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DISCOVERING THOUGHTS AND INVENTING FUTURE

Lamborgini Factory

Highlights

- Architecture from a Styling Envelope
- An Investigation on The Variation
- Distance Measuring Hurdle detection System
- The Implications of Importation of Used Vehicles

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Generation of Optimised Hybrid Electric Vehicle Body in White Architecture from a Styling Envelope

By J. Christensen, C. Bastien, M. V. Blundel, O. Grimes, A. Appella, G. Bareham, K. O'Sullivan

Coventry University, Priory Street, CV1 5FB, UK

Abstract - As focus on the world climate rises, so does the demand for ever more environmentally friendly technologies. The response from the automotive industry includes vehicles whose primary propulsion systems are not based upon fossil fuels, namely Full Electrical Vehicles (FEV). There is an opportunity to design and engineer new innovative FEV architectures, whilst minimising their mass in order to further reduce carbon emissions. This paper proposes an engineering process for optimising new FEV lightweight vehicle architecture based on a technique entitled topology optimisation, which extracts the idealised load paths for a given set of load cases. Subsequently shape and size optimisations are conducted in order to obtain detailed information of localised vehicle geometry such as individual BIW cross-sections. The research discusses each individual step of the overall process including successes, limitations and further engineering challenges and complications which will need to be resolved in order to automate the vehicle architecture design to include e.g. durability and (dynamic) crashworthiness performance.

Keywords : BIW, topology optimisation, shape optimisation, size optimisation, crashworthiness, roof crush.

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GENERATION OF OPTIMISED HYBRID ELECTRIC VEHICLE BODY IN WHITE ARCHITECTURE FROM A STYLING ENVELOPE

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J. Christensen[α], C. Bastien[α], M. V. Blundel[α], O. Grimes[α], A. Appella[α], G. Bareham[α], K. O'Sullivan[α]

Abstract - As focus on the world climate rises, so does the demand for ever more environmentally friendly technologies. The response from the automotive industry includes vehicles whose primary propulsion systems are not based upon fossil fuels, namely Full Electrical Vehicles (FEV). There is an opportunity to design and engineer new innovative FEV architectures, whilst minimising their mass in order to further reduce carbon emissions. This paper proposes an engineering process for optimising new FEV lightweight vehicle architecture based on a technique entitled topology optimisation, which extracts the idealised load paths for a given set of load cases. Subsequently shape and size optimisations are conducted in order to obtain detailed information of localised vehicle geometry such as individual BIW cross-sections. The research discusses each individual step of the overall process including successes, limitations and further engineering challenges and complications which will need to be resolved in order to automate the vehicle architecture design to include e.g. durability and (dynamic) crashworthiness performance.

Keywords : BIW, topology optimisation, shape optimisation, size optimisation, crashworthiness, roof crush.

I. Introduction

Given the current state of the economy there is a global consensus to reduce Carbon Emissions (CE) in relation to the automotive industry. Stringent targets have been set in order to achieve a 30% reduction in CE by 2020 [Greencars (2010)] for reducing greenhouse gas emissions by a minimum of 20% relative to 1990 levels, to increase the share of renewable energy sources in our final energy consumption to 20%, and to increase energy efficiency by 20%. The public expectations to move towards the electrification of road transport are driven by a multitude of factors and concerns including: climate change, primary energy dependence, public health as well as cost and scarcity of raw materials. However, it is the growing awareness that the underlying technology has gained a sufficient level of maturity which is also driving the need for more rapid development thereof.

Users are demanding Electric Vehicles (EV) to perform well beyond those that the Original Equipment Manufacturers (OEMs) can deliver at present. However, the spread of "unsafe" vehicles, polluting vehicles, bad practices and inefficient infrastructures should be avoided. This EU initiative significantly affects the design of new vehicles, leading to new green technologies aimed at reducing CO_2 levels. These include automatic stop/start, KER (Kinetic Energy Restitution by braking) and better engine management systems. Electric battery vehicles are now being considered as potentials to replace current Fossil Fuelled Vehicles (FFV). EVs are however still in the early stages of development, and their acceptance as a full replacement for FFVs still not universal. As part of the Cabled project [Cabled (2011)] a fleet of 110 new vehicles fitted with electric technology is currently being tested in Coventry (UK) and Birmingham (UK), aimed at assessing customer attitude to initial purchase price as well as range anxiety for longer journeys which remains to be resolved before mass deployment of EVs.

All these new technologies will potentially be beneficial to aid in the reduction of CO_2 emissions. However, the electric components required for EVs most often lead to a substantial increase in overall vehicle mass, resulting in increased energy consumption for vehicle propulsion. Other significant questions also remain unanswered, primarily relating to the safety of batteries, particularly during impacts scenarios.

The Low Carbon Vehicle Technology Project (LCVTP) [LCVTP (2011)] addressed the problem of electrical vehicle light weighting, in order to compensate for the added mass of the battery. This was achieved by performing advanced Body In White (BIW) topology optimisation[4], mainly focussed on structures utilising isotropic materials. The vehicle BIW design optimisation primarily considered a multi-disciplinary approach to design optimisation, mainly focused at EuroNCAP equivalent static load cases as well a torsional rigidity. The Low Carbon Vehicle Technology Project has been instrumental in understanding vital attributes essential for engineering lightweight vehicle structures. Additional funded projects are presently underway, such as the EPSRC (UK) funded project, Towards Affordable, Closed-Loop Recyclable Future Low Carbon Vehicle Structures (TARF-LCV) project [EPSRC (2011)]. The overall aim of the TARF-LCV project is to define a comprehensive scientific and technological foundation for future LCV development in the strategic areas of

Author α : Coventry University, Faculty of Engineering and Computing, Priory Street, CV1 5FB, UK

advanced materials, low carbon manufacturing technologies, holistic mass-optimised vehicle structure design and closed-loop recycling of End Of Life Vehicles (ELV). Another example of a current project is the FP7 European funded research project entitled Ecoshell [Ecoshell (2012)], the overall aim of which is to develop bio-composite based super light electric passenger vehicles.

The project is concerned with the development of optimal structural solutions for superlight electric vehicles (category L6 and L7e, i.e. lighter than 400kg without batteries), decreasing the environmental footprint, and using an innovative bio-composite material for the vehicle body.

These projects demonstrates the timeliness and urgency of developing tools and techniques related to vehicle light weighting, especially within the field of electrical vehicles.

One of the major improvements needed from the LCVTP project was the improved definition of the architecture obtained by utilising topology optimisation techniques [Huang and Xie (2010)], [GACM (2011)] and [Duddeck (2007). Indeed, generating a BIW topology by means of optimisation does not provide detailed knowledge of the individual section properties, rather an indication of force flow throughout the structure [Duddeck (2007)].

This paper aims to utilise the findings of the results and techniques obtained from the research undertaken in the LCVTP [Bastien and Christensen (2011)], [Christensen et. al (2011)], [Christensen et. al (2011a)], [Bastien (2010)] propose a framework to automatically generate the BIW architecture including detailed cross-sectional properties of the vehicle architecture.

II. Optimisation Technique Used in the Framework and Limitations

The objective of the study was to minimise the BIW mass when exposed to the load cases illustrated by Figure 1. These include front impact Rigid Wall (RW) and Offset Deformable Barrier (ODB), pole impact, side barrier impact, roof crush on top of A-pillar, low speed centred rear impact, high speed rear impact and torsional rigidity.

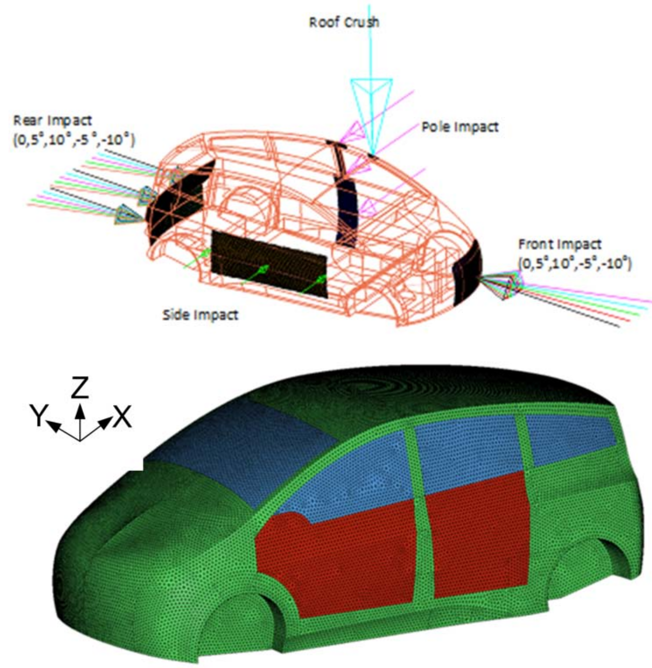

Figure 1 : Loads applied on the vehicle and associated analytical model

To solve the problem, two different types of constraints were considered, Single Point Constraints (SPC) and Inertia Relief, (IR).

The SPC constrains the Degree Of Freedom (DOF) for selected nodes, the model thereby seeks to obtain force equilibrium of the structure, by means of equation (1).

$$\{F\} = [k] \cdot \{u\} \qquad (1)$$

IR works by balancing the external loading with inertial loads and accelerations within the structure itself, without constraining any DOF. This is specifically done by "adding" an extra displacement-dependent load to the load vector, and subsequently adapting the stiffness matrix [k], as indicated in equation (2), where $[k_{add}]$ represents the additional terms of the stiffness matrix, [k] is the "original" stiffness matrix in equation (1), [Altair (2010)].

$$\{F\} = [k_{IR}] \cdot \{u\} = \begin{bmatrix} [k] & 0 \\ 0 & [k_{add}] \end{bmatrix} \cdot \{u\} \qquad (2)$$

Both methods were investigated and it was concluded that the IR method provided the most stable and adequate solution [Christensen et. al (2011)].

It has to be noted that the current state of the art optimisation methodology is based upon an implicit linear solving algorithm, which is very well suited for structural stiffness design. This method can however not predict non-linearity, let alone complex buckling events, such as the collapse of a front longitudinal member. Within these limitations it has been documented that the solution provided by the linear solver produces a "reasonable" topology for the safety (passenger) cell, roof and floor [Bastien and Christensen (2011)]. The linear static topology optimisation algorithms used were based on the Solid Isotropic Material with Penalisation (SIMP) interpolation scheme [Bendsøe and Sigmund (2003)], stipulating that the relationship between the stiffness matrix [k] or [k_{IR}] and the volumetric mass density (ρ) was defined by the "power law for representation of elasticity properties" as equation (3) [Altair (2010)]:

$$\underline{[\mathrm{k}]}(\rho) = \rho^{p}[\mathrm{k}] \quad (3)$$

In equation (3), $\underline{[k]}$ is the penalised stiffness matrix, and p is the penalisation factor, which is used to determine the "type" of relationship between [k] and ρ. As long as ρ is equal to 1.0 the two are directly proportional, as illustrated in Figure 2.

This relationship can be adjusted, by varying ρ with the effects as indicated in Fig. 3. The reason for adjusting this relationship is typically to penalise intermediate density values, in order to avoid "vague" definitions of topology, this is also sometimes referred to as "checkerboard effect".

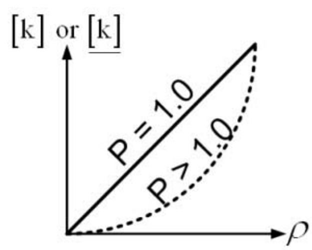

Figure 2 : Relationship between [k] and ρ.

However, initial analyses revealed that this was not a widespread problem for the models in question. Therefore in the remainder of this paper the value of p will be 1.0, i.e. a linear relationship between the stiffness matrix [k] and the mass density ρ will exist.

From the tools used, and within the current mathematical limitations for topology algorithms, it has been well documented that topology optimisation on its own is adequate for safety cage development (A-pillar, side rails, headers, roof structures and floor) [Bastien and Christensen (2011)], [Christensen et. al (2011)], [Christensen et. al (2011a)], [Bastien (2010)], but not for the generation of the front end crash structure, which is expected to plastically deform during crash scenarios, i.e. experience non-linear behaviour.

III. Automation of Design Process

The optimisation processes proposed in this paper, utilises the design envelope of the Tata Beacon [LCVTP (2011)]. The ultimate aim of this process is to complement the topology optimisation phase by providing further detailed definitions of the local BIW structure (cross-sections) whilst keeping the vehicle architecture mass to a minimum. BIW development processes do in general not utilise both topology-, shape-, and size- optimisation in succession to each other, consequently leading to BIW designs not fully exploiting the potential of structural optimisation for minimising BIW mass [Duddeck (2007)].

The flow-chart of the proposed design process is illustrated in Figure 3; outlining the necessary steps to minimise BIW mass. The starting point is the styling envelope of the vehicle used to define the design volume for the topology optimisation process. The design volume definition is key for the success of a truly lightweight architecture characterisation.

