical and software component by which the real time continuous analyzing of air can be possible. The rise of pollution is one of the concerned matter of the central government. In INDIA where population is nearly 135 cr, it is nearly impossible to make pollution testing centre for all vehicle owner & also to processes a PUC certificate takes considerable testing and time. CO, HC, NOx are the most harmful gasses produced due to burning of fuel and if the level of these pollutant is not checked it can cause some serious hamper to environment and humanity. Carbon monoxide produced due to the incomplete burning of fuel. Hydrocarbon is produced due to unburnt fuel. When the emission reacts with the oxygen and nitrogen of air it produced Nitrogen Oxides. So it is need to make an on board system in car to check the emission of that car which can continuously monitored the emission level of the particular vehicle. The system will sense the presence of three most harmful toxic gases (CO, HC, NOx) with the help of three different type of sensor.

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The value of the sensor will read by the Arduino Uno& if the amount of the gases crosses the set value defined in the programme then LCD will show that. As the proposed system is installed in the car near to the tailpipe and the owner can see the quality of emission at that time. We implemented this system through application and IOT. Due to incorporation of IOT the owner of the vehicle can monitor the quality of emission through application & simultaneously the value will be updated in the server which can be access by the vehicle owner. Android application will help us to monitor the process smoothly & seamlessly. This application increases the range of this system so that it can be applied on large no of vehicle. So the owner himself can monitor the quality of his vehicle emission from anywhere even he is not present within the vehicle and also shows the quality of his vehicle emission to the PUC certificate board. And it can be beneficial for the PUC board to provide the certificate and also save time. And if any consequences occurs the owner can further analyse his vehicle performance at the service.

A. Block Diagram

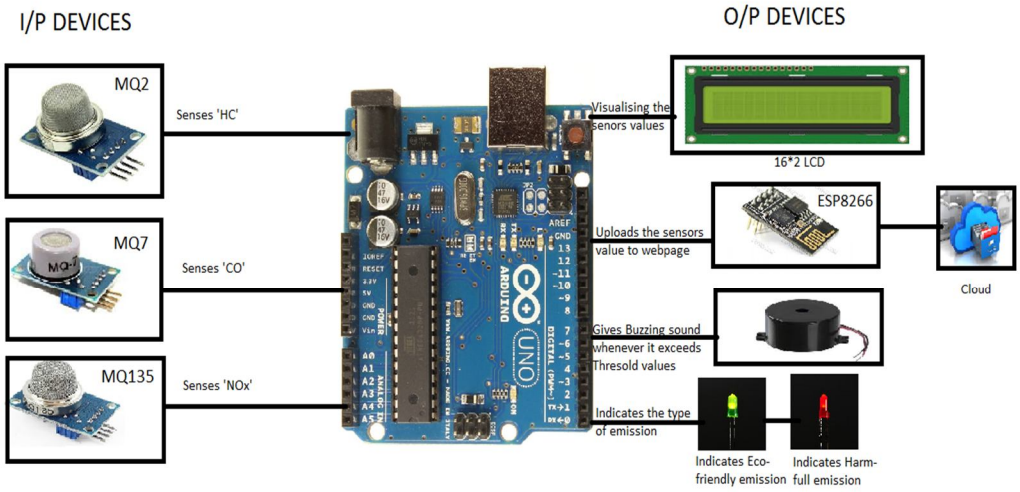


Fig 2: Block Diagram

B. Component

1) Arduino Uno: It is a microcontroller board consist of ATMEGA328P microcontroller. It is developed by Arduino.cc**.** This board cosists different type of input-output pins, in which 14 are digital I/O pins & 6 analog I/O pins. Different types of module can be attached with this board. It plays a vital role in this device. This board is programmed according to the needs of the system. It can be power through the pc or DC power jack.

