Recent Investigation on Fuels, EV and Hybrid Electrical Vehicles impacts on Pollution Control Techniques and Predictions Using IOT Technology

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ABSTRACT
As there is a growing rate of urbanization it is no new news that our world is being affected by global warming which is majorly caused by automobiles and its pollution taking their first spot and the rest settling down to their lower ranks. Evolvement in automobiles like electrical and hybrid electrical vehicles had lead to ease in day to day activities at the same time there is an increase in direct and life cycle emissions. In recent years people have shown interest towards developing IOT, it helps in monitoring and detecting the emissions and involve wireless sensors and gas sensors. The detected emission results are transferred to the database using the internet. The scope of this paper is to give an overview of predictions and control techniques of pollutions caused by vehicles using the IOT technology. IOT helps in acquiring and refining the result, it is an efficient and effective way to determine the pollutants compared to other methods and it is economical than other methodologies. Finally the main objective is to find a solution for environmental pollution.
Keywords: IOT: Internet of Things, Wireless Sensors, Electric Vehicle and Life Cycle Emissions.

INTRODUCTION
There has been an evident increase in the technological implementation in a mundane world. Automobiles have been the major part of technological developments and it has become a necessity to an average human being [1]. Electric vehicles and hybrid electric vehicles have played a major role in focusing on major developments of less fuel consuming automobiles. The emissions released by the cars into the environment that are causing humongous problems to the mankind have been brought into light [2]. The fuel on which a vehicle runs gets burned inside the engine which in turn emits various harmful gases into the environment causing environmental problems like increase in CO2 which in turn results in increase in temperature and causes global warming, ozone layer depletion, climatic changes, respiratory issues and various other health hazards. The hazardous emissions from the vehicles such as Carbon Monoxides(CO),Nitrogen Oxides(NOX), Carbon Oxides(COX) can increase or decrease from the criteria set by the Central Pollution Control Board that can be monitored and predicted using IOT technology [3]. To control air pollution we have to calculate the pollutants emitted from the vehicles and it gets easy to use IOT monitoring system. It gathers

and analyzes the pollutants exhausted from the vehicle [4]. As there have been many advancement in the field of computer technology and one such captivating development is IOT and IOT branches with many other fields. The detectors and sensors for CO, CO2, and HC sense the gas and conveys to the user interface device [5]. These emissions are detected by IOT technology where the physical device like raspberry pi and sensors like mq2, mq7 and mq135 helps in detecting emissions and is connected to the user-interface device, and the collected and sorted information is accessed by user through internet [6].This paper presents to predict the vehicle emissions by sensors and techniques involved in controlling the emissions by collecting data using IOT.