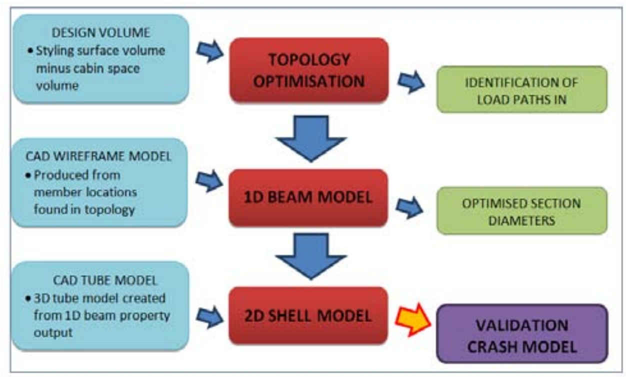

Figure 3 : Automatic Design Process

a) *Design Volume*

Firstly, the Design Volume was defined by removing the interior cabin volume from the volume created by the exterior styling surfaces. In locations where thin walls existed (i.e. roof and sides) design volume was created (e.g. a 50mm) to allow space for structural members to form during the topology optimisation process.

All non-structural components were excluded from the BIW design volume, such as the electric motor, the batteries and the range extender, as these were not assumed to transmit any load originating from crash scenarios. Excluding these from the design volume ensured that no structural members were defined in these areas during the topology optimisation, thus allowing sufficient space for these components and vehicle packaging in general.

Furthermore, vehicle apertures were only considered to be attached at hinges and locking points, hence these were detached from the main body (design volume) and were fixed to the main body in such a way that they only provided longitudinal stiffness for the appropriate load cases.

With the above considerations the design volume for the BIW was defined. This provides the starting point for the optimisation process, as dictated by Figure 3.

b) Topology Optimisation

The general load paths for the BIW architecture were then extracted by means of topology optimisation, removing inefficient material with respect to the structural integrity of the BIW, exposed to the pre-defined load cases.

The design volume was meshed with first order tetrahedral elements, and also included concentrated nodal masses to reproduce the inertial effects originating from e.g. battery mass. Vehicle apertures were constrained to the main vehicle body at the hinge and lock locations, in order to represent longitudinal stiffness in connection with the relevant load cases illustrated in Figure 1.

As previously discussed, the load cases represented equivalent static forces relative to those utilised for a dynamic crash scenario modelling, extracted from relevant crash tests. These included front-, rear-, side-, pole-impact as well as roof crush scenarios. The front and rear load cases also considered application angle sensitivities by adding load cases with the loads applied at 5°, 10°,-5° and -10° relative to the global x-axis, Figure 1. The roof crush loading was applied at the top of the A-pillar, thus representing a vehicle roll-over. The pole impact scenario was applied at the B-pillar. The side impact loading was evenly distributed spread over a rectangular area between the front and rear doors.

2D elements (shell barriers) were created at the locations of the applied forces, with coincident nodes to the 3D elements of the design volume. Subsequently the loading was applied to the 2D elements, allowing the entire vehicle body to undergo volume reduction optimisation. The purpose of this was to eliminate the requirement for non-design areas to maintain constant applied loading as material was removed (3D elements) during the topology optimisation.

c) Wireframe Model from Topology Design Fraction

Following the topology optimisation a wireframe model was created based upon the optimised load path, Figure 5.

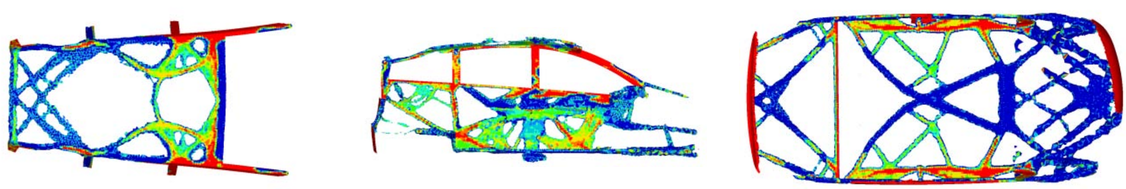

Figure 4 : Topology results. Roof (left), Side (centre) and floor (right)

As the final BIW design was required to be symmetrical (around the xz-plane, Figure 1), the topology optimisation was set up using symmetry constraints. Consequently it was sufficient to utilise "half" the wireframe model in the continued optimisation study. The wireframe model is illustrated in Figure 5.

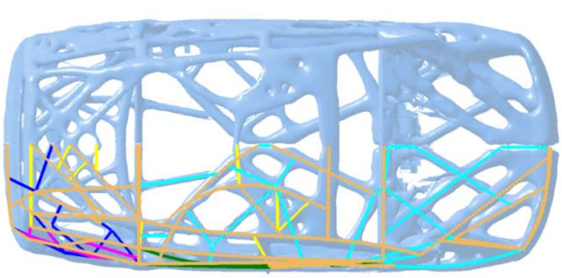

Figure 5 : Topology Optimisation result with wireframe overlay

In order to continue the BIW optimisation process of Figure 3, it was necessary to simplify the BIW topology, utilising beams to represent the individual load paths. This step was the only one of the entire process to be completed manually. The primary reason for this was the complexity associated with interpreting the results. This required profound "engineering intuition", which is extremely difficult, if not impossible to program. The location of these beams relative to the topology optimisation results are illustrated in Figure 5.

d) 1D Beam Model

The objective of the beam model was to create a model where each individual section (member) could be optimised independently of one another. This was to be achieved within the pre-set optimisation constraints, aimed at producing a lightweight structure. In order to transform the beams produced by the topology optimisation into hollow beam sections to be further optimised, an initial beam property needed to be specified. A tube section profile was chosen in order to find the ideal sectional stiffness' and dimensions using a minimal number of design variables. Since the topology optimisation produced in excess of 100 individual members, the starting cross-sectional properties of each individual member, as well as the associated design variables needed to be defined. This was achieved using an automatic script generation process, allowing the parameters to be automatically created in the architecture of the input deck. Each property specified a sequential property ID to which the relevant beam was associated. Each property ID had the relevant Design Relationship (DVPREL input card [Altair (2010)]) defined and related to it. This was in order to define the variables of the cross-sectional dimensions, a Design Equation (DEQATN input card [Altair (2010)]) linking the section dimensions to prevent the crossing of the inner and outer radii and a Design Variable (DESVAR input card [Altair (2010)]) to specify the initial dimensions and the sizing limitations of the individual member.

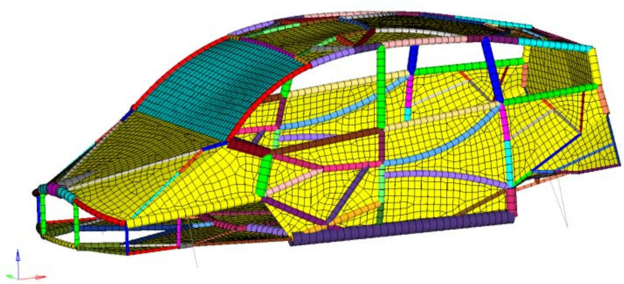

Figure 6 : 1D Beam model with shear panels

The wireframe model was used to position beam elements at the locations produced from the topology optimisation. Each line mesh was assigned relevant section property IDs which included the corresponding dimensions and general optimisation setup. Shell elements were used to represent shear panels between the beam elements, characterising the outside body panels of the BIW. The beam and shell elements in areas representing apertures were only attached at hinge and lock point locations, to represent the same fixing of that used for the topology optimisation.

It was imperative to ensure that the load steps of the 1D beam model were applied analogue to the ones used for the topology optimisation. In addition, the 1D model also utilised Inertia Relief boundary conditions.

At this point, an additional loadcase was added to ensure a static torsional rigidity between 16-20 kN/m. Previous studies had shown that this was not necessary to include during the topology optimisation stage, as this did not have any significant effects upon the topology optimisation results. However, this load case was fundamental in order to generate appropriate BIW topology to resist torsion and twist, even without monitoring the magnitudes thereof.

In addition to the optimisation constraints outlined above, it was also crucial to include considerations with respect to buckling of individual members. The importance of this can be realised by considering the consequences of roof members buckling during roll over cases. Existing linear buckling analyses models using eigenvalue extraction were unsuitable for the purpose of this model [Altair (2010)]. This was due to the incompatibility between inertia relief boundary conditions and eigenvalue models. Because severe crashes are one off events to the BIW, the deformation is only a concern when the limit load of the bifurcation point is reached.

Instead, the detection of buckling modes utilised Euler's buckling formula, equation (4), in order to calculate the critical buckling force F_{crit} for each member.

$$F_{crit} = \frac{\pi^2 \cdot E \cdot I}{k \cdot L^2} \tag{4}$$

In equation (4), E is Young's modulus, I is the second moment of area, k is the slenderness ratio whilst L is the length of the beam member. The worst case buckling mode occurs when k in equation (4) is equal to 1.

By monitoring the second moment of area, the critical buckling load of the individual member could be monitored for each iteration. Furthermore, by extracting the axial forces in the members caused by the external loading, the likelihood of buckling could be monitored and evaluated. The likelihood of buckling occurring could thus be controlled by ensuring that the buckling factor, equation (5), remained true.

$$Buckling\ factor = \frac{Element\ axial\ force}{F_{crit}} < 1 \tag{5}$$

The further below 1 the buckling factor is, the more reduced the likelihood of buckling occurring becomes. However, this may also be indicative of an over dimensioned member, thus defeating the purpose of the optimisation, thus the maximum buckling factor had to be globally adjustable. By doing so also provided additional control for later stages of the optimisation process, particularly if key members were found to buckle when utilising dynamic crash modelling.

With the above considerations the optimisation of the beam (and shell model) was conducted.

e) CAD Tube Model

Following the beam and shell optimisation, the wireframe CAD model was reused to produce tubular surfaces over the wireframe. The radii of the tube sections were parameterised with the corresponding member beam ID. The CAD model was then linked to the property output file from the last iteration of the beam model optimisation, thus automatically converting the 1D beam model into a 3D tubular CAD model.

f) 2D Shell Model

Following the generation of the 3D tubular CAD model, a loose shrink-wrap mesh was produced based upon the 3D geometry, this is illustrated in Figure 7.

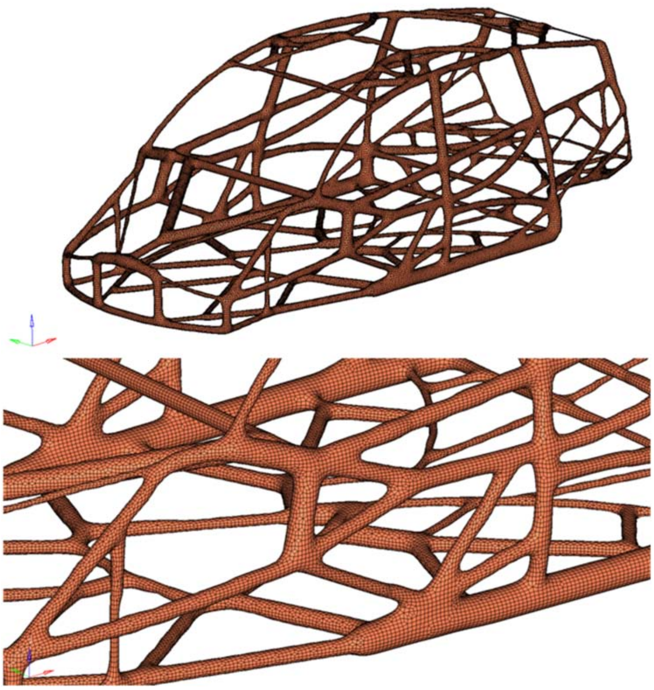

Figure 7 : 2D Shell Model using Shrink-wrap meshing

The shrink mesh produced a single shell (thickness) structural mesh with hollow member sections, representing the optimised dimensions. The shrink wrap mesh produced blended connections between the individual members. The cross-sectional dimensions were created from the tube sizing, however the sectional thicknesses were extracted from the beam model, and inserted into the shell element properties. This was automatically done by assigning an element located inside a "block" created by the coordinates of the member's line and radius.

g) Validation Crash Model

The 2D shrink map model was subsequently imported into commercial crash simulation software, and a non-linear dynamic impact analysis was completed. The purpose of this was to further validate the crashworthiness of the optimised design. Thus, it was possible to ensure that buckling of key members did not occur during individual load cases, particularly during the roof crush scenario, ODB and RW. Additional nodal masses across the entire structure were included in the model in order to replicate the total mass of the vehicle, including drivetrain and seven occupants, thus realistically replicating the inertial effects during all load case scenarios.

For the front crash scenario a rigid barrier was inserted, and subsequently collided with the BIW at a relative velocity of 35km/h.

As the BIW was developed based upon linear static topology optimisation, it was anticipated that the front crash scenario would propose the largest challenges to the optimised BIW during dynamic crash modelling, due to the maximum buckling effect caused by the overhang of the front crash structure. The results from the front crash analysis are represented by Figure 8.