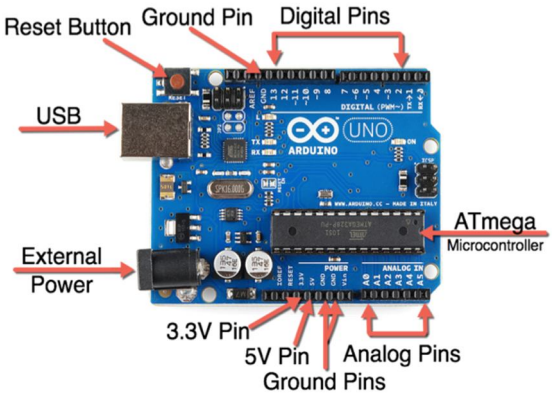


Fig 3: Arduino Uno

Source: https://wiki.eprolabs.com/index.php?title=File:ArduinoParts.png

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2) *Carbon Monoxide Sensor (CO):* One of the toxic gases present in the car emission is Carbon Monoxide. The MQ7 sensor is used in our device to detect the presence of CO in the emission & it is capable to detect the concentrations from 20 to 2000 PPM . In the emission of the vehicle contains CO particle due to the incomplete combustion of fuel. The operating voltage for this module is 5V.



Fig 4: Carbon Monoxide Sensor

Source: https://osoyoo.com/2018/11/15/arduino-lesson-mq-7-gas-sensor/

TABLE I. Co Sensor Module Pin Specification

PIN NAME	WORKING
VCC (5V)	Supply Pin
GND	Ground Pin
AO	Analog Output Pin
DO	Digital Output Pin

3) *Hydro Carbon Sensor (HC):* Hydro carbon is the another toxic gas present is the emission of the vehicle. The MQ2 sensor is used in our device to detect the presence of HC in the emission & it is capable to detect the concentrations from 200 to 10000 PPM. The operating voltage for this module is 5V.



Fig 5: Hydro Carbon Sensor

Source: https://diyprojects.io/mq2-gas-smoke-detector-arduino/#.XtJGjTozbIU

TABLE II
HC Sensor Module Pin Specification

PIN NAME	WORKING
VCC	Supply Pin
GND	Ground Pin
AO	Analog Output Pin
DO	Digital Output Pin

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4) *Nitrogen Oxide Sensor (NOx):*Nitrogen oxide primarily emitted from vehicle exhaust except that it emitted from burning of coal, oil, diesel fuel. .MQ135 sensor is used for detecting of nitrogen oxide from the emission. The operating voltage for the sensor module is 2.5V to 5V.



Fig 6: Nitrogen Oxide Sensor

Source: https://www.elprocus.com/mq-135-alcohol-sensor-circuit-and-working/

TABLE III
NOX Sensor Module Pin Specification

PIN NAME	WORKING
VCC	Supply Pin
GND	Ground Pin
AO	Analog Output Pin
DO	Digital Output Pin

5) *Liquid Crystal Display (16*2):* It is a flat panel display and use light modulating properties of liquid crystals combined with polarizer. In this device lcd works as a displaying medium of the sensors values. It plays a vital role in this on board device by representing the screen of the car. The owner of the car can check the emission of the car by seeing the screen of the car which is connected with the device.

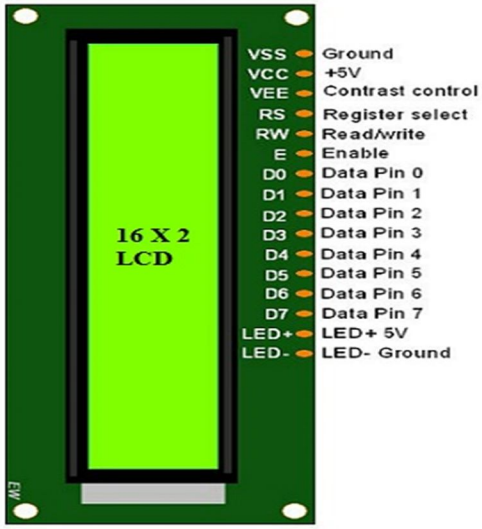


Fig 7: Liquid Crystal Display

Source: : https://www.elprocus.com/lcd-16x2-pin-configuration-and-its-working/

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6) I2C BUS I2C module is used for connecting the LCD with the arduino. It uses the PCF8574T IC chip and converts I2C serial data to parallel data for the LCD display. It simplifies the connection between arduino and LCD module