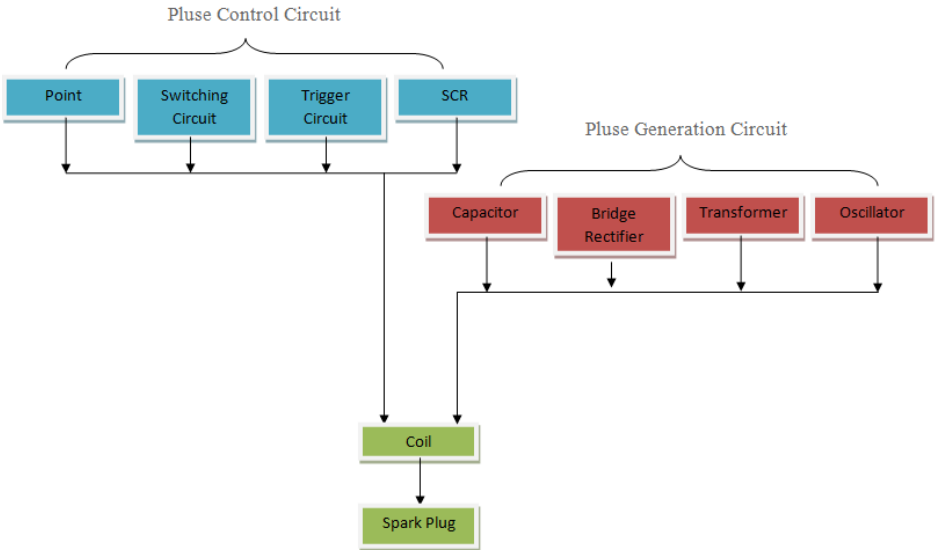

Fig.1 CDI Block Diagram

2. LITERATURE SURVEY

2.1 Direct Injection

First generation diesel engines were equipped with the functioning of direct injection; the fuel is injected into the combustion chamber directly. Although it has a higher low-end torque, lower maintenance and a very long engine life its many drawback is that it is compatible to a heavier engine and the noise produced i.e. higher NVH levels (Noise, Vibration and Harshness). Payri et al. has experimented and analyzed on the transfer of heat from the gases to the walls of single cylinder of DI engines using Computational Fluid Dynamics (CFD) and compared with a zero-dimensional thermodynamic model based on a variant of the Woschni equation. Two DI engine geometries, a heavy duty one with a displacement of 2.0 L and a small one of 0.4 L are taken at different working points and the CFD calculations of the compression and expansion strokes are done. Mean flow behavior and turbulence levels influence the heat transfer rate to the surface of the cylinder. Conclusions are drawn from the more accurate CFD results [28] and a simple modification of the terms included in the Woschni-like equation of the thermodynamic model is proposed to better take into account the significant influence of the swirl on the heat transfer [3]

C. D. Rakopoulos et al. has examined and verified the destruction in a DI diesel engine with reference to the limited cooled case. Calculating irreversibility during the combustion and availability f working medium at the terminal point of expansion process in a DI engine can be done to determine the fuel relation rate that helps in determining the combustion irreversibility production rate by a formulated analytical mathematical equation using combination of first and second law of thermodynamics. To get the combustion irreversibility the expression derived from the usage of first and second law of thermodynamics is merged with the standard first law calculations and is integrated finally. The analysis of availability destruction and accumulation is a tool for determining the utilization of the ability of fuels to give reversible production in the Di engine with a given fixed conditions. Earlier researches have dealt and came up with a similar case study; their definition of availability in a closed chemically reacting system within the limits of a larger surrounding one, as is the case of the closed part of the cycle of a piston internal combustion engine, is given in such a manner that the maximum work-producing ability of the working medium is defined as availability, by means of the second law of thermodynamics [4].

The subtraction of increase in system availability work from the availability of transferred work into combustion in form of heat and input fuel is irreversibility. Rakopoulos C.D. has derived that the subtraction when mathematically processed leads to the connection of rate of irreversibility product with the working medium thermodynamic properties, the rate of change of products of the reaction and the rate of fuel reaction and preparation. This was expressed through experimental indicator figures of a cylinder, naturally aspirated, Di, LV1diesel engine, four strokes which were taken as the equipment's for the experiment. The objective of their experiment is to investigate the effect of the operating variables on each term of the engine availability balance [4]. The aim also includes the evaluation of heat transfer reduction i.e., limited cooling engine, by the second law on the potential for the improvements with less heat rejection to the cooling medium with the help of availability in recovery device as power turbines. DI is being adopted into light vehicles for low CO2 emission and high thermal efficiency. DI has an enormous amount of NOX and particulate emissions releasing from it. To reduce the emission of NOX controlling the combustion temperature and taking control of O2 intake is done. A common rail (CR) system is used to supply the electro-injectors with high pressure fuel independently by the quantity of fuel. This is done to decouple the regulation of the pump by the operation of the injectors, differently from traditional injection systems where the mechanic pump generates a pressure varying with the quantity of fuel to be injected [5]. The sole function of the Fuel Injection Pump is to supply the accurately measured amount of fuel to each cylinder at specific time intervals in accordance with the position of the piston. According to the load and speed the fuel is compressed into high pressure and then is injected into it. The presence of an oil cooler in the diesel engine acts as an cooling medium and the heat is removed by the oil cooler. The piston cooling and the rubbing friction which causes power loss can be calculated by subtracting the pumping loss and access power from the motoring power. A practical method for this is the Willan's line; a plot of flow rate Vs. BMEP is to extrapolate to zero fuel flow rate to calculate the MEP or power.

