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Smart Automobile Air Pollution Monitoring Assistance Using Fuzzy Logic

Niwaz.P.M[1],Kaleeswaran.M[2], Prabhu.C.A[3],
Mohamed Raseem.A[4], Amali.C[*5]

[1,2,3,4]UG scholar,Department of Electronics and Communication Engineering
[5]Assistant professor, Department of Electronics and Communication Engineering
Valliammai Engineering College,SRM nagar,Kattankulathoor,Kancheepuram (India)

ABSTRACT

Catastrophic effects of the green house gases has been inclining day by day due to the peaked use of petrochemicals for automation of vehicles by the human society. The inflated use of these automobiles has been releasing immense amount of carbon monoxide into the atmosphere which causes predicament in the ozone layer indirectly leading to the global warming issue. This project is employed in eliminating the situation by monitoring the cars that produces increased air contaminants than the specified limits [2]. This experiment tryout the use of fuzzy logic which acts as a crucible neural network in making the decisions. Thereby, the process involves a mixed use of gas sensors and MEMS sensors to analyze the air pollutants level produced by the vehicles through the exhaust during the combustion process by the engine.

Keywords : Arduino , Fuzzy logic , Gas Sensor, MEMS Sensor

I. INTRODUCTION

Pollution is an uprising quagmire that has been inclining as a gigantic and catastrophic effect that can relentlessly destroy the earth's atmosphere within certain decades. The major dilemmatic threat the world has been imposed on is air pollution.

The increase of the particulate micro matters that causes several toxic diseases to the human beings has been inflated due to the air pollution that has been prevailing in the society. The day to day increase in vehicles has set a major drawback for the human society as they result in the emission of hulking amount of carbon monoxide .The carbon monoxide imposes various menaces in the health of human beings.

The carbon monoxide restricts the flow of stream of blood and deflates oxygen supply and thereby making the heart disease curbed patient sensitive during the indispensable situations. Similarly several threats can be influenced by the CO gas. Thus the air pollution monitoring employing fuzzy logic [3-5] can be employed in vehicles to gather information about the air pollutants levels and thereby helps in monitoring the pollution caused by each vehicle and can perform the necessary actions.

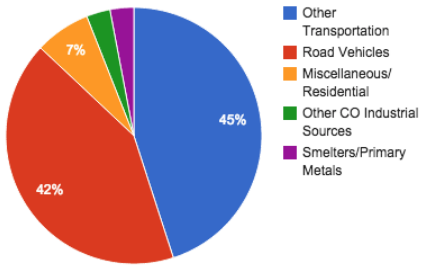

Fig 1. Carbon monoxide production by various sectors

The fuzzy logic exists as an important primal foundations for artificial intelligence. It revolves around the case of if –then rules such that it may proceeds out for a partial true or a partial false value from which certain actions can be made. The fuzzy algorithm acts as an important requisite by academia and industrialists for further implementation of neural networks in the process of air pollution monitoring.

The air contaminants produced by the vehicles may involve certain gases and dust particles .They are analyzed by the gas sensors [13] in an imminent and operative way and the information are analyzed by the fuzzy logic to gain the partial value to perform certain response for the exceeding limits. Similarly the MEMS sensor keenly dissects the driving designation of the user such that if the user is indulged in such abnormal driving characterizations, the speed of the engine drops below a particular margin [1]. The information about the aberrant limits were passed on to the particular vehicle user when it crosses the toll plaza [6,7] by the use of GSM[9-11] which is a cost effective module with a massive amount of base stations deployed over every nook of the globe. Based on the particular emission level effectual steps can be further perpetrated by the user to lower the emissions produced by the vehicle.The paper can be proceeded with the sections given below. Section-II illustrates about the related works. A brief knowledge about fuzzy logic is discussed in section-III. The proposed architecture is mooted in section IV. Implementation of the unique architecture is discussed in section-V. Cordially, we end up with section VI.