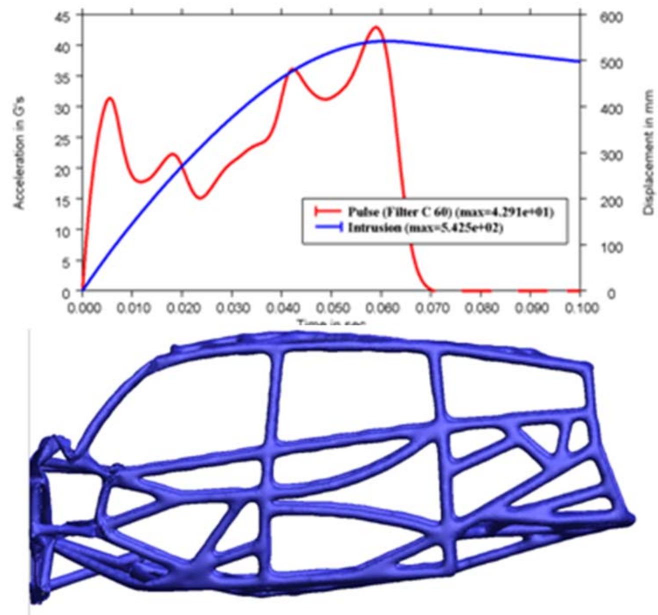

Figure 8 : Crash Model validation. Deformation at t=60ms; crash pulse/ displacement characteristic (top)

As indicated in Figure 8, the crash structure resisted the crash scenario, and that critical buckling of the safety cell was avoided. This indicates that the linear buckling sizing performed on the 1D beam elements were a success.

The small (or inexistent) magnitude of the overhang of the safety cell substantiates the low buckling failure is low, and that the optimised beams of these areas are suitably dimensioned for the impact scenario.

It should however be noted that the acceleration levels and crush length results obtained from this analysis could not have been predicted based upon the linear topology or sizing optimisation, as the solving was not transient dynamics. Therefore it was necessary that the optimisation process included a validation phase for the full structure, as illustrated by Figure 8, using a non-linear explicit solving technique.

IV. Conclusion

The skeleton of an automatic process to generate an optimised BIW architecture has been demonstrated and represents all steps needed to develop a crash model based upon basic styling surfaces. This process can be completed within a very short time, realistically within 1 working day.

The structure generated is very suitable for the definition of the vehicle performance (i.e. torsional rigidity) and the safety cell in general. However, caution needs to be exerted, especially with respect to the front crash structure where the linear topology optimisation algorithm provides a load path which does not directly consider aspects such as buckling, bifurcation, material strain rates, material and structural damage etc.

Therefore, it would be strongly advisable to review the front end design after the full process has been completed and converged. This is in order to extract the necessary loads in the A pillar and the seals in order to propose a perhaps more suitable (conventional) front end crash structure, which subsequently can be optimised for mass, utilising the extracted loads as maximum loading objective functions.

There is a need to research alternative means of conducting topology optimisation for non-linear events, in large deformations, bucking and damage events.

The next stage of this research is to automate all the above steps in combination, thus increasing the solution turn-around time in order to parameterise the vehicle styling, to take into account for example aerodynamics, wheel base and pedestrian mark-up as well as investigating the best compromise between vehicle aesthetics and holistic engineering performance.

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An Investigation on the Variation of Vehicular Emissions with Ambient Temperature and Humidity in the Tropics

By O.S. Udeozor, A.N. Nzeako
University of Nigeria, Nsukka, Enugu State, Nigeria

Abstract - In this study, we proposed an approach for investigating whether vehicular emissions vary with Ambient Temperature and Humidity of the day. The proposal includes mathematical models that can be used to predict the amount of pollutants dispersed into the atmosphere at a particular time of the day. The pollutants include; NOx, CO, CxHy. These pollutants were measured and analyzed during the morning and afternoon periods, using the Exhaust Gas Analyzer and the Digital Thermometer/Hygrometer. The measured and estimated values of these pollutants compared favorably using MATLAB simulations.

Keywords : Ambient Temperature, Humidity, Exhaust Gas Analyzer, Digital Hygrometer, Vehicular Emissions.

GJRE-B Classification: FOR Code: 889802

AN INVESTIGATION ON THE VARIATION OF VEHICULAR EMISSIONS WITH AMBIENT TEMPERATURE AND HUMIDITY IN THE TROPICS

Strictly as per the compliance and regulations of:

An Investigation on the Variation of Vehicular Emissions with Ambient Temperature and Humidity in the Tropics

O.S. Udeozor [α], A.N. Nzeako [σ]

Abstract - In this study, we proposed an approach for investigating whether vehicular emissions vary with Ambient Temperature and Humidity of the day. The proposal includes mathematical models that can be used to predict the amount of pollutants dispersed into the atmosphere at a particular time of the day. The pollutants include; **NO_x, CO, C_xH_y**. These pollutants were measured and analyzed during the morning and afternoon periods, using the Exhaust Gas Analyzer and the Digital Thermometer/Hygrometer. The measured and estimated values of these pollutants compared favorably using MATLAB simulations.

Keywords : Ambient Temperature, Humidity, Exhaust Gas Analyzer, Digital Hygrometer, Vehicular Emissions.

I. Introduction

Research work had been carried out in the past to investigate the influence of ambient temperature on exhaust emissions [1 – 14]. It was reported that exhaust emissions could be increased tremendously at cold ambient conditions. For instance, the hydrocarbon emissions could increased by 650% at -20°C and carbon monoxide emissions could increased by 800% at -20°C, compared to standard certification values at +25°C [8, 9]. However, the influence of cold temperatures on NOx was much lower and more complex as cold temperatures increase engine heat losses and cool the flame, thus reducing NOx emissions from the engine. This partially offset the slower catalyst light off.

The low ambient temperature can reduce lubricating oil pumpability and increase viscosity of lubricating oil and thus results in higher mechanical losses for engine's cold start. The performance of the battery would be affected by low ambient temperature. The air and fuel mixture can be affected due to poor volatility of fuel at low ambient temperature and therefore cause deterioration of combustion quality. The lower the ambient temperature, the richer the air fuel mixture required for a start up. Incomplete combustion with excess fuel results in increased carbon monoxide and hydrocarbon emissions. The low ambient temperature can also delay the light-off of the catalyst, which is one of the most important reasons accounting for high emissions at cold start.

Author [α σ] : Department of Electronic Engineering, University of Nigeria, Nsukka, Enugu State, Nigeria. E-mail : ogcafe@yahoo.com

The literature above reveals the influence of ambient temperature on vehicular emissions at 'cold start' period only. However not much work has been done to investigate the variation of vehicular emissions with ambient temperature and humidity at both the morning and afternoon periods, which entails the cold start and warm-up period of the engine.

With a unique approach, this study investigates the variation of vehicular emissions with ambient temperature and humidity in the tropics by considering both the morning and afternoon period for exhaust emission measurements and analysis.

II. Method of Investigation

Certain exhaust samples were collected from a number of vehicle engines (that use Motor Premium Spirit) and analyzed using the Exhaust Gas Analyzer with Model number "Testo 350 XL". These samples were collected during the morning (low temperature and high humidity) and afternoon (high temperature and low humidity) periods. A temperature and humidity sensing device (Digital Thermometer/Hygrometer with Model number IT 202) was used to measure both temperature and humidity during those periods. The investigation was carried out in some parts of Edo State of Nigeria and thereafter mathematical models and graphical representation of the investigations were obtained using MATLAB. (See table 1)

Table 1 : Showing measured values of temperature and humidity

Temperature (°C)	Humidity (%)
26.9	70
28.5	64
29.2	61
31.8	54
33.4	49

III. Results and Discussion

Using linear and quadratic fitting of the MATLAB code, the following mathematical and graphical models for CO, CxHy, and NOx emissions were obtained;

$$CO = \begin{cases} 14000 - 440T........25 \le T \le 27.5 \\ 3300 - 48T...........27.5 \prec T \le 30 \\ 9800 - 260T..........30 \prec T \le 32.5 \\ 4200 - 90T...........32.5 \prec T \le 35 \end{cases} \quad (1)$$

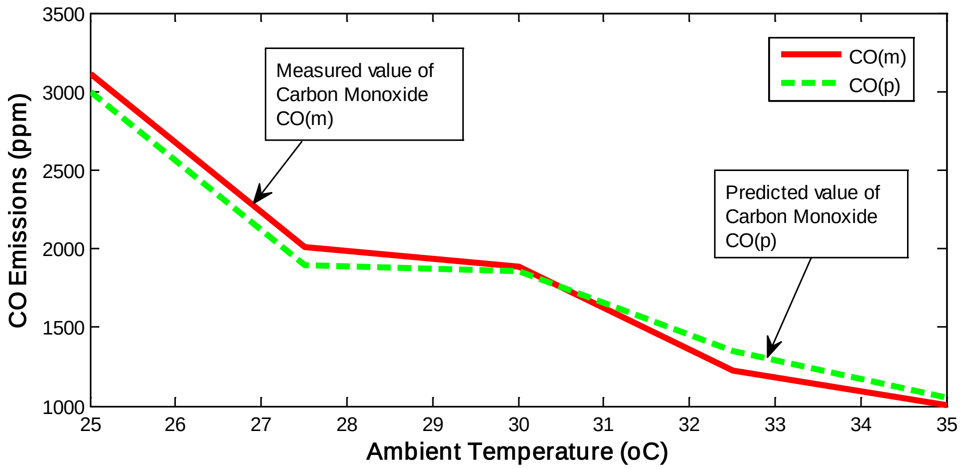

Fig 1 : Graph of Predicted and Measured Values of Carbon Monoxide against Temperature.

$$CxHy = \begin{cases} -1500T + 46000......25 \le T \le 27.5 \\ 0.84T^2 - 500T + 17000......27.5 \prec T \le 35 \end{cases} \quad (2)$$

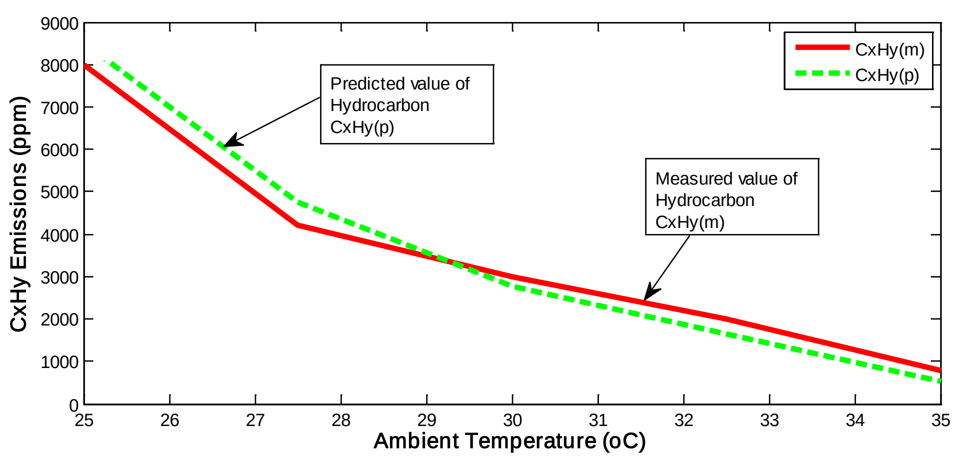

Fig 2 : Graph of Predicted and Measured Values of Hydrocarbon against Temperature.

a) CO and CxHy Emissions

Figure 1 & 2 above show the Carbon monoxide (CO) and Hydrocarbon (CxHy) emissions as function of the Ambient Temperature. The result above shows a high concentration of CO and CxHy emissions at 3114ppm (25^{o}C) and 7987ppm (25^{o}C) during the morning period when the ambient temperature was very low and the vehicle engine and catalyst are just warming up. As the temperature increases to 35^{o}C during the afternoon period, the concentration of CO and CxHy decreased to 1001ppm and 800ppm, respectively. The reason for the decrease of the pollutants at 35^{o}C is that the humidity level in the atmosphere at this point is very low and again the vehicle engine and catalyst is fully warmed-up; as the engine completely burns off the fuel present in the combustion chamber.

$$NOx = \begin{cases} -0.28T^2 + 25T - 400 ....25 \le T \le 32.5 \\ 26T - 740 ....32.5 \prec T \le 35 \end{cases} \tag{3}$$

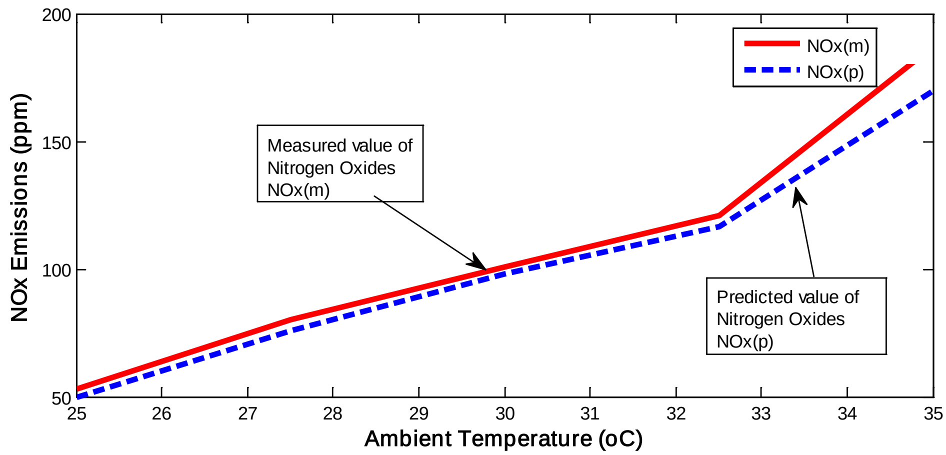

Fig 3 : Graph of Predicted and Measured Value of Nitrogen Oxides against Temperature.

b) NOx Emissions

Figure 3 above shows the Nitrogen Oxides emissions as a function of the temperature. The result of figure 3 above shows that the "engine out NOx emissions" are reduced in the morning period when the ambient temperature is very low, but increased during the afternoon period when the ambient temperature was high. This implies that the increase of NOx emission is directly proportional to the ambient temperature. The reason for this is that NOx is a temperature dependent pollutant as it is formed in the combustion chamber when the combustion temperature increases to 2000^{o}C [3]. This means that, as the temperatures decreases, the engine heat loss increases thereby cooling the flame temperature and therefore reducing the amount of NOx released from the engine exhaust.