Yue Chen et al. in 2014 has experimented on the multi objective optimization of combustion chamber of a DI engine taking the NLPQL algorithm into consideration to reduce soot and

NOx emissions because of the local low excess air coefficient, uneven air/fuel mixing and high combustion temperature in the combustion process; while parallelly maintaining a reasonable performance. Parameters related to injection and features of the combustions are optimized as they influence air or fuel mixing, combustion and formations of emissions. Use of orthogonal method achieves a set of optimized parameters of combustion chamber to reduce the soot. Formation of emissions can be identified accurately and comprehensively by comparing the before and after of transient flow field [6].

Xusheng Zhang has observed that emissions of NOx and consumptions of fuel are higher when there is a increase in biodiesel (soybean methyl ester) percentage in the input fuel. At different loads and constant speed the single-cylinder Direct Injection (DI) experiment was conducted; Compared with the baseline diesel fuel, B20 (20% biodiesel) has a slight increase of NOx emission and similar fuel consumption.[7]The results have shown that start of combustion(SOC) for the biodiesel(B20) is earlier than that of diesel. This is due to the advanced injection timing from higher density and bulk modulus and lower ignition delay from higher cetane number. The poor rate of evaporation and atomization features of B20 decreases the peak of heat release rate (PHRR) and lowers the ignition delay from higher CN (Cetane Number). The hot Exhaust Gas Recirculation (EGR) will decrease the NOx emissions from the diesel significantly. NOx emission of pure biodiesel is lower than baseline of diesel at about 10% EGR rate.

The engines output is increased by 3 percent with smoke, HC and CO; and particulate matter showing lesser values when esterified soybean oil was used as a diesel. A DI engine running on olive oil results in same efficiency and engine performance as of baseline diesel with a noticeable reduction of C02, CO, NOx and SO2 emissions by 8.6%,59%,32% and 57% respectively[8].

2.2 Engine Configuration

Modern Spark Ignition Engines (SI) to have either a Straight engine layout, engine being positioned in parallel to the vehicle or, Inline engine(I) layout provided with more space for the other components or, a boxer engine layout to keep low centre of gravity of automobiles making it convenient to handle [11, 28].

A Das *et al.* have examined and observed various mixtures of Natural Gas (NG) used in modern Spark Ignition Engines (SI) tending to have higher compression ratios and reduce in the occurrences of irregular process of combustion leading to damage of engine. Different engines have different optimum Compression Ratios (CR), Production engine running on Natural gas has optimum CR of 15:1 and a V-8 engine with gasoline has optimum CR ranging between 14:1 and 18:1. Four-valve pent roof combustion chamber is observed to have higher combustion rate and flame speed .For efficient combustion of lean mixtures of natural gas, reduction flame travel time, increasing of burning rate and increasing of propagation speed done through means of positioning of spark ignition at centre, swirl and tumble induction and squish motion have been observed to improve. The Natural Gas combustion in engines have shown to emit only 65 percent of carbon dioxide (CO2) of petrol-based cars, reduction in emissions of other Hydro carbons (HC), Nitrogen oxides (NOx) and to improve efficiency of automobile as well [11]

In Piston internal combustion engines, it is observed that the efficiency of the automobile could be affected by the local heat transfer in the engine configuration which could be reduced up to 5-20% depending on the crankshaft speed by cross profiling of the intake and exhaust pipes. It has also been observed that elements in the exhaust pipe have had less thermal stress and efficiency of the turbine of the turbocharger to be improved [9]

The Automobile Industry have been having considerate interest in Hybrid Electric vehicles as they are used to provide a better reliable alternative for its efficient fuel economy, reduced emissions of pollutants or increased horsepower of vehicle. The combination of traditional combustion engine configuration and electric motors might help to meet the objectives intended in future [12]