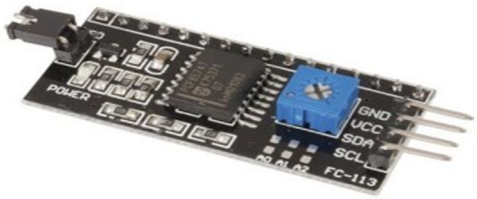


Fig 8: I2C Bus

Source: https://deepbluembedded.com/interfacing-i2c-lcd-16x2-tutorial-with-pic-microcontrollers-mplab-xc8/

TABLE IV

I2C Bus Module Pin Specification

PIN NAME	WORKING
VCC	5V
GND	GND
SDA	Serial Data
SLC	Serial Clock

*7) WiFi Module (ESP8266):*This module is self contained SOC with TCP/IP protocol stack which gives access to any microcontroller board to use the WIFI network. This module is pre programmed with AT command set firmware. This module needs 3.3V to operate . This module is extremely cost effective board for ever growing community. By applying this module to the device, the accessibility of the device increases & made this device a digitally powerful.

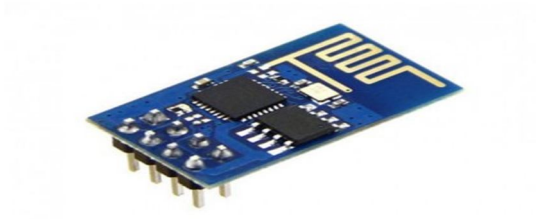


Fig 9: Wifi Module

Source: https://www.electronicwings.com/sensors-modules/esp8266-wifi-module

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TABLE V
WIFI Module (ESP 8266) Pin Specification

PIN NAME	WORKING
VCC	Supply pin(3.3V)
GND	Ground
TX(GPIO-I)	Serial Communication Pin
RX(GPIO-3)	Serial Communication Pin
RESET	Reset
CH_EN	Chip Enable-Active High
GPIO-0	General Purpose Input/Output Pin
GPIO-2	General Purpose Input/Output Pin

8) Buzzer: A Buzzer or Beeper is an audio signaling device, which converts the electrical signsl ito audio signal. A Buzzer is a small but very effective & efficient component and as it name suggest, its deliver some noise (Beepp..) to the specific or application oriented projects and add significance to it. The Operating voltage is 4 V to 8 V & the rated current is less than 30mA



Fig 10: Buzzer

Source: https://dumblebots.com/2019/04/01/arduino-tutorial-buzzing-buzzers/

TABLE VI
Buzzer Module (ESP 8266) Pin Specification

PIN NAME	WORKING
Positive (+ve)	Supply Pin
Negative (-ve)	Ground Pin

9) LED: Light Emitting Diode is the light emitting source which emits light when current passes through it. It is a semiconductor device where electron recombines with holes and produces energy in the form of photon. It use less electricity and don't get hot and also it is tiny in nature so that it can be use in every electrical circuits.