The mathematical model and graphical representations of the pollutants against the humidity (H) are shown below;

$$CO = \begin{cases} 38H - 690..........45 \le H \le 51 \\ 110H - 4400.......51 \prec H \le 57 \\ 20H + 740..........57 \prec H \le 63 \\ 180H - 9600.......63 \prec H \le 69 \end{cases} \tag{4}$$

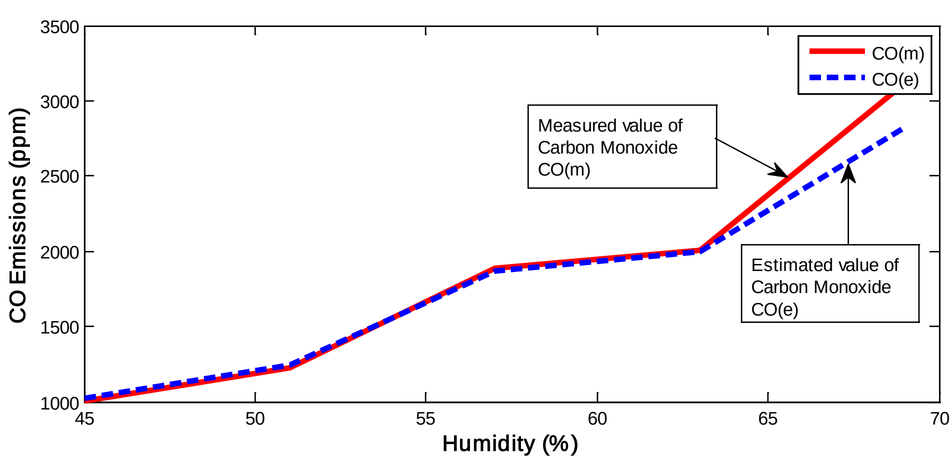

Fig 4 : Plots of Estimated and Measured Values of Carbon Monoxides against Humidity.

$$CxHy = \begin{cases} 190H - 7600.......45 \le H \le 63 \\ 630H - 35000.....63 \prec H \le 69 \end{cases} \tag{5}$$

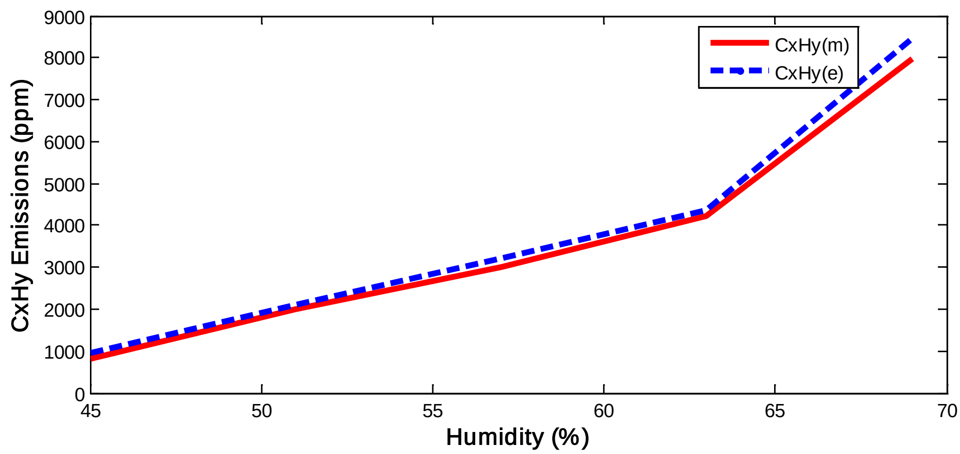

Fig 5 : Plots of Estimated and Measured Values of Hydrocarbon against Humidity.

$$NOx = \begin{cases} -11H + 680.........45 \le H \le 51 \\ -0.049H^2 + 2.1H + 140.....51 \prec H \le 69 \end{cases} \tag{6}$$

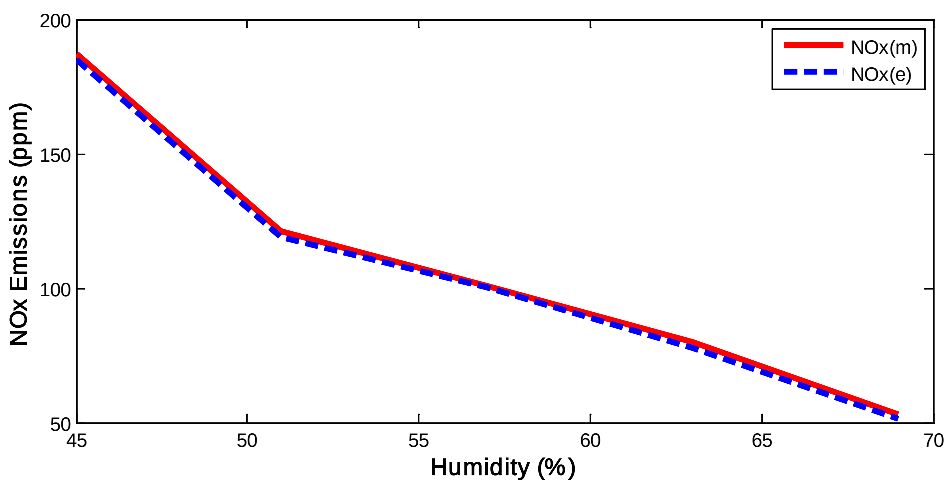

Fig 6 : Plots of Estimated and Measured Values of Nitrogen Oxide against Humidity.

Figures of 4 & 5 show Carbon Monoxide and Hydrocarbon emissions as functions of humidity. It is observed that when the humidity is very high, the concentration of the pollutants (CO & CxHy) will also be high and when the amount of humidity present in the atmosphere is very low, the concentration will automatically be low. The reason for this is that high amount of humidity in the atmosphere can cause poor mixing of fuel and air in the combustion chamber, thereby resulting in incomplete combustion which will in turn results in excessive release of CO and CxHy pollutants [5].

The case is the reverse for NOx emissions of figure 6 above as high humidity will result in the reduction of NOx pollutants released from the engine exhaust. The reason for these has been explain in the previous paragraph of this study.

The estimated value of these pollutants can be obtained by substituting the different range of values of temperature 'T' and humidity 'H' into the modeled equations 1, 2, 3, 4, 5 and 6. The plots of the estimated values of these pollutants are shown in Figures 1, 2, 3, 4, 5 & 6. Both the Measured and the Estimated values of these pollutants are closely related which shows that the mathematical models have been validated.

IV. Conclusion

Investigations carried out in this study tend to show that vehicular emissions vary with ambient temperature and humidity at different times of the day. There seem to be much increase in emission rates when the ambient temperature falls below the standard temperature of 75 ^{o}F, this might be due to "cold start problem of the vehicle engine". It could also be that it takes a long time for the emission control system (catalytic converter) to warm up, indicating that more fuel is required in the combustion chamber for smooth combustion (rich fuel/air mixture).

The findings from this study have shown high concentration of CO and C_xH_y pollutants during the early morning periods when the engine is just warming up, and high concentration of NO_x emissions during the afternoon period when the engine is fully warmed up. These pollutants are capable of causing harm to the environment by contributing to the formation of smog, ground level ozone and global warming.

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Distance Measuring (Hurdle detection System) for Safe Environment in Vehicles through Ultrasonic Rays

By Muqaddas Bin Tahir, Musarat Abdullah
Comsats Institute of Information Technology, Wah Cantt, Pakistan

Abstract - Cars and vehicles have been incorporated into culture as one of the most resourceful, easiest and accessible means of transportation available. But besides being a suitable and common means, it is equally an incredibly dangerous mode of transport. Thousands of people die in vehicle accidents each year, whether it is accident with another vehicle or with a motionless object. A method of early accident exposure and evasion can control several accidents that may be associated to factors such as loss of control, careless driving, tired/intoxicated drivers, and not paying concentration to the road. As the current market does not present a normal safety feature in any car, the use of sensory tools to sense potentially hazardous objects a definite distance away and either slows the car down or shove to a safer path has not been released. In this research paper a new technique is introduced for safety against accidents. Eight ultrasonic sensors are used to sense different types of objects. By implementing a possible improvement in safety/sanctuary systems in vehicles, the vehicle and sensor would be able to operate normally until the sensor detects possible risk. In our project, the sensor does not give output or signal until the car comes within ~75 feet of an object, at which timer sends information of hurdle to driver. The sensor only indicates the presence of an object; it is up to the user or driver to tackle the hurdle.

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DISTANCE MEASURING HURDLE DETECTION SYSTEMFOR SAFE ENVIRONMENT IN VEHICLES THROUGH ULTRASONIC RAYS

Strictly as per the compliance and regulations of:

Distance Measuring (Hurdle detection System) for Safe Environment in Vehicles through Ultrasonic Rays

Muqaddas Bin Tahir[α], Musarat Abdullah[α]

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I. Introduction

Today Personal Computer usage has been increased very much for different purposes and for performing important tasks and its usage is increasing day by day in many fields.

The technique presented here has three parts, each part containing some tasks to perform through the computer. First part includes controlling the car through computer by using data pins of parallel port. Second part includes hurdle detection through sensor and displays this information from left, right, front and back side of the vehicle on the computer screen. The third and last part is implementation in which the vehicle moves automatically and selects its right path with the help of sensors.

The procedure adopted for doing the above mentioned tasks includes the use of parallel port of the computer. The main hardware of the presented technique will be attached to the parallel port of PC so that all tasks are being handling by this port. The software programmed in Visual Basic is interfaced with the hardware for implementing all the above mentioned tasks. Visual Basic is used because of the reason that it is user friendly language and provides easy and efficient support in interfacing with the hardware. Visual Basic programs can easily access the parallel port [1].

II. Previous Work

Today many companies work to create the safe environment (Hurdle detection and distance measuring) for drivers, out of which the most important companies working on these issues are Mercedes Benz and Honda. Mercedes Benz [2] is prepared with the option of innovative '*distronic*' distance control system which makes sure the security of cruise control for highway by reducing the vehicle speed if the system detects a slower running vehicle up to 150 meters in front of it. The Mercedes is installed with a radar sensor which senses the hurdle at a distance of 150 meters from the driver's car and slows down the car according to the distance which means that as the distance decreases, the speed of car is also decreased. These sensors observe the traffic with a high performance computer so that the safety distance remains maintained. When the vehicle moves too close to another vehicle, the electronic system automatically reduces the speed of the car and activates the brakes as well whenever it is required to do so. Once a safe distance gets covered, the system comes back to the pervious selected driving speed. The second most prominent company Honda has designed the Honda intelligent [2] Driver Support System (HIDS) that helps the driver in two driving tasks- keeping in lane and maintaining vehicle speed. The millimeter wave radar is used with C-MOS camera to detect and analyze the lane marker and to determine the other vehicle. Allison Smyth used an automotive accident monitoring system that mounts on the front of archetype vehicle. [3] The system tested for this device would be conducted at speeds less than 20 mph. This device uses sonar technology (mostly used in submarine) to send out signal from the front of vehicle. This signal will warn the driver if the vehicle he is driving is too close with another vehicle. The warning will be sent through a chain of light emitting diodes (LEDs). A green LED tells the driver that he is doing fine, amber LED is a warning and red means that the driver needs to slow down immediately. Another

Author α : Comsats Institute of Information Technology, Wah Cantt, Pakistan. E-mail : tahir.muqaddas@gmail.com

system having similar concept has been developed with the exception that the speed has already been set depending on the distance between the two cars. This system is based on the laboratory scale and PIC was used as the core of the project in order to slow down the motor. This is to make sure that the distance is always maintained in a certain range. Otherwise, the speed will reduce robotically. There were 3 distances that had been classified: Far>30 cm; Medium 15 cm_x_30 cm; Critical_15 cm. The speed will retort based on the distance. Infra red sensors were used in the project and it was found out that a lot of limitations need to be considered if it was to be applied in real environment [2] [3].