Mehrdad Ehsani*et al.* studied that there has been an increase in the manufacturing and development of hybrid-electric vehicles in the automobiles industries. HEV's are used to power the vehicle by two sources one being the internal combustion (IC) engine and other the electric motor drive and chemical batteries. Since there are two power sources in HEV, there involves various power flow combination patterns according to the load requirements is the concept of hybrid drive train and it is said to be implemented either in Series Hybrid Drive train architecture or Parallel Hybrid Drive train architecture or Series-Parallel Hybrid Drive train architecture. Series Hybrid drive train architecture is used in heavy vehicles, buses and military vehicles where as parallel Hybrid and series- parallel hybrid drive trains are used in small cars and vehicles. Hybrid Energy storage is a proper combination of chemical batteries and ultra capacitors, that has been observed to be characterized with high energy and high power compared to Chemical batteries such as SAFT batteries that has developed Li-ion batteries producing power and energy of 4000 and 600 W/kg being sold at higher cost or Ultra-capacitors developed by Maxwells Technologies of 2.55-kW/kg specific power and 3.23-Wh/kg specific energy having relatively less specific energy. Hybrid Electric Vehicles have been considered to be the better alternatives for the fuel-based vehicles for its high performance, high fuel efficiency, long operating period and less emissions [10].

As there is a power split in hybrid electric vehicles optimization over the control of power split can be achieved by the ECMS strategy that is based on the fuel equivalent of the electrical energy. Few control parameters and no priori knowledge of future driving conditions are the aspects involved.

DI engines and IC engines have undergone some high extent of developments but also has observed the combustion results of engines in emissions of NOx, HC, COx which could be minimized by improving the combustion process in the engine. Over-leaning of fuels, Over-riching of fuels and engine load plays an evident role in heterogeneous combustion of fuels and emissions of HC's in DI engines [14]

There have been many techniques implied such as water diesel fuel emulsion injection, variable compression ratio, EGR, pilot injection to lower the temperature due to combustion in engine but Porous medium (PM) technology has been observed to be controlling the combustion process and mixture formation in an engine. Combustion in porous media has been observed to have high heat transfer rate, high heat capacity and heat resistance of material and extended region for combustion process. Engines adopting PM technology has been observed to have control over combustion process and improve the steady and unsteady

state combustion process. Overall, the reduction in emissions and improvement in engine efficiency has been observed in porous medium combustion technique [13].

2.3 Capacitor Discharge Ignition System

Evolution of solid-state electronics has resulted in voluminous improvements in the field of technology, and has replaced all the enormous heavy components into compact and efficient electronic systems and Ignition system is one such instance. CDI is also known as thyristor ignition and it was introduced to overcome the long charging time of Inductive Discharge Ignition (IDI).

Michikata Kono *et al*. studied that higher ignition power could improve the efficiency of the automotive and higher ignition power is also associated with spark energy and sparkduration. Capacitor Discharge Ignition (CDI) system is studied to have higher ignition ability and better convenience in installing and synchronizing with the vehicle's engine. CDI uses a capacitor that stores and discharges electric charges and the high currents produced by the discharging capacitor, charges the coils for ignition. CDI system consists of capacitor, diode, silicon-controlled rectifier (SCR), triggering unit, excitation unit, ignition coil and spark plug [15].

CDI also consists of pulse generation circuit and pulse control circuit, and is responsible for the generation of DC voltage. The induced excitation coil sends an electric current that is used for charging the capacitor. The diode prevents the capacitor from discharging as it can allow current to flow only in one direction but, the SCR connected with the capacitor, makes it discharge as it gets triggered. The discharging capacitor charges the primary coil that in turn changes the magnetic field around it. This induces a very high voltage in the secondary coil and is used for producing the sparks. CDI system requires a lesser time for charging the capacitor and has a fast rise in the voltage but, the spark duration is less and has a possibility of electromagnetic noise [16].

Audris et al. studied that the multi spark Capacitor Discharge Ignition system (CDI) satisfies the modern ignition system for SI engines (Spark ignition) by eliminating misfired ignition cycles and providing reliable spark duration for the ignition of fuels. CDI and IDI are two of the systems adapted by modern ignition systems in SI engines. Inductive Discharge Ignition (IDI) is said to have long spark duration that is suitable for SI engines at low rpm, but for the heavy loads short spark is reliable and longer spark duration might cause energy wastage and erosion of spark plug. Multi spark CDI system is observed to produce sequential sparks at low rpm and have shorter charging time in contrast to IDI systems. Automotive running at low rpm with lean fuel mixture and light load with higher spark energy and spark duration is said to have better fuel economy and it has been observed that fuel economy of SI engine increased by 2-3% at no load and speed between 950-1900 rpm. Adapting a spark ignition system for different operations of SI engine helps in reducing the exhaust emissions and improve fuel economy. Multi spark CDI system is observed to have better functionality at low speed and light load and one spark short spark discharge of CDI system to be better working at high speeds and loads [17].