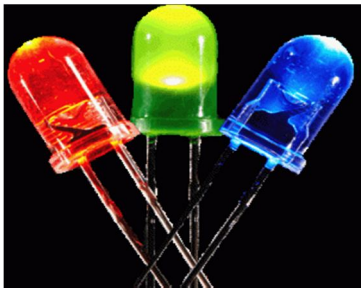


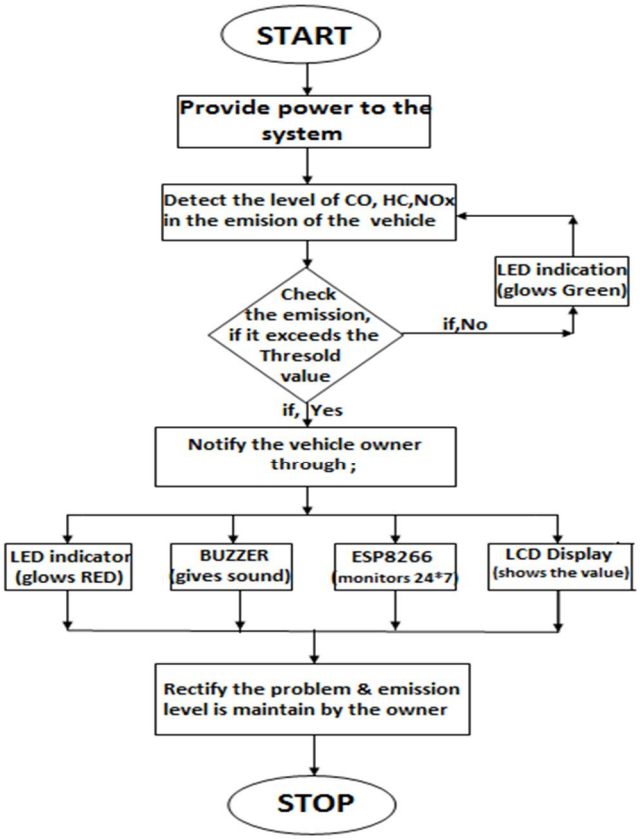
Fig 11: LED

Source: https://falconerelectronics.com/history-of-leds/

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C. Flow Chart



IV. LIMITATIONS & SOLUTIONS

A. Limitations

As this system is designed as an onboard system, so there are some limitations to install this system in the vehicle. The application of internet of things needs the internet hotspot to work properly. This limitations are very hard to solve in some cases. Hence, this project cannot be claimed to be flawless. The limitations of this project are as follows:

1) *Absence of Internet Module*: The absence of internet hotspot in some old vehicle will make an obstacle for implementation of this system.
2) *Presence of Buzzer:* The use of buzzer will make some disturbances as this system will work as a onboard system. If the threshold value cross it will produce buzzing sound & there are no such programme written in the software to stop the buzzer.
3) *Absence of screens in Two Wheelers:* The application of this system may create problems for two wheelers because there is no such screen like the four wheelers. So it will be hard to check the emissions.

B. Solutions

Aforesaid problems have some **solutions**:

1) *Internet Module:* There are some internet module is available in the market by which it is possible to arrange the internet hotspot for the old car. Some new car is in market with this feature within it.
2) *Arrangement For Buzzer:* It is possible to make some arrangement by which the sound of the buzzer can be stop.
3) *Android Application or GSM Module:* For the two wheelers the GSM can play a vital role by giving the messages when the threshold will cross. Android application can also be used to overcome this problem.

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V. CONCLUSION

In current scenario where pollution is increasing day by day we need to make some system by which this pollution can be reduced. Continuous Monitoring system is one of the best way to reduce the vehicular pollution as this system provides monitoring of emission at regular basis. Recently introduced BSVI emission standards compliant vehicles has lots of modern technologies and security devices but there is no such devices which will do the continuous monitoring of vehicle emission. Our proposed system is a sensor equipped system which will do the continuous monitoring as an onboard system. This system is also equipped with IOT which will help to watch the emission from anywhere of the world. This proposed system also has the android application which make this system easily accessible for all type of vehicle owner.