III. Proposed Work

The proposed method for safe environment includes three main parts, each one providing different functionality according to the tasks assigned to it. These parts are mentioned below:-

1. Distance of object (Hurdle) from vehicle.
2. Speed of coming object (Hurdle).
3. Location (Side) of hurdle.
4. Collision time (Future Planning)

In the proposed technique the user can easily drive the vehicle through computer. The proposed method will automatically inform about the hurdle in the path of the vehicle on the computer with the help of different sensors. In this technique the vehicle is controlled through parallel ports of computer. Ultrasonic sensors are connected in the vehicle to sense the object (Hurdle) and send signals to the computer. The computer takes different actions based on these signals in order to create a safe environment for the driver (user).

a) Car Movement Controlling System

The system involves the controlling of vehicle through the PC. Different commands are sent to the ports to control its movement. The controlling function receives commands denoting the direction of the vehicle and output an encoded 8 bit value of these directions. The input signals will come from metal contacts of the switches on the original controller to 4 input port pins (indicating forward, reverse, left and right).

If you notice a vehicle has total six movements.

1) Forward
2) Reverse
3) Forward + Right
4) Forward + Left
5) Reverse + Left
6) Reverse + Right

Parallel ports have 8 data pins but 4 will be used out of them to control the car.

Forward	Reverse	Right	Left	
0	0	0	0	
1	0	0	0	Forward
0	1	0	0	Reverse
1	0	1	0	Forward + Right
1	0	0	1	Forward + Left
0	1	1	0	Reverse + Right
0	1	0	1	Reverse + Left

Figure.1 : Binary codes to control vehicle mechanism.

According to figure 1, 9 combinations are spare. The combinations shown in figure will be applied on first four data pins of parallel ports [4] [5]. "0" means OFF and "1" means ON for ports. In Visual Basic-6, these combinations will be used for port handling command. These combinations will then be sent to the circuitry connected between computer and remote control of vehicle for controlling its different moves.

b) Hurdle Detection on Different sides

The purpose of this part of the proposed method is the secure movement of car or security of driver and vehicle against different hurdles. To achieve this target ultrasonic sensors are used on left, right, back and front sides. Each sensor has one transmitter and one receiver. The transmitter of each sensor will continuously transmit the signals. When these signals will collide with any object and will be reflected back, the receiver of sensor will catch these reflected signals and forward them to the computer on port 889 of parallel port. To find out the object side the signal is send to processing unit through parallel ports. Each side or receiver has its own address which is unique. Through this uniqueness or address the proposed method finds out the side of object (Hurdle). In ultrasonic sensor the power is directly proportional to range of ultrasonic sensor.

P ∞ Range

c) Ultrasonic Hurdle detection Circuit

The speed of the sound in the dry air is about 340 m/s. We can not hear the echo if we send a short ultrasonic pulse at 200 KHz in the air but it is possible to detect the back pulse with an ultrasonic sensor. If you know the time of the forth & back travel of the ultrasonic wave, you know the distance. Divide the distance by two and you know the range from the ultrasonic sensor to the first hurdle in front of it. Here the proposed method also uses an ultrasonic piezzo transmitter with its receiver because they are very efficient, easy to find and quite cheap.

In the proposed technique, first send the pulse: it is easy to get a 20 KHz pulse from a PIC PWM output. You can drive an ultrasonic transmitter directly from the PIC output, but the sense range will not exceed 50 cm.

Using a transistor and a resonator circuit, the ultrasonic transmitter will get around 20 volts to generate 200 KHz pulse and the sense range will be extended up to 75 feet.

d) Creation of Ultrasonic Cycle

To achieve this target 8 ultrasonic sensors are used. The range of these sensors is equal to ~75 feet which means that they sense ultrasonic rays at a distance of 75 feet. As this distance is covered the ultrasonic rays are going to be stretched as shown in diagram.

The ultrasonic rays get disappeared after traveling a distance of ~75 feet. All eight sensors are attached with the vehicle in a way that they create an ultrasonic wall around the vehicle but no overlapping between the ultrasonic waves of sensors as shown in figure 4.

All eight ultrasonic sensors are connected to the computer parallel port (LPT port) which sends information (distance, location) about hurdle at real time [7]. This wall is only used to gather information about hurdle which means that it neither restricts the driver nor does it slow down the speed of vehicle like Mercedes Benz because of the reason that the driver may have some better option to handle the hurdle detection problem.

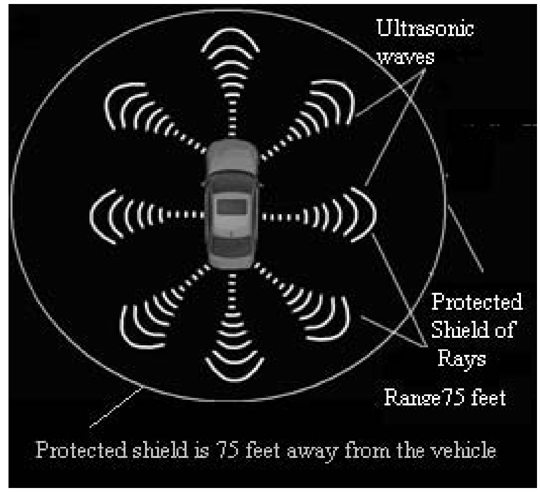


Figure.4 : Wall response on hurdle

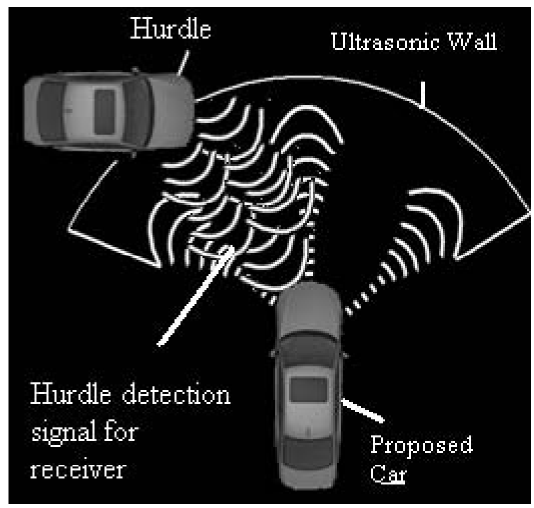
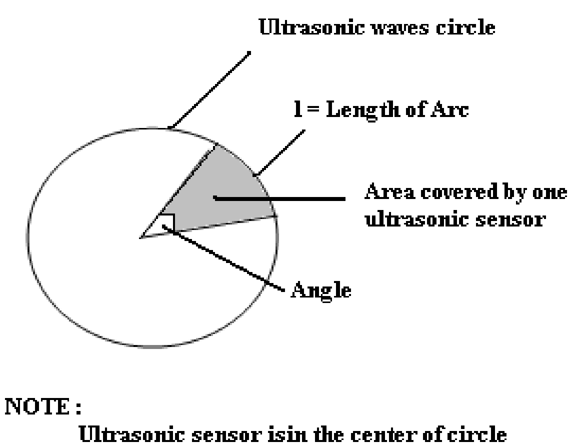


Figure.5 : Ultrasonic Wall creation



$$\textbf{Diameter of circle} = T_{uls} * L_1$$

L = *Length of arc of one ultrasonic sensor*

T_{uls} = *Total Number of Ultrasonic Sensor*

$$\textbf{Length of arc} = r\theta$$

Radius (R) = Range of ultrasonic Sensor

Figure 6 : Role of one ultrasonic sensor in circle

e) Identification of Object

To fulfill this target we attached a computer with the vehicle and eight ultrasonic sensors are connected with the computer parallel ports (printer port) to receive the signals coming from ultrasonic sensors [12]. These sensors are attached with the vehicle in such a way that they create an ultrasonic wall or layer around the vehicle to sense any object (hurdle) coming towards it from either side. In this layer all rays travel independently without any overlapping between them. The sensors attached to all sides of vehicle work according to their specified directions. For example, if an object comes from left side of vehicle, only left sensor will send the signal to the computer. In order to find out that the computer has received signal from which specific sensor, we have attached the transmitters and receivers of all sensors with data pins (D0 to D7) of the computer because of the reason that each pin has its own unique address which find out that which sensor has sent signal, Through this unique address we can easily identify that which sensor sense the object means on which side of the car object is come. To find out these unique addresses we put object against the each sensor and when sensor send signal on pin of parallel port then parallel port send address of this pin to computer and this address is unique means each pin of parallel port has its own address. These unique addresses are use to find the side means to find out that on which side of the car object is coming. Another more important thing is that when two or more that two sensor sense a objects at a same time then another unique address is created through this we ca easily find out that when two sensors give response at a same time then which type of address is coming and when six sensors response at same time then which type of sensor is coming out. Mostly such situation is created when a wall is coming in front of the vehicle or in the back of the vehicle. So in the proposed method no object can enter in range without giving an information.

f) Distance measurement of hurdle from Vehicle

For distance measuring the voltages or signals of receiver first convert into digital because ultrasonic sensor work in analog signals and computer works on digital signals so for this we first convert the analog signal into digital signals[11]. If we take a diagram of voltages of ultrasonic receiver then you note that when distance is less then the height of the wave of voltage on oscilloscope is tall but when distance is greater. The height of wave is small on oscilloscope. Actually this module of proposed method is work on correspondence between the height of wave and distance. For distance measurement the proposed method set a background table (Correspondence table between height of wave and distance). The first six iteration of correspondence table are set by manually calculation of distance. The further iteration is set by automatically by proposed algorithm to find out the distance.

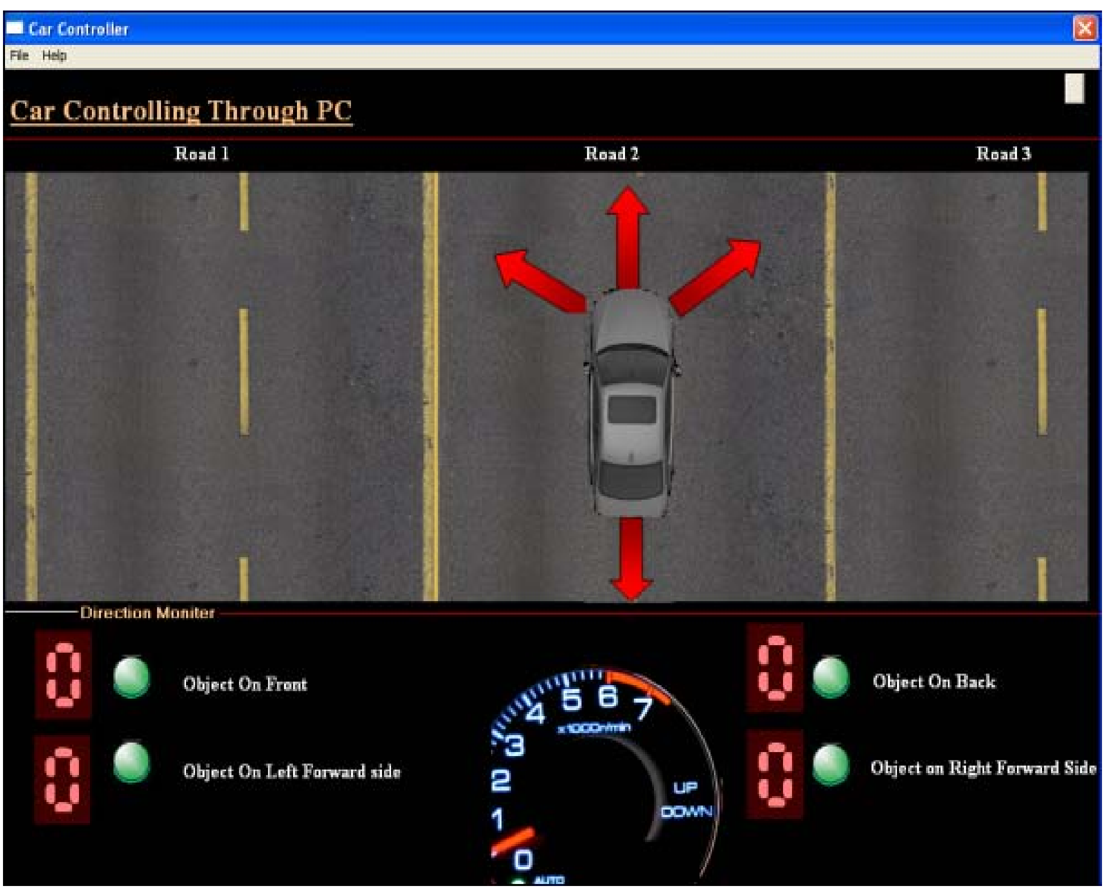


Figure.7 : Distance Measuring interface on PC (Software)

Another way to find out the distance between hurdle and vehicle is that first find out the elapsed time **(T_e)** and multiply with speed of sound (Ultrasonic wave) and divide this product by two.

$$\textbf{\textit{Distance}} = \frac{\textit{Elapsed Time * Speed of Sound}}{2}$$

IV. Response of Different Ultrasonic Frequencies on Flat Surface

Relative Echo Levels for different Ultrasonic frequencies

In case of ultrasonic waves the entire wave is reflected when ultrasonic waves are reflected from flat surface. This total reflection is equivalent to a virtual source at twice the distance.

$$\text{Spreading loss for reflected wave} = 20 \log (2R)$$

$$\text{Absorption loss} = 2\alpha R.$$

To reduce this loss it is necessary that the flat surface is larger than the entire ultrasonic wave and perpendicular to the wave. [14]

The below Equation (2) is used to find out the relative effect from different distances from ultrasonic sensors of varying the sound frequency on echoes created from a large flat reflector (surface).

$$SPL\ (R_0) = 20 \log (p) \qquad (1)$$

$$SPL(R) = SPL\ (R_0) - 20 \log (R/R_0) - \alpha\ (f)\ R \qquad (2)$$

SPL(R)	sound pressure level at distance R in dB//1µPa
SPL(R_0)	sound pressure level at distance R_0 in dB//1µPa
α(f)	attenuation coefficient in dB/unit distance at frequency f
R	Reference Distance
P	Pressure of sound in micropascals

In reference 14 a graph is drawn on assumption that all ultrasonic sensors create same SPL at a range of on feet. This graph represents that changes in EL are just a function of varying reduction and the reason of that are only the different frequencies of sound. For each frequency the maximum reduction for all humidities was use for the value of **α.**

V. Internal Design of Vehicle

All ultrasonic sensors in the car are connected with the parallel port (LPT port) of computer and computer is attached inside the vehicle to detect the hurdles on real time bases.