2.4 Population Effects on Pollution

As there has been a significant development in distinct fields of study for the urge of satisfying human convenience and needs, there has also been strain in environment. As the countries trying to economically stand firm and compete with other countries, it's causing a collateral damage on environment causing in depletion of resources, environmental degradation, and pollution. Population explosion is one of the main reasons for causes of pollution, as the number of people begin to increase, the resource's demand starts to increase as well [18].

Increase in population has been observed to deteriorate not only air pollution but also global warming conditions, increase in energy production and consumption, degradation of natural resources such as minerals, fuels and ground water. Population growth and increase in poverty has observed to have had more strain on environment and controlling the population and poverty issues would lead in conservation of environment and natural resources for future purposes [21].

Badami studied and observed that the contributing factors towards urban pollution in India are vehicles such as M2W and M3W being the majority of Indian vehicles fleet are responsible for the emissions of hydrocarbons, Nitrogen oxides and suspended particles that results in morbidity issues related to respiratory, cardiovascular, leukaemia and cancer. The fuel consumed by vehicles having more lead content than allowed such as in gasoline also significantly contributes to the pollution criteria. Automobile configuration and combustion process of fuel, construction and infrastructure of roads, congestion issues and transportation system has also been observed as a crucial factor for pollution in India. It has been studied that vehicle emission control policies such as emission standards being strictive, fuel adulteration to be reduced and fuel licensing implemented, improving the vehicle combustion configuration, proper vehicle registrations, transportation management and traffic control could help in reducing the urban pollution in India [20].

Shrivastava R. K *et al.* studied that air pollution is one of the major outcomes of rapid urbanization and population explosion, and that transportation sector plays a prominent role in contribution to air pollution, as the exhaust pollutants released by the vehicles such as carbon monoxide (CO), Oxides of nitrogen and sulphur (NO2 &S02), Lead (Pb) and Suspended Particulate Matter (SPM) are hazardous to both humans and the environment. In developing countries like India, it has been observed that road transportation is leading to emission of almost 261 tonnes of C02 causing some serious damage and factors involved are age of vehicle, combustion mechanism of fuel involved and type of fuel used, but most vehicles have Internal Combustion Engine systems (ICE) that is responsible for emissions including CO as well contributing almost 90% total emissions of pollutants followed by NOx and SPM [21].

As hazardous emissions from vehicles are one of the major contributions to the pollution factor in environment, it can be reduced by implementing sensor detection of emissions from exhaust of automobiles [27-30]. By installing semi-conductor sensor in the exhaust of

vehicles, it can detect the amount of CO, NOx, Hydrocarbons being emitted that if exceeds the standardized amount would indicate the limit that has reached and cut off the fuel supply. This system could be one of the advantageous add on to the vehicle and reduce the air pollution factor [22].

