Volume 1, Inaugural Issue, October-December, 2021

ARAI Journal of Mobility Technology

A Quarterly Peer-Reviewed Journal

Publication from
ARAI®
Progress through Research
The Automotive Research Association of India
An ISO 9001, ISO 14001, ISO 27001, OHSAS 18001 and NABL Accredited R&D Institute

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Published by

BSP Books Pvt. Ltd.

Foreword

At the outset I would like to congratulate ARAI for starting a "Journal of Mobility Technology", so crucial and important for our Automotive & Allied industry, in line with national perspective. I am pleased to be on the Board of ARAI journal of Mobility Technology.

Honorable Prime Minister Shri Narendra Modi has been launching a series of initiatives right from 2014, since he assumed office as the Prime Minister of India. Swachha Bharat Abhiyan, Digital India, Skill India, Smart Cities, Make in India, Startup India and Atma Nirbhar Bharat. All these initiatives are linked with each other to create a New India, an aspirational India with inspiration for the youth to be not just innovative but employable and entrepreneurial.

Amongst all the industries, two domains stand out: The IT and Automotive industry with huge potential for the growth of Indian Economy and create large scale employment opportunities through Startups, MSMEs hand in hand with large auto industries. It is in this context that a lot of Innovation and Research & Development taking shape in India.

There was an urgent need felt for providing a grand platform where all developments needed can be showcased. This vacuum has been filled by the Journal of Mobility Technology. The research in EVs, batteries charging infrastructure, the modifications in engines for multi fuel injection including green chemistry and green fuels has huge potential in reducing pollution and increasing efficiency.

This journal shall provide opportunity for the young researchers to present their findings and prepare for collaborative development and make a mark in global industry. The journal should also provide job openings and internship opportunities for engineering graduates and students. My best wishes for the editorial team of the Journal.

Yours sincerely,

Prof. Anil D. Sahasrabudhe
Chairman AICTE
New Delhi

Message

It gives me immense pleasure to introduce the first issue of "ARAI Journal of Mobility Technology (AJMT)" published through BSP Books Pvt. Ltd. AJMT is the first technical journal of its kind to serve as a platform for the dissemination of high-quality research in the field of mobility technology. Since establishment in 1996, ARAI has been serving the automotive and allied industry for over five & half decades to produce environment-friendly and safer mobility. ARAI's transformation from a test agency to renowned global Automotive R&D Institute is appreciable. In the spectrum of ARAI's activities, research has always occupied a crucial place, with an institutional emphasis on strong and pervasive interface between research, testing and training. Some of the measures of research are paper publications and patents.

We are delighted to launch this journal. Our goal in launching this new journal is to provide a top tier publication outlet for the latest research in the rapidly growing field of automotive technologies. We would like to publish articles that use real world data to solve real world problems in a creative and innovative manner. We solicit articles that specifically address an interesting research problem, collect and/or repurpose multiple types of data sets, develop and evaluate methodologies to solve the problem in a new and novel way.

Our first issue features ten invited papers on a variety of topics including Safe, Smart and Sustainable Mobility. I am confident that this inaugural issue, which includes all of the published technical papers, will be a valuable resource for researchers, students and concerned stakeholders. All of these articles will be published online in our journal website (https://araijournal.com/) in order to effectively disseminate information around the world. We hope you enjoy reading this first issue and we invite you and your colleagues to contribute to future issues of AJMT.

I would like to thank everyone on the Editorial team and the Advisory Board for their efforts in putting this issue together.

Sincerely,

Dr. Reji Mathai
Director - ARAI
Chairman - Advisory Board
(ARAI Journal of Mobility Technology)

Message

With this inaugural issue, we celebrate the launch of the ARAI Journal of Mobility Technology (AJMT) with immense pleasure, humility and anticipation. We would like to extend a warm welcome to the AJMT readership on behalf of the Editorial Team. We like to take this opportunity to thank our readers, authors, editors & advisory board members, who all have volunteered to help the journal succeed.

The purpose of this journal is to meet the needs of professionals, academia and industry, as well as to disseminate original research in all fields of automotive technology and its related subjects. One of the objectives of this journal is to encourage publication from different streams of research, which will help to enrich the discourse on various topics.