II. RELATED WORKS

[1] Javier.E.Maseguer proposes the method to characterize the fuel consumption of the vehicles by their respective driving style. The neural networks has been employed in this process to conclude how a driving style may increase the fuel consumption and thereby leading to the emission of green house gases like CO which depletes ozone.

[2] Muhammad Saqib Jamil discusses about the use of WSN in public places to collect the information about the emission limits of particular public transport vehicles like buses. The proposed method gets the information about the emission levels using LTE-M network such that the vehicles which needs further maintenance can be classified. The proposed system concludes that the mesh network can gather information in a better manner.

[3], [4] in different localities and countries involves fuzzy logic inference systems to gather and perform actions based on the inference values. The systems conclude by employing CO emission reduction based on the gathered emission limits in order to stabilize the temperature.

[5] Dong Liang-Cai experiments a deliberate method of deriving an air quality index based sytem by employing fuzzy algorithm. The paper concludes by deriving a database that's based on the fuzzy decision index so as to make government aware about the green house gas producing systems in a particular locality.

[6] Uzunova proposed the method to control gas emissions that are produced by traffic velocities using a toll plaza. Such that the CO emissions can be reduced to a greater bound due to the arranged flow of traffic such that it ensures a fluid flow of vehicles on the road.

[7], [8] Gualtieri proposes the method of integrated monitoring for the monitoring of fluid flow traffics in urban areas and thereby assessing the results of air pollution in the particular urban areas.

[9-13] proposes the method to monitor air quality using gas sensors. The particular emissive levels if found to be above the abrasive limits, the vehicles information can be shared by using vehicular cloud environment and thereby the respective steps can be taken towards the user by intimating the user about the particular emission levels using GSM. If the denial of the alert message continues on, the information about the particular vehicle can be intended to be shared to the transport corporation so that the necessary steps can be taken towards the particular vehicle owner.

III. FUZZY LOGIC

The fuzzy logic prevail its utmost existence long before it was officially found. The fuzzy logic gives a base to the artificial intelligence system such that it can make human like decisions and it helps in exclaiming out the flexibility of the process in an effectual manner. The fuzzy logic is usually based on the partial true or a partial false statement. They depict the probabilities and range from 0 to 1 and the fuzzy logic not only uses the ranges but it also employs the mathematical vagueness as a degree of truth.

The fuzzy logic includes three processes comprising fuzzification, fuzzy rules knowledge inference, defuzzification. The input variables has to move through these proceedings to get the flexible reliable output.

The input fixed variable are given in the fuzzification module such that they may be divided based on their partial truth value. These inputs are depicted by triangle or trapezoid forms. They remain in a fixed manner.

Once the external variables are given to the process, they reach out the fuzzy inference base and the values are compared with the fuzzy rules. They mainly depend on the classic if-then rules. So if a condition is provided and if it's not satisfied by the external variable, then particular action takes place to compensate the process.

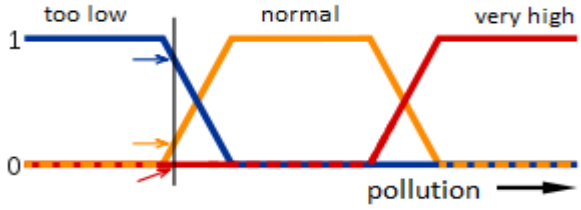

Fig 2. Depicting the trapezoidal form of fuzzy logic

After the values are compared with the fuzzy inference base, the defuzzification process takes place. It tends to give the continuous variable from fuzzy truth values. Such that the output variables are combined using OR operator and the center of weight for the particular process is found.