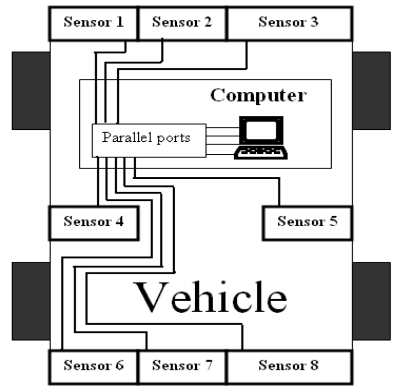


Figure.8 : Block diagram of interfacing Ultrasonic sensor with Vehicle

VI. Experimental Result

In this section, experimental results are illustrated to demonstrate the feasibility and validity of our proposed hurdle detection and distance measuring mechanism through ultrasonic rays. In this section different situations (environments) and conditions are applied upon proposed method. Actually the only way that researcher can establish cause-and-effect relationship through research is by carrying out an experiment. In a formal experiment, the relationship between two or more variables is investigated by deliberately producing a change in one variable in a salutation and observing the effects of that change on other aspects of the situation.

Several steps are involved in carrying out an experiment, but the process typically begins with the development of one or more hypotheses for the experiment to test.

Case.1

In case 1 the proposed vehicle is tested upon different speed limits and observes the quick response of ultrasonic sensors on different speed limits. In case.1 the proposed car was run on 130km / hr and ultrasonic sensor build in car has range of 75 Ft and car that run on 130km/hr cover this distance in 5.35979 seconds and time limit of ultrasonic hurdle detection response is

$$\textit{Speed} = \textit{Distance} / \textit{Time}$$

$$V = D / T \quad => (V{*}T) = D$$

$$T = D / V$$

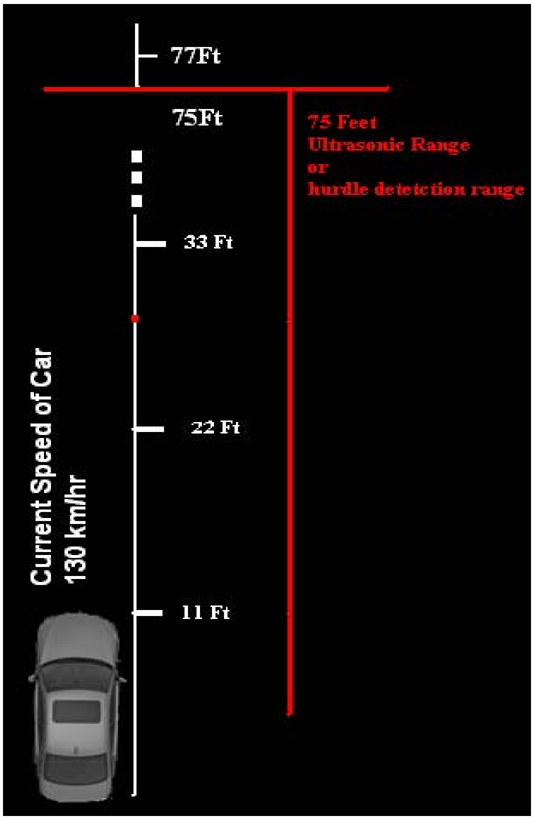


Figure.10 : Case.1 Distance and speed simulation of proposed Vehicle

Case.2

In case.2 the proposed vehicle was check in different weather (fogy, rainy, sunny). The ultrasonic ways work perfectly in rainy weather because in submarine the sonar was used in which ultrasonic waves are used to sense the different hurdle in water so in this way ultrasonic waves has no problem to work in rainy and fogy weather.

Case.3

In case.3 the proposed vehicle checked in night or on those places where there is no light mostly in parking areas or where the vehicle head lights not work. In these places the infrared rays and video technology cannot work. On these places the proposed vehicle work very accurately tells information (Distance, location) of other vehicle.

VII. Comparisons of Different Sensors Technologies

	Lidar	Ultrasonic	Video camera
Direct velocity measurement	--	0	--
Operation in rain	-	0	0
Operation in fog & snow	-	+	-
Operation in dirt	0	+	--
Operation in night	++	++	--

++ (perfectly matched)

\+ (fine Performance)

0 (achievable)

\- (realistic)

-- (impractical)

Figure.11 : Comparison of different Domains for distance measuring in different conditions

Figure.11 shows that ultrasonic technology gives a cost effective method to achieve the result with exclusive properties not obsessed by other sensing technologies. For e.g.

1) Ultrasonic works for long ranges up to 50 feet whereas inductive sensors and limit switches do not.
2) Another very major property of ultrasonic senor is broad area detection .Ultrasonic senor work in both wide and narrow area while a number of photo electric sensors can sense over long distances they lack the skill to detect over a wide area without using a large number of sensors.
3) Ultrasonic sensor can easily work in different environments (liquid, solid, porous, wood, dust, night and etc).
4) Work on all colors (black, red, yellow and etc).

VIII. Conclusion

Overall, our design met our basic expectations; however, we were not able to achieve everything that we wanted due to time constraints. In this research work we more emphasizes on the on hurdle detection through ultrasonic waves which is the back bone of this technique. By applying different environments on proposed work it is not easy enter in the ultrasonic wall without giving any information (distance and location) to user. In the ultrasonic wall creation we observe that there is no side or there is no gap from which anything enters in the area of ultrasonic waves it means that wall is fully filled with ultrasonic waves without overlapping of ultrasonic waves. However, there are some problems need to be worked on, such as low frequency environmental noise, reverberation, and hurdle strength, etc.

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The Implications of Importation of Used Vehicles on the Environment

By O.S. Udeozor, A.N. Nzeako
University of Nigeria, Nsukka, Enugu State, Nigeria

Abstract - This study investigates the impact of used vehicles on the environment by sampling a number of such vehicles and carrying out exhaust emission measurements using the Exhaust Gas Analyzer. The exhaust emissions (CO, CxHy, NOx, CO2, SO2) were analyzed to ascertain the level of its concentration.

Keywords : Imported Used Vehicles, Pistons and Piston Rings, and Harmful exhaust emissions.

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THE IMPLICATIONS OF IMPORTATION OF USED VEHICLES ON THE ENVIRONMENT

Strictly as per the compliance and regulations of:

The Implications of Importation of Used Vehicles on the Environment

O.S. Udeozor[α], A.N. Nzeako[α]

Abstract - **This study investigates the impact of used vehicles on the environment by sampling a number of such vehicles and carrying out exhaust emission measurements using the Exhaust Gas Analyzer. The exhaust emissions (CO, C_xH_y, NO_x, CO_2, SO_2) were analyzed to ascertain the level of its concentration.**

Keywords : Imported Used Vehicles, Pistons and Piston Rings, and Harmful exhaust emissions.

I. Introduction

Thousands of used vehicles are imported into Nigeria each year. Some of these are not supposed to be allowed into the country, having passed the age of serviceability. Many of these vehicles pack up finally after a few years of service on Nigeria roads, Thereby, turning the country into a scrap yard. Worst still, in the absence of appropriate recycling facilities, these vehicles degrade our environment [3]. They pollute the air with harmful exhaust emissions caused by the wear of piston rings, valve seals, valve guides and cylinder bore [4, 5, &7]. The pollutants include: CO, CO_x, NO_x, SO_x, Benzene, Chlorinated Organic Compounds, Ozonides and Peroxides. CO_2 has greenhouse effects, NO_2 (oxidizes to HNO_3) and SO_2 (oxidizes to H_2SO_4), which eventually fall as acid rain or mist or fog.

In Europe, numerous studies have been undertaken by the European Fuel Oxygenates Association (EFOA) to determine the impact of car emissions on human health and the environment. The results were alarming as the findings of EFOA [10] showed that;

- Long-term exposure to air pollution from cars in adults of over 30 years of age caused an extra 21,000 premature deaths per year resulting from respiratory or heart disease. This was more than the total annual deaths of about 9,900 recorded from road traffic accidents,
- Each year, air pollution from cars causes 300,000 extra cases of bronchitis in children, plus 15,000 hospital admissions for heart disease. 395,000 asthma attacks in adults and 162,000 attacks in children.

The 1999 WHO report on health-costs due to road traffic-related air pollution also showed that car-related pollution kills more people than car accidents in the three European countries where the study took place (Austria, France, and Switzerland).

Ajayi carried out analysis of study to shows the increase in used vehicles imported into Nigeria between the periods of 1988 – 2005 using time-series analysis. Although there were reduction of these used vehicles in 1994 and 1998, he however pointed out that the high rate of pollution on the environment was majorly caused by this increased importations [1].

In this study, a practical approach was adopted to investigate the impact of imported used vehicles on the environment by measuring and analyzing certain exhaust pollutants from used vehicles, the measured pollutants include; Nitrogen Oxides, Sulphur Dioxide, Carbon Monoxide, Carbon Dioxide and Unburned Hydrocarbons (NO_x, SO_2, CO, CO_2, C_xH_y).

II. Materials and Method

Measurements on the concentration of harmful exhaust emissions from a number of vehicle engines were taken at some motor parks in both Edo and Delta States of Nigeria. An Exhaust Gas Analyzer with model number "Testo 350 XL" was used to carry out the measurements, by inserting the probe into the vehicle exhaust. The graphical representations and tabular results of measured pollutants from vehicle engines using Premium Motor Spirit (PMS) and Automotive Gas Oil (AGO) are discussed in the next section.

III. Results

(i) The graphical representations of measured pollutants from vehicle engines using Premium Motor Spirit (PMS) between the ages of 4-20 months are shown in Figures 3(a) – 3(c) below.

Author [α] : Department of Electronic Engineering, University of Nigeria, Nsukka, Enugu State, Nigeria. E-mail : ogcafe@yahoo.com

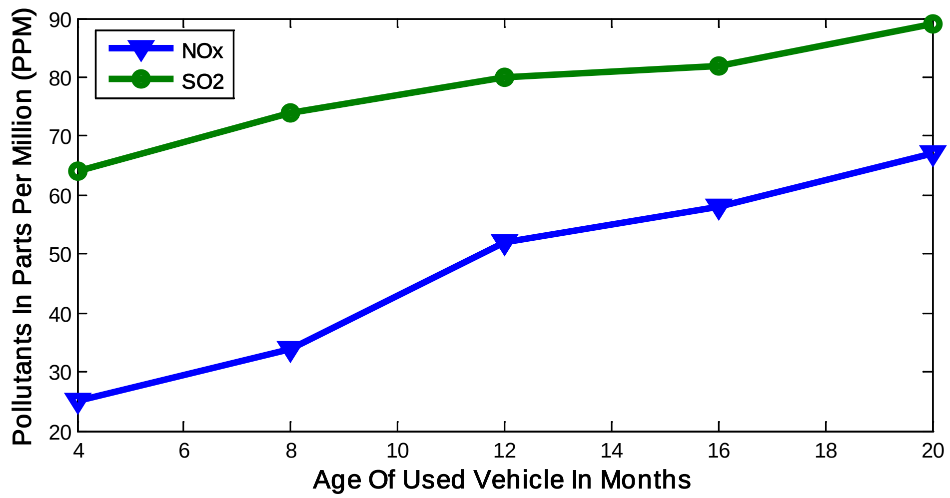

Fig 3(a) : Graph of NO_x & SO_2 pollutants from relatively new vehicles using (PMS).