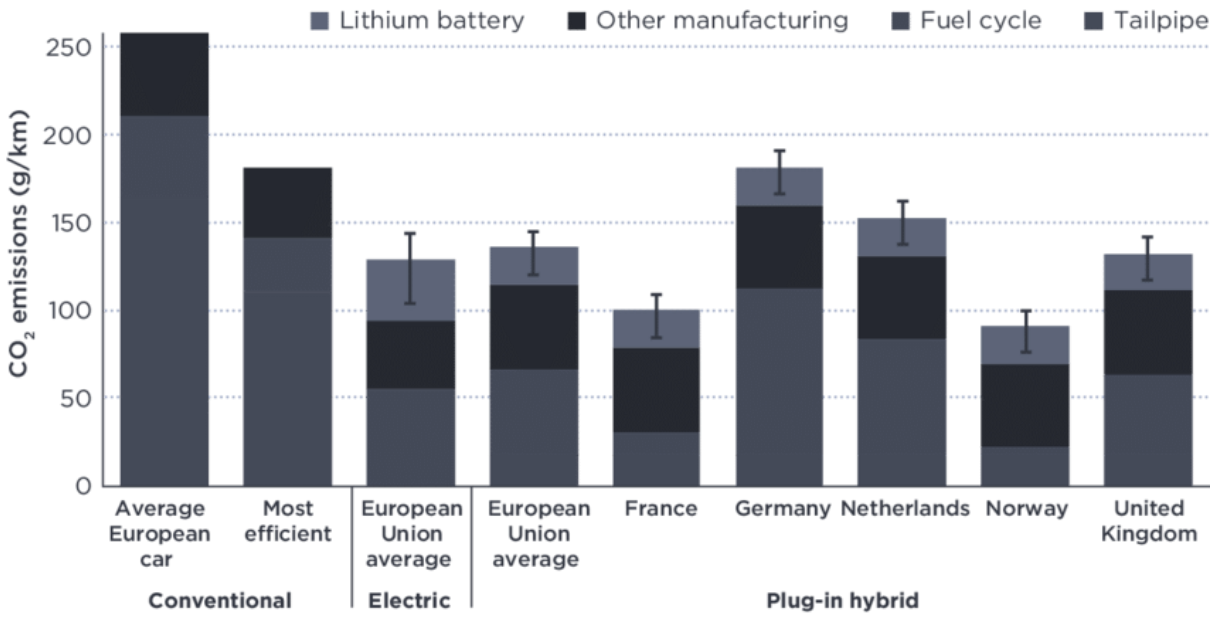

Fig.2 Co_2 Emission measures in Conventional, Electric and Plug-in hybrid

2.5 Internet of Things on Pollution Monitoring

Adnan A. et.al has observed that In 2012 Cisco initiated a new computing model called Fog to assist the cloud computing to inflate QoS and to develop variety of IOT applications also commonly called edge computing. Fog on the users end enables the data to be preprocessed and modify them from raw data to smart data that can traverse through media efficiently; due to its reduction in size bandwidth is not compromised, increases capacity and performance. Fog is independent of internet connection leading it to have more mobility. Emerging technology like virtual reality can provide sustenance by Fog. Security was not taken as a priority while building IOT devices. Security can only be accomplished in these devices by a solution that delivers visibility, segmentation and provides protection to the network as a whole. As technology has advanced more than ever in this century, security is a concern to those using IOT solutions today. There is a scarcity in startups in the field of cybersecurity, it is an area in heavy investments and the research will be a growing trend in the coming years. It is also known that block chain can be used to increase or achieve higher security in IOT. Fog increases security to data by encrypting it before sending the data to the cloud server [23].

Piyush Patil has experimented on technology to detect pollution and noise from a vehicle using an IOT device. The experiment was done using a Raspberry Pi 3, a GSM module, a RFID Reader and tag, a MQ-2, MQ-7 and noise sensors.