The standard logistic function for the fuzzy logic can be given by

$$S(a) = 1 / (1+e^{-a})$$

The process has the following symmetry property

$$S(a) + S(-a) = 1$$

The operators that has been used in fuzzy logic are as follows

Boolean	**Fuzzy**
AND(a,b)	Min(a,b)
OR(a,b)	Max(a,b)
NOT(a)	1-a

Thus these are some of the processes that have been taking part in fuzzy logic principles. Thus the fuzzy logic helps in making human based decisions and it helps in providing flexibility to the process. Thus this process gives an air pollution assessment such that the pollution level can be noticed as too low or too high based on the user that uses the vehicle and thereby it helps in monitoring the pollution.

IV. PROPOSED FRAMEWORK

The actual system can be achieved using particular sensors which get the values for the process and the values are further calculated for data acquisition. The block architecture can be given to depict the process that takes place in the system. The architectural design consists of air quality sensor to extract the information about the gas emissions produced from certain amount of smoke or dust and the process employs the use of MEMS sensor to know about the acceleration in the vehicle and to characterize the driving movements produced by the driver.

A. Gas Sensor

The gas sensor employed here is the MQ-135 air quality sensor. The Mq-135 sensor employs a good sensitivity for carbon monoxide. It has adjustable sensitivity and it produces analog values from 0 to 4095 which are further converted to digital values. The gas sensor obtains the value from the exhaust smoke of the vehicle and convert analog values to the requires form.

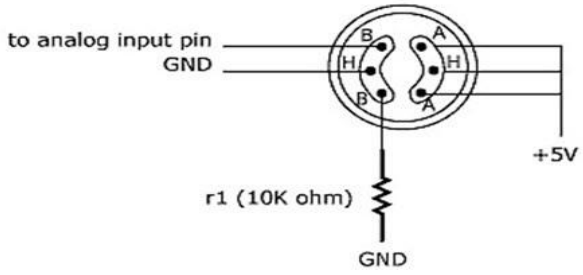

Fig 3 . Pin diagram of gas sensor

B. MEMS sensor

The MEMS sensor employs the use of ADXL-335 sensor. It involves a 3 axis sensing. The process takes horizontal and vertical axis into account and hence when the driving style is characterized for the user and if abnormal driving is characterized, engine slows down.

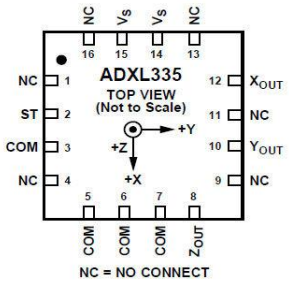

Fig 4. Pin diagram of MEMS sensor

C. GSM

The GSM has been employed in this process to intimate the user once the limit has gone beyond the threshold value. The GSM simulates on the quad band and hence it's easier to operate GSM in remote areas. It uses the process of TDMA and hence one user can be allotted with a particular space. The messages are delivered to the user once the peak level reaches and the messages are issued every time it occurs.

D. ATmega 328microcontroller

The Uno version of arduino microcontroller containing the AT mega 328 is used in this process to carry out the processing. The information that are sensed by the gas and MEMS sensors are streamed to the Uno microcontroller such that it passes the information through the fuzzy logic and gathers output back through the defuzzification module. Thus the embedded processes are carried out in Uno version of arduino microcontroller with the help of the analog pins which gets the analog information and convert them to digital ones.

E. Tranceivers

The tranceivers are the one which work on the ground of radio frequency. The information that is collected from the arduino is stored in transceivers. Once they reach the toll plaza, the transceivers comes in contact with another transceivers such that the information are assimilated in the database that governs about the vehicles information. The transceivers works on the ground of RSSI algorithm to pass out the information and to store the information in the database.