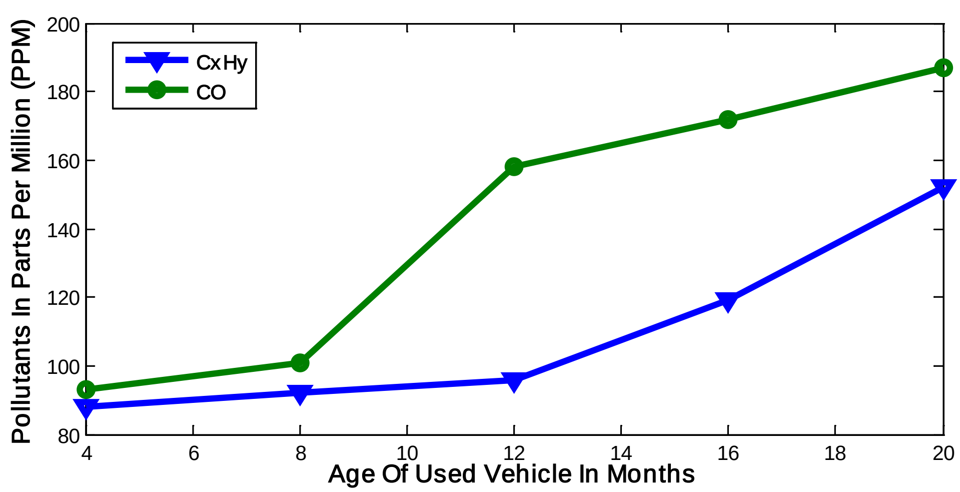

Fig 3(b) : Graph of CO & C_xH_y pollutants from relatively new vehicles using (PMS)

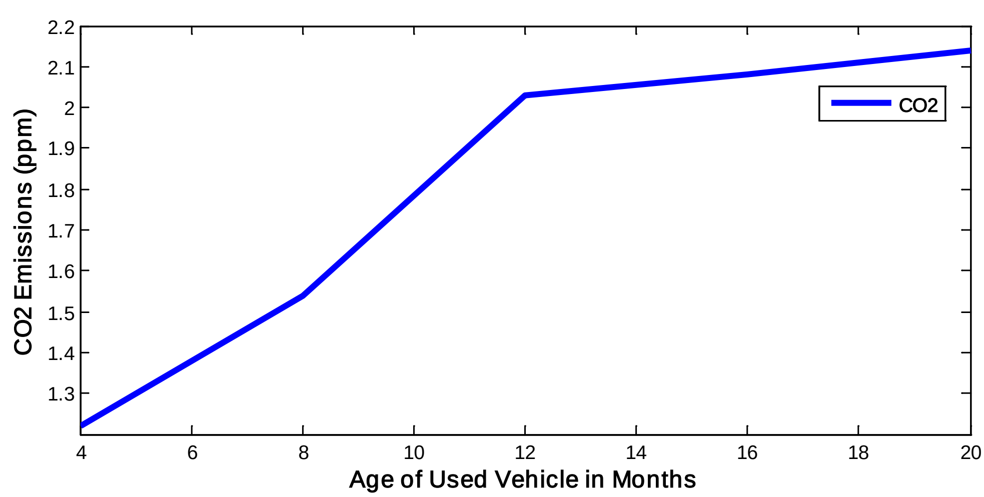

Fig 3(c) : Graph of CO_2 emission from relatively new vehicles using (PMS)

(ii) Graphical representations of measured pollutants taken from Vehicle exhaust using Automotive Gas Oil (AGO) between the ages of 4-20 months are shown in Figures 4(a) – 4(c).

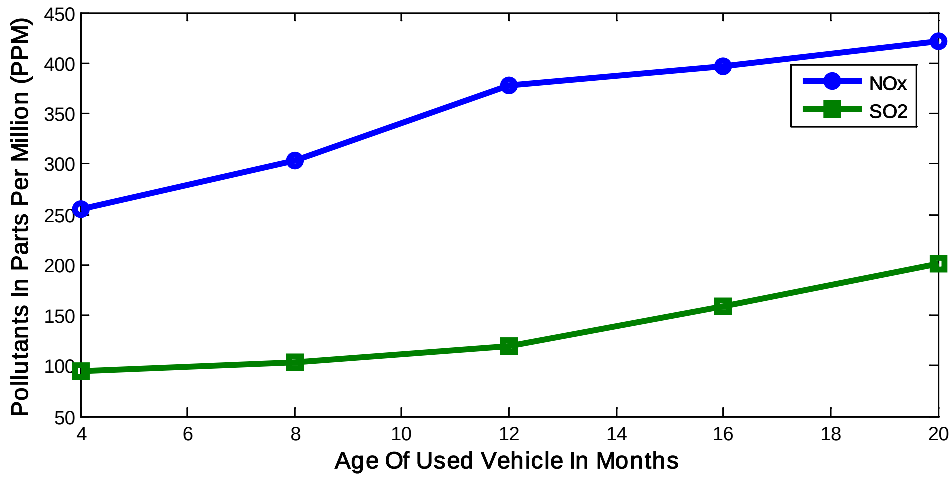

Fig. 4(a) : Graph of NO_x & SO_2 emissions from relatively new vehicles using (AGO)

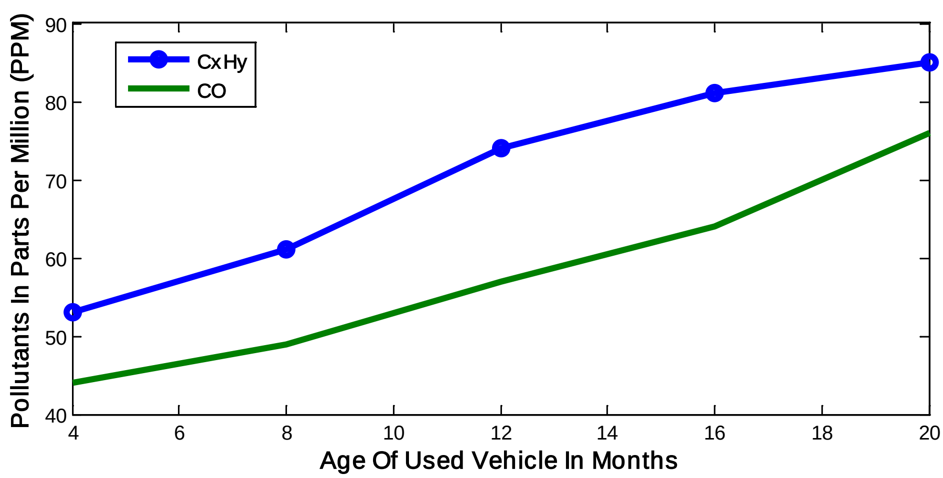

Fig 4.0(b) : Graph of C_xH_y & CO from relatively new vehicles using (AGO)

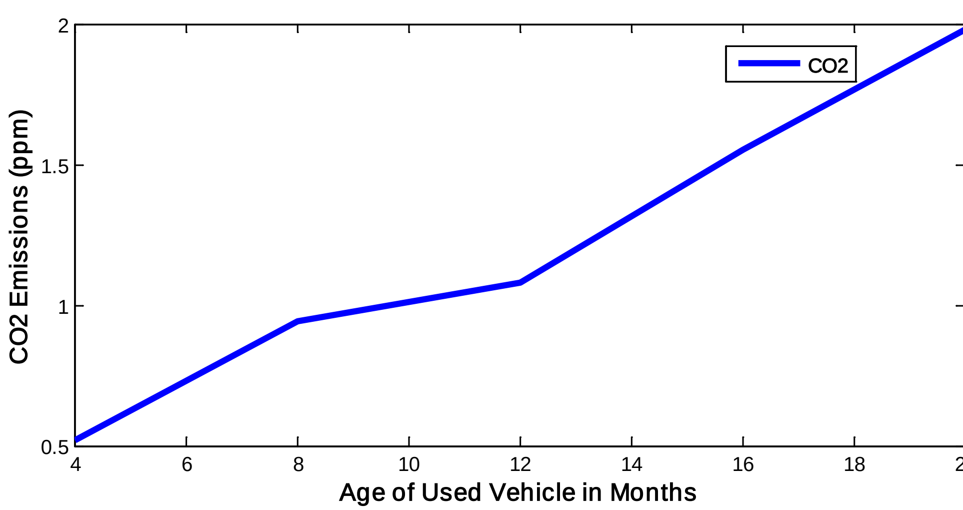

Fig 4(c) : Graph of CO_2 emission from relatively new vehicles using (AGO)

(iii) The graphical representations of measured pollutants from vehicle exhaust using Premium Motor Spirit between the ages of 5-25 years are shown in Figures 5(a) – 5(c)

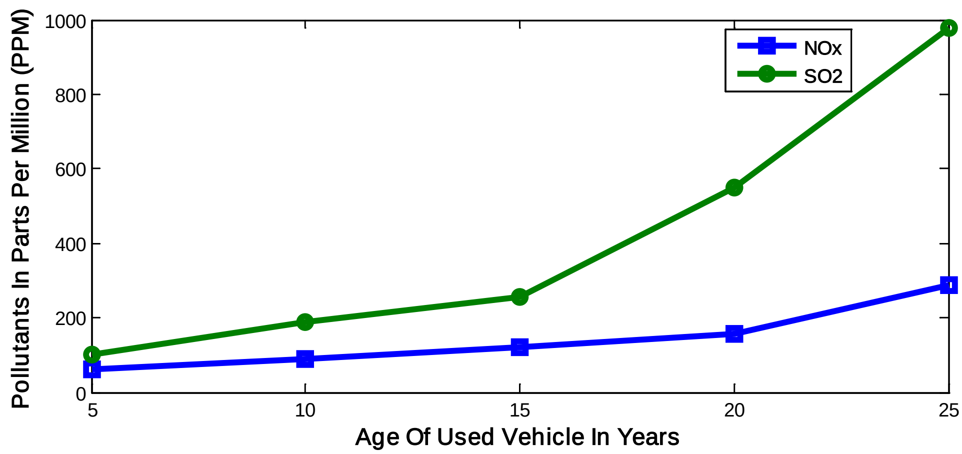

Fig 5(a) : Graph of NO_x & SO_2 pollutants from vehicles using (PMS)

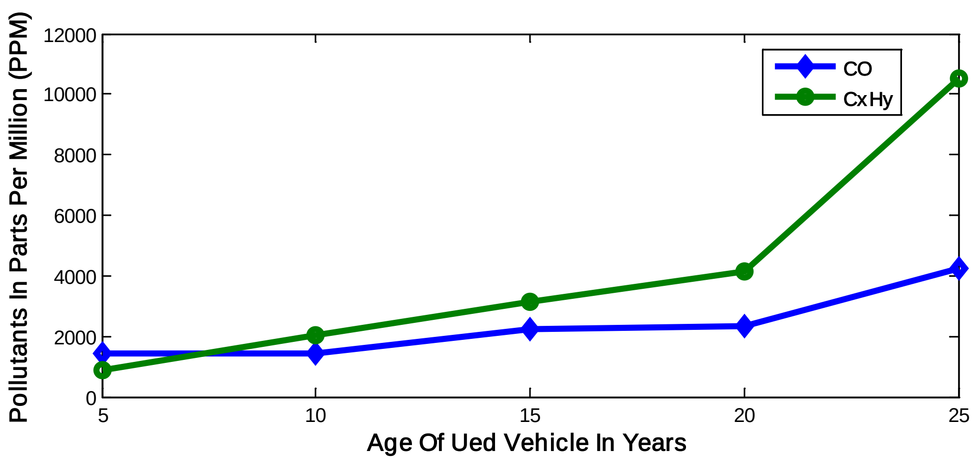

Fig 5(b) : Graph of CO & C_xH_y pollutants from vehicles using (PMS).

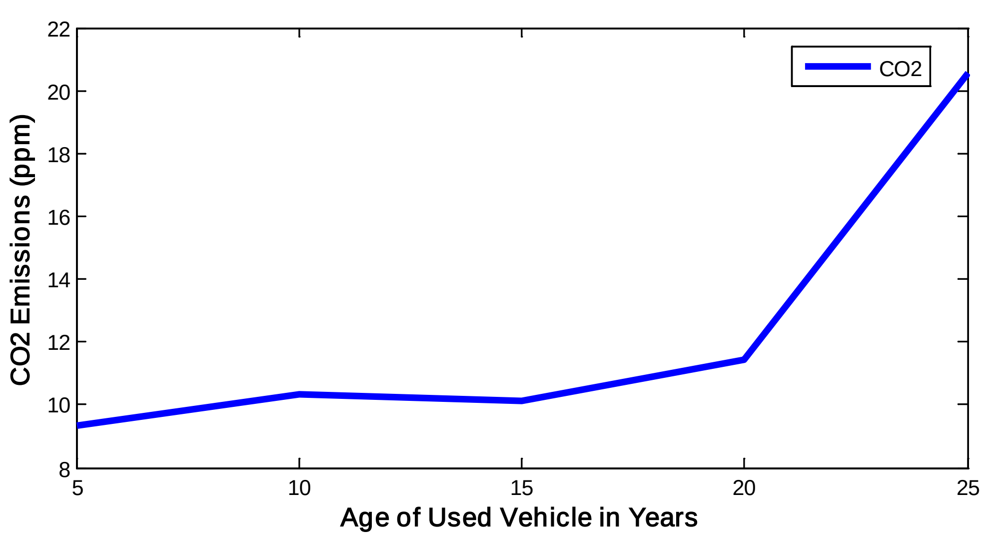

Fig 5(c) : Graph of CO_2 emission from vehicles using (PMS)

(iv) Graphical representations of measured pollutants taken from vehicle exhaust using Automotive Gas Oil (AGO) between the ages of 5-25 years are shown in Figures 6(a) – 6(c).