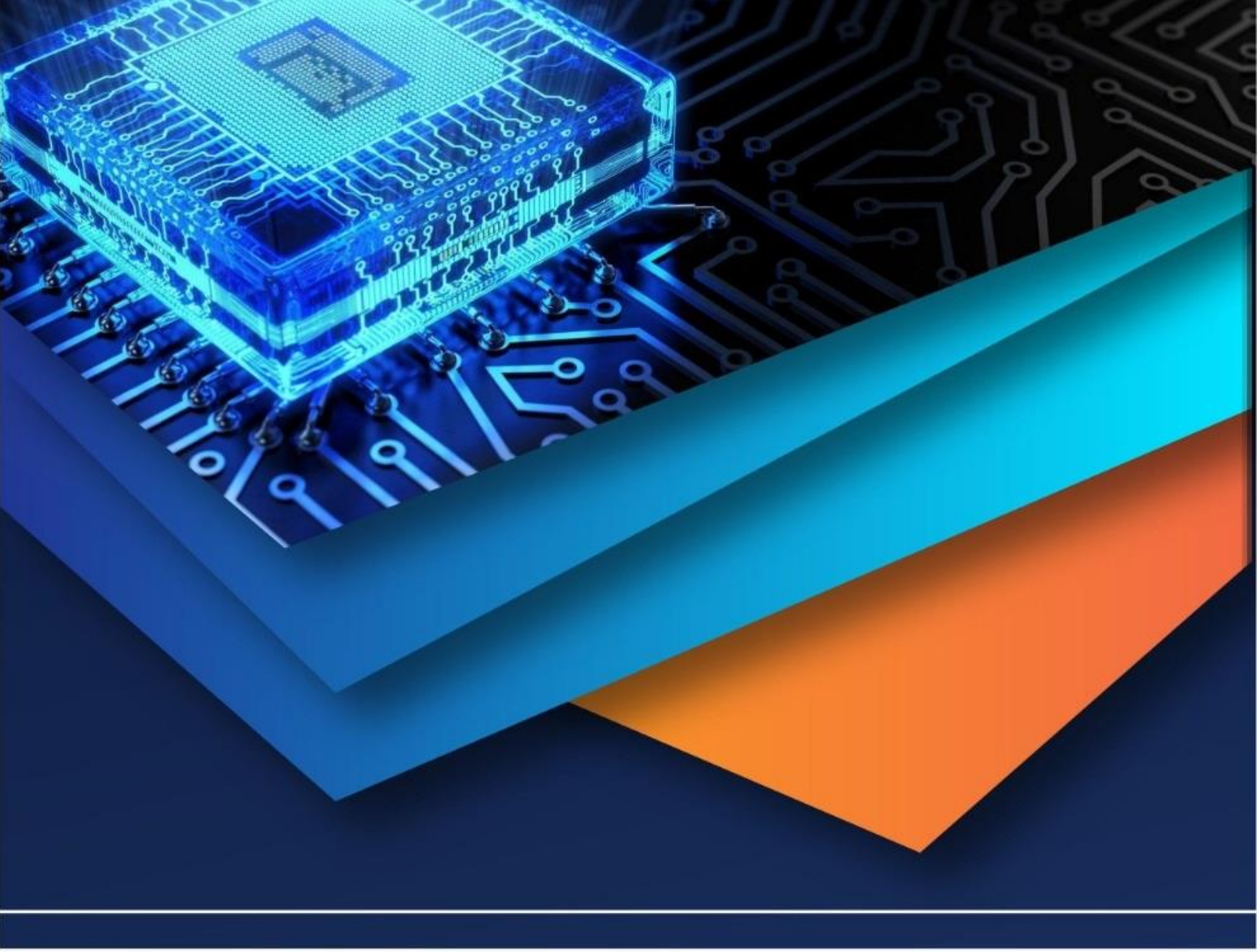
VI. ACKNOWLEDGEMENT

This project is the symbol of the team work of all the authors. At first the idea of this project comes in the mind of author Suman Dutta. The entire research work behind this idea was done by author Soumyadeep Das Adhikary and Suman Dutta .Choosing of components and related circuit operation was carried out by co-author Sohini Mondal & Sarbojit Ghosh. And the related diagrams and programming was done by co-author Sourav Mallick & Souvik Dhar. Mr. Partha Das (Assistant professor) guided this project and showed his immense support, courage throughout the work.

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