The Block Diagram can be provided as follows

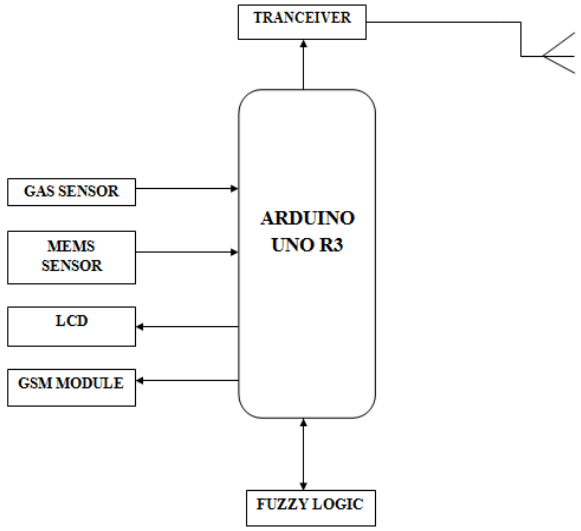

Fig 5. Block diagram of the system in vehicle

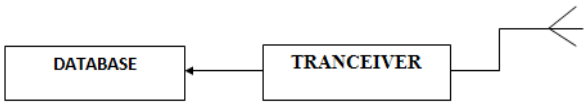

Fig 6. Block Diagram of the system in tollbooth

V. IMPLEMENTATION OF ARCHITECTURE

The steps that take place in this proposed system proceeds as follows. The information is gathered by the sensor and the values are streamed such that the air quality gas sensor value reaches the Uno r3 version of arduino. The microcontroller after receiving the information from the gas sensors sends the input variables to FLC module. The fuzzy module consists of the fixed variables in the fuzzification module.

The information from the gas sensor send by the arduino is the moved through the fuzzification of system such that it reaches the fuzzy inference system where the fixed input values are compared with the inputs gathered from the Uno version of arduino microcontroller. If the values found are beyond the threshold levels, defuzzification process will continue and arduino receives the information and the messages are transmitted using GSM system.

If the alert messages were issued more than 3 times, fine will be deduced from the user's digitalized credential account. If the fine process occurs more than 3 times, intimation will be given to the control regarding information of the vehicle and hence the vehicle can be seized.

The emission of CO gas due to rash driving can be characterized by means of MEMS accelerometer sensor. The MEMS sensor calculates both the horizontal and vertical axis such that it characterizes the driving movement of vehicle user and if any change occurs in the speed or angle of tilt more than needed; the movement of automobile reduces to 40 Kmph.

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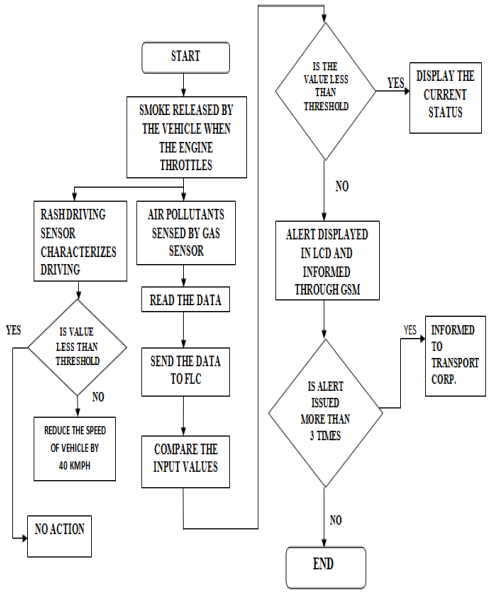