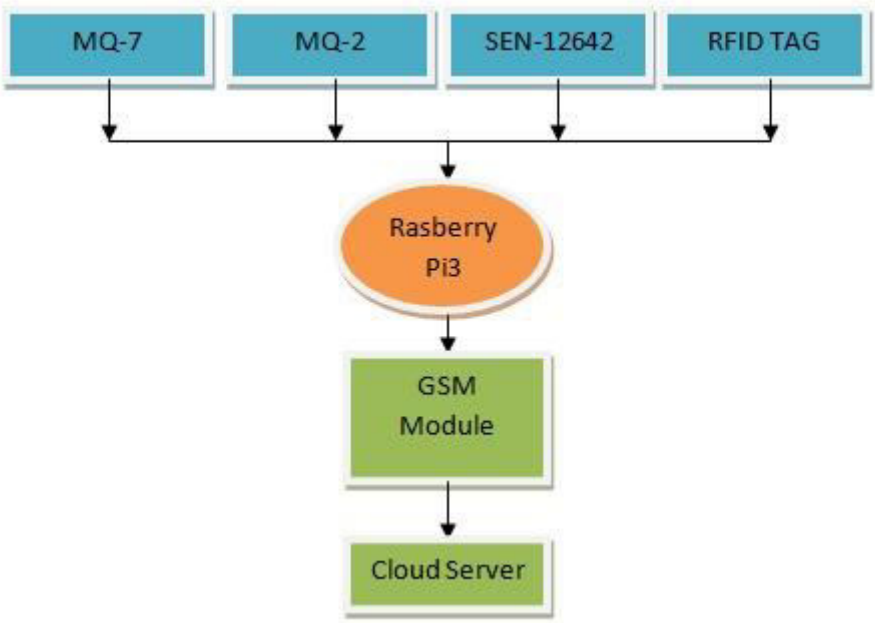

Fig.3 Configuration of IoT System

Raspberry Pi is a micro controller used to receive the output from the sensors and transfer the analog data into a PC (cloud server). Raspberry Pi 3 was preferred than Raspberry Pi 2 cause the version 3 has a 1.2ghz ARM V8 CPU, a Bluetooth version 4.1, a wireless LAN 802.1 in and these features are not present in the old version of Raspberry Pi the raspberry Pi 2 [24]. A GSM Module is used to transfer the data into the PC (cloud server) from the Raspberry Pi. MQ 2 is a sensor to detect the concentration of H2, CH4, CO, LPG, Smoke and etc. in the air. It is made up of Aluminum oxide ceramic tube, SNo2, electrodes and heater are attached to a plastic and stainless steel net. MQ 2 is taken for this experiment because of its good detective senses in a wide range. MQ 7 is a sensor used to detect the concentration of carbon monoxide in air. It is made of the same elements as of MQ 2. This sensor can measure a concentration of CO from 10-10,000 parts per million. MQ 7 is concedered because of its low cost and stability. SEN-12642 is a noise sensor that is used to detect the noise made in the engine combustion chamber that allows the fuel and air to be compressed and ignited resulting in noise (sound) production. RFID abbreviates to radio frequency identification, this technology has a EPC number also called the electronic product code number that acts like a pointer to a package that holds the additional information of the RFID tag; this tag is sensed by a RFID reader from a certain distance. This experiment is set in a way that First the vehicle is started which triggers the Raspberry Pi to ON that initializes the three sensors and starts to convert the analog data. A threshold limit is given as 20 minutes that indicated the Raspberry Pi to take the analog data every 20 minutes and the GSM module is used to send the data to the cloud. RFID tag is assigned to a car and the RFID reader is set to the traffic signal pole. This experiment uses a Display Screen and LED attached to a car. If the MQ-2 and MQ-7 sensors sense gas emitted crossing the limit set then the LED will change its color to RED and if not then to GREEN and the noise sensed by the SEN-12642 is displayed on the screen. These values are sent to the cloud and stored in it and if the values are alarming then it is sent to the department of traffic for future actions [27]. As the sensors are sensitive the values are taken

more than once over a period of time and are averaged to get the optimal values. This is done due to the readings taking in the values of air pollution caused by other vehicles during the time of heavy traffic [25]. D. Arunkumar et.al has experimented on a similar technology of detecting air pollution using IOT by clubbing the sensor like humidity sensor, temperature sensor, gas, sensor, smoke sensor etc. together as a single device by using IOT that receives the readings indicating the pollution existing in a specific location [26].

Discussion & Conclusion

In this study, the review focuses on a system that shows the usage of edge computing to develop an air pollution detection system.

- Using this system as a proof of concept to demonstrate that several air pollution sensor-equipped devices may be used efficiently to monitor air quality levels covering a small geographical area or distance in real time. The futuristic technology concentrated on integrating edge computing capacities with cloud compute capabilities throughout the implementation of our system. In order to monitor air pollution in real time, the research focuses on designing, a cost-efficient solution which uses low cost edge equipment.

- The findings show the efficiency of using a model based on the edge for the surveillance of air pollution levels. In addition, it shows that the development of a low-cost device network with sensors can be used to receive air pollution data in real time. These data could then be used further for further observations or decision-making.

- Moreover, it is important to integrate the area where this data is created to establish any pattern for changes in air pollution. This gives you greater insights into the construction of major pollution incidents with the contextual information acquired. The information may be beneficial for smart cities. The cost-effectiveness of the system means that it is easy to use and can be accessed by many users remotely. The use of edge computing however imposes certain limits as the scale of IoT devices.

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