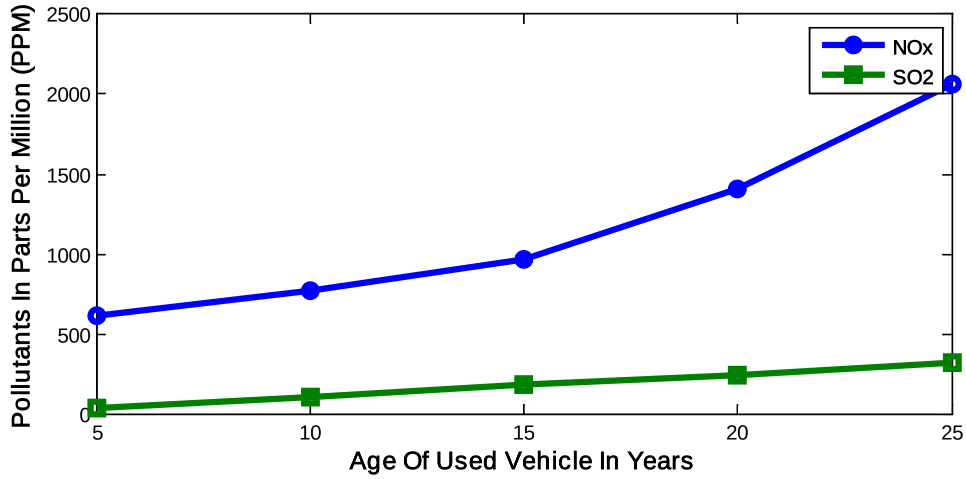

Fig 6(a) : Graph of NO_x & SO_2 emissions from vehicles using (AGO)

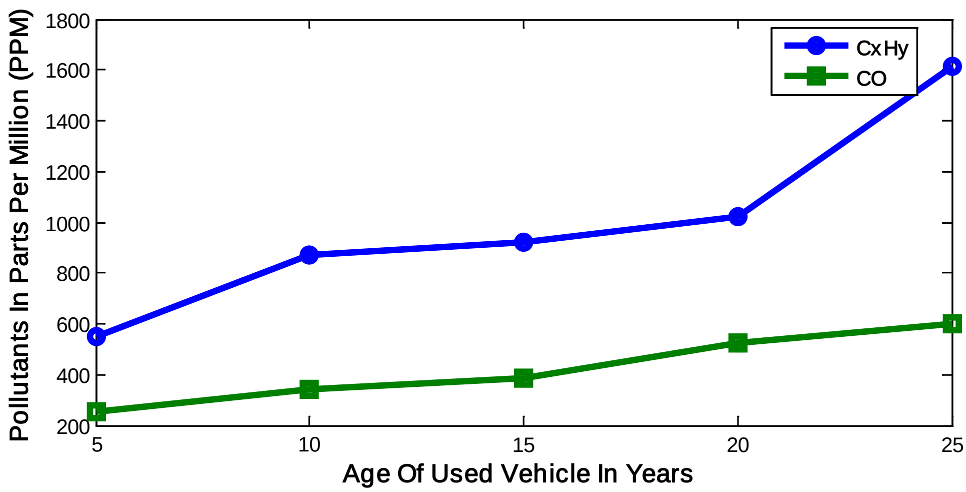

Fig 6(b) : Graph of C_xH_y & CO pollutants from vehicles using (AGO).

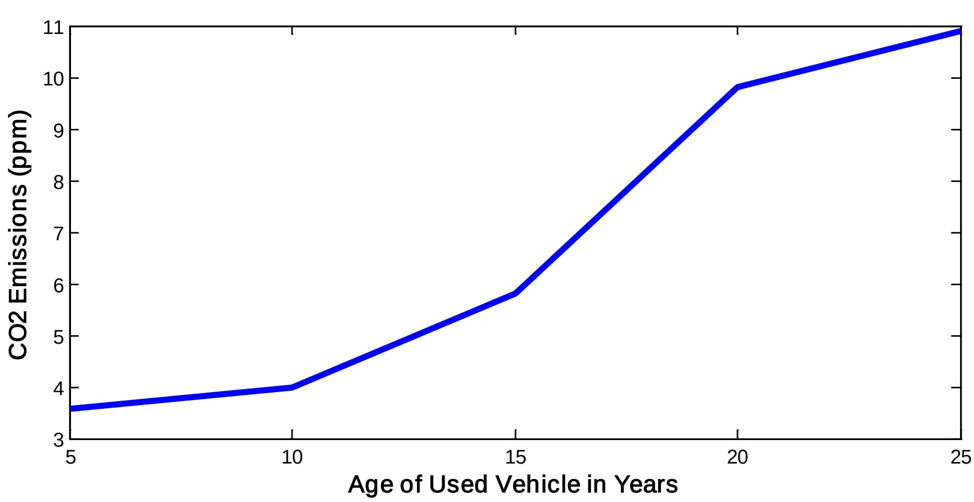

Fig 6(C) : Graph of CO_2 emission from vehicles using (AGO).

(v) The tabular readings for vehicles using (PMS) and (AGO) for the period of 5-25 years is shown in Table 1 & 2.

Table 1 : Results of exhaust emissions from vehicles using (PMS)

Age of Used Vehicle (Yrs)	CO_2 in %	Parts Per Million (PPM)			
		NO_x	C_xH_y	CO	SO_2
5	9.33	60	890	1442	103
10	10.33	89	2040	1446	189
15	10.10	120	3132	2228	254
20	11.44	156	4159	2347	550
25	20.56	288	10500	4228	980

Table 2 : Results of exhaust emissions from vehicles using (AGO)

Age of Used Vehicle (Yrs)	CO_2 in %	Parts Per Million (PPM)			
		NO_x	C_xH_y	CO	SO_2
5	3.57	615	550	251	36
9	4.0	765	870	344	102
14	5.8	967	920	386	178
16	9.8	1406	1020	523	245
25	10.9	2067	1615	597	314

IV. Discussion

The graphs (Figs 3a-Fig 4c) of both Premium Motor Spirit and that of Automotive Gas Oil show a rise in concentration of pollutants released from vehicles older than six months and above, this is known as the 'running-in' period of the engine. At this period the concentration of pollutants are quite low. The second stage, which is known as the 'normal' period in the life of the engine spans from 5- 15years. At this stage the pollutant concentration is relatively high; while the sharp rise from 15- 25years is the disaster stage of the engine. This last stage needs serious attention, as it is characterized by very high emissions from the exhaust.

It is also observed that the graph of (PMS) for NO_x emission shows less concentration when compared to the graph of (AGO) with the same pollutant. The reason could be that most of the vehicles using PMS probably have "Three-Way Catalytic Converters" in their exhaust system, which makes the release of NO_x minimal because most of the Nitrogen Oxide has been broken down into Nitrogen and Oxygen by this catalytic converter. This is unlike vehicles of AGO that probably uses the "Two Way Catalytic Converters", whose main function in diesel engines is to reduce hydrocarbon and carbon monoxide emissions.

The results of Table 1 & 2 (in PPM) did not compared favourably with Table 3, as the values of Table 1 & 2 happens to be higher when compared to the Hourly Mean, Daily Average, and Annual Mean values (in PPM) of the National Air Quality Guidelines for Maximum Exposure (EGASPIN) of Table 3. This is a clear indication that most of these vehicles on the Nigerian roads pose a great risk to the environment.

Table 3 : National Air Quality Guidelines for Maximum Exposure (EGASPIN) [2]

Pollutant	1-Hour Mean ($\mu g/m^3$)	8-Hour Mean ($\mu g/m^3$)	Daily Average Mean ($\mu g/m^3$)	Annual Mean ($\mu g/m^3$)
Suspended Particulate matter (SPM)				
Black Smoke				40 - 60
Total (SPM)	150 - 230		60 - 90	
Carbon Monoxide (CO)	30 26.09ppm		10 8.70ppm	
Sulphur Dioxide (SO_x)	350 0.14ppm		100 – 150 0.04 – 0.06ppm	40 – 60 0.016 – 0.24ppm
Nitrogen Dioxide (NO_x)	400 0.02ppm		150 0.08ppm	
Lead				0.5 – 1.0

The potential harmful effects of these automobile exhaust pollutants on human health and the environment are summarized as follows:

Table 4 : Pollutants and their Health and Environmental Effects [8-10]

Pollutants	**Health Effects**	**Environmental Effects**
Carbon Monoxide (CO)	Reduces the flow of oxygen in the blood stream and increases the likelihood of exercise-related heart pain in people with coronary heart disease. At low doses it can impair concentration and neurobehavioral function.	Greenhouse gas contributing to global warming.
Carbon Dioxide (CO_2)	Non	Major greenhouse gas contributing to global warming
Nitrogen Oxides (NO_x)	May exacerbate asthma and possible increase susceptibility to infections. It could also lead to coughing, shortness of breath and decreased lung function	Formation of ground-level ozone or "smog," which is highly corrosive and damages crops and forests. It contributes to acid rain and is a greenhouse gas that contributes to global warming.
Unburned Hydrocarbons (HC)	Low molecular weight compounds cause eye irritation, coughing and drowsiness. High molecular weight compounds can be mutagenic or carcinogenic	Ground level ozone precursor
Sulfur Oxides	It irritates the eyes and increases the frequency and severity of respiratory symptoms and lung disease.	It is a major precursor of acid rain

V. Conclusion and Recommendation

This study has shown that the concentration of pollutants of imported used vehicles within the ages of 5 – 25years are much higher than the emission standards set by the "National Air Quality Guidelines for Maximum Exposure" (See Table 3), implying that such vehicles are very harmful to the environment and climate (See Table 4).

This study suggests that the following measures be put in place;

- Used vehicles entering the country must pass an approved emission test to demonstrate that their emission control equipment is functioning as intended,
- Public and consumer awareness campaigns should be created on the havoc of used vehicles on the environment,
- Vehicle inspection centers should be set up to test and certify compliance,
- Vehicle owners should be made to understand why they should regularly go for checks and maintenance, so that exhaust emissions could be reduced.

If these measures are properly observed, greenhouse gases and other harmful substances will be reduced and Nigeria will be making a shift towards a green economy.

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4. Manuscript's Category,

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· Use present tense to report well accepted

· Use past tense to describe specific results

· Shun familiar wording, don't address the reviewer directly, and don't use slang, slang language, or superlatives

· Shun use of extra pictures - include only those figures essential to presenting results

Title Page:

Choose a revealing title. It should be short. It should not have non-standard acronyms or abbreviations. It should not exceed two printed lines. It should include the name(s) and address (es) of all authors.

Abstract:

The summary should be two hundred words or less. It should briefly and clearly explain the key findings reported in the manuscript--must have precise statistics. It should not have abnormal acronyms or abbreviations. It should be logical in itself. Shun citing references at this point.

An abstract is a brief distinct paragraph summary of finished work or work in development. In a minute or less a reviewer can be taught the foundation behind the study, common approach to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Yet, use comprehensive sentences and do not let go readability for briefness. You can maintain it succinct by phrasing sentences so that they provide more than lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study, with the subsequent elements in any summary. Try to maintain the initial two items to no more than one ruling each.

- Reason of the study - theory, overall issue, purpose
- Fundamental goal
- To the point depiction of the research
- Consequences, including definite statistics - if the consequences are quantitative in nature, account quantitative data; results of any numerical analysis should be reported
- Significant conclusions or questions that track from the research(es)

Approach:

- Single section, and succinct
- As a outline of job done, it is always written in past tense
- A conceptual should situate on its own, and not submit to any other part of the paper such as a form or table
- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
- Exact spelling, clearness of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else

Introduction:

The **Introduction** should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable to comprehend and calculate the purpose of your study without having to submit to other works. The basis for the study should be offered. Give most important references but shun difficult to make a comprehensive appraisal of the topic. In the introduction, describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will have no attention in your result. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here. Following approach can create a valuable beginning:

- Explain the value (significance) of the study
- Shield the model - why did you employ this particular system or method? What is its compensation? You strength remark on its appropriateness from a abstract point of vision as well as point out sensible reasons for using it.
- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled the declared objectives.

Approach:

- Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done.
- Sort out your thoughts; manufacture one key point with every section. If you make the four points listed above, you will need a least of four paragraphs.
- Present surroundings information only as desirable in order hold up a situation. The reviewer does not desire to read the whole thing you know about a topic.
- Shape the theory/purpose specifically - do not take a broad view.
- As always, give awareness to spelling, simplicity and correctness of sentences and phrases.

Procedures (Methods and Materials):

This part is supposed to be the easiest to carve if you have good skills. A sound written Procedures segment allows a capable scientist to replacement your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt for the least amount of information that would permit another capable scientist to spare your outcome but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section. When a technique is used that has been well described in another object, mention the specific item describing a way but draw the basic principle while stating the situation. The purpose is to text all particular resources and broad procedures, so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step by step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

- Explain materials individually only if the study is so complex that it saves liberty this way.
- Embrace particular materials, and any tools or provisions that are not frequently found in laboratories.
- Do not take in frequently found.
- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

Methods:

- Report the method (not particulars of each process that engaged the same methodology)
- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

What to keep away from

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings - save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or in manuscript form.

What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all, take in raw data or intermediate calculations in a research manuscript.

- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
- If you desire, you may place your figures and tables properly within the text of your results part.

Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
- In spite of position, each table must be titled, numbered one after the other and complete with heading
- All figure and table must be adequately complete that it could situate on its own, divide from text

Discussion:

The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a argument should be. Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly described. Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved with prospect, and let it drop at that.

- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work
- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.

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Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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