Fig 7. Flowchart

VI. RESULTS AND CONCLUSION

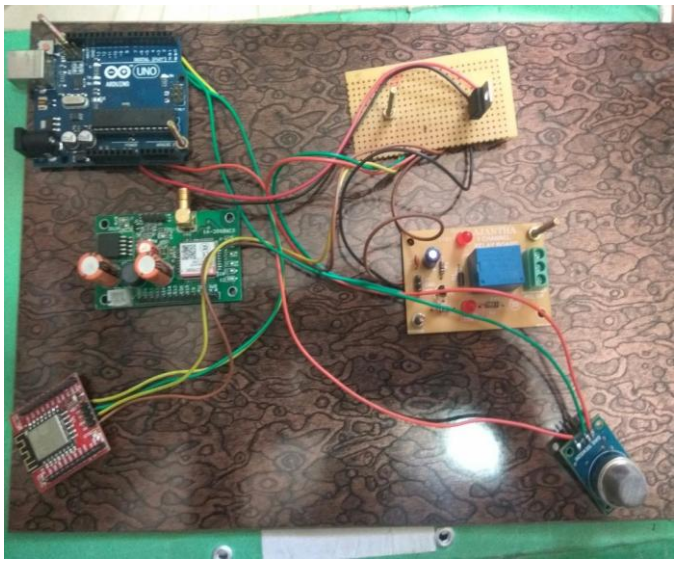

Fig 8. Integrating gas sensor and MEMS sensor with arduino

The process experimentally implemented to detect the amount of micro particle carbon monoxide exhausted by the vehicles.The CO concentration of vehicles analysed can be given as follows

Vehicle id	Day 1	Day 2	Day 3	Day 4	Day 5
1	402	385	397	420	389
2	405	406	396	398	407
3	398	392	397	394	399
4	402	399	395	380	382

Table. Contents of Carbon Monoxide produced in vehicles.

The following table content gives the experimental results about the project. The vehicles are provided with a particular id .Such that each id stores the information about the user. Whenever the vehicle crosses the tollbooth the emission levels are sent to the respective database. The database shows the information about the vehicle and the gas emitted in the last 5 days. There were variations in the amount of micro particulate carbon monoxide

produced by the vehicles. Then the experimental results are analyzed by using the process in the exhaust of the vehicle. So that the poisonous smokes released are known by the process using certain gas sensors that we use up along with the fuzzy logic modules. The gas sensors module plays a substantial role in deliberating the value of CO and toxic gas concentrations in the process.

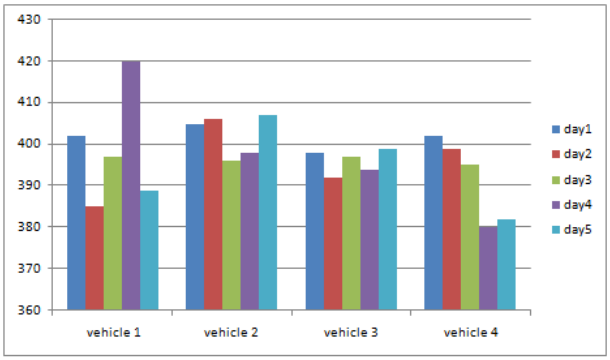

Fig 9. Representing the CO data obtained from vehicles

These are the data that are gathered through the process of air pollution monitoring. We can infer that pollution limits varies day by day. However the fuzzy logic grounds a momentous and prominent role in making the actions against a particular increase in limits of the process.

The fuzzy logic limits are applied to the process by analyzing the graph given above. The fuzzy logic which is employing the if-then rules compares the values in the form such that the values can be clearly differentiated as too low, normal and very high. The data when moving beyond the limits are provided with high emission level alert and the emission which stays in order need not be intimated with alert messages. Thus the fuzzy logic thereby provides flexibility by introducing ranges and probabilities that includes mathematical vagueness as a part of truth value.

The CO level was provided with a particular limit starting from 0 to 1000 ppm. The value 250 can be deliberated as an average for moderately vehicle populated areas. Whenever it crosses the limit of above 450 ppm, the vehicle can be considered as producer for major gas Carbon Monoxide which acts as a major threat to the health of the people who live in the society and as an imminent peril for the future generations.

Thus the process can be exiled out in thick populated urban areas [8] with large amount of small weighing and heavy weighing vehicles .A critical analysis about the pollutant levels about the vehicle can be listed out in an unadulterated manner. So that necessary care could be taken for the particular user and vehicle in assisting them by issuing alert messages to the particular user to carry out maintenance in vehicle . The data analyzed by the

system can be stored in cloud database [12] that could be governed effectively by the government which could help in analyzing the data about the pollution.

VII. ACKNOWLEDGMENT

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