AJMT covers a wide range of topics in the automotive and related areas: Advance Driver Assistance Systems (ADAS); After Treatment System; All-terrain Vehicle Technology; Alternate Fuels; Artificial Intelligence; Automotive Electronics; Automotive Lightweight Technology; Automotive Safety; Functional Safety; Autonomous / Connected Mobility; Shared Mobility; Computational Fluid Dynamics; Computer Aided Engineering; Computer Aided Design; Control Systems; Electric & Hybrid Vehicles; Emission; Energy; Environment Research; Heat & Mass Transfer; HVAC; Impact Biomechanics; Industrial Management; Innovation and Collaboration; Materials & Manufacturing; Mechanics of Discrete Systems; Noise, Vibration and Harshness; Off Highway Vehicle; Powertrain Technologies; Automotive Components; Prototyping; Recycling; Simulation; Suspension, Steering & Brakes; Testing & Validation, Certification & Homologation; Tyres; Vehicle Design; Vehicle Dynamics; Structural Dynamics. We would also like to include topics from Smart, Safe, and Sustainable mobility, with an aim to develop an understanding of the current scenario of ACES (Autonomous, Connected, Electric Shared vehicles).

The AJMT will provide an excellent forum for the exchange of information on all of the above topics, in two formats: full-length research papers and review papers written by industry experts. The editorial board of the journal is confident that this initiative will produce technical-driven, peer-reviewed papers that adhere to the rigorous processes and editorial standards expected by the automotive community. This journal will be published four times a year (Quarterly). To ensure timely dissemination of information, we aim to complete each paper's review process within two months of initial submission.

The AJMT is committed to publishing original work. Each paper should present some novelty and new results in the form of a uniquely written paper entirely in the author's own words. Furthermore, we will issue special calls for papers on a regular basis to modernize and strengthen areas of research and development highlighted in automotive and related subjects, which will be published as special issues.

We conclude by inviting everyone to submit their exciting research to AJMT. All papers that receive a high level of enthusiasm during the peer-review process will be published in AJMT. As a result, we are dedicated to publishing any and all discoveries, methods, resources and reviews that significantly advance the field of automotive technology and its applications.

We would like to welcome you once again to the ARAI Journal of Mobility Technology. We believe that with your help as authors, reviewers and editors, AJMT will be able to serve the mobility community even better in the future. We hope to hear from you soon and we appreciate any feedback you may have!

If you have any queries, suggestions or concerns, please use the website feedback form to express them. Thank you very much. We hope you will find AJMT useful.

Sincerely,
Editorial Team

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Dr. S. S. Thipse

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About the Journal

ARAI Journal of Mobility Technology is a print and online technical journal in automotive and its related fields. To cater to the needs of Professionals, Academia & Industry and to further the dissemination of original research in all fields of automotive technology, ARAI is publishing a Technical Journal. This Journal is published under the editorial supervision of Chief Editor and the editorial team. In addition, journal is published under the directions of eminent and expert editorial board from India, USA and other countries. It is published by ARAI in collaboration with BSP Books Pvt. Ltd.

One of the objective of this Journal is to provide a platform for the publication of articles covering a wide range of automotive and its allied subjects. Manuscript published in this journal will receive very high publicity and acquire a very high reputation in the automotive and research communities.

This journal is open to all researchers worldwide for contribution and publication and it is targeted at scholars, academicians and professionals involved in the Automotive Industry.

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- Free publication: No article processing charges for first two years (Till 31st March 2023).
- Fair evaluation: Rapid and prompt processing of manuscripts, fair peer and editorial evaluation process.
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(d) Name of the Editor-in-Chief	**Dr. K. C. Vora** Sr. Deputy Director ARAI, Pune

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Impact of 20% Ethanol-blended Gasoline (E20) on Metals and Non-metals used in Fuel-system Components of Vehicles

Moqtik A. Bawase and Sukrut S. Thipse

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ABSTRACT

Ethanol is considered as a potential biofuel for blending with gasoline and, in India, it is planned to increase the ethanol content to 20 percent in gasoline by year 2025 from present allowable limit of maximum 10percent. It is important to evaluate the impact of E20 fuel on the materials used in fuel-system components. An evaluation of 8 metals, 6 elastomers and 4 plastics used in various fuel-system components was conducted through systematic exercise of laboratory immersion following standard methods like SAE J1747 and SAE J 1748 with all the quality and quality assurance measures. The study was conducted with E20 as test fuel and commercial gasoline (BS IV) as a baseline fuel for comparative assessment. Impact of E20 on metals was evaluated through calculation of corrosion rates in mm/year based on data obtained for change in mass post-immersion in above fuels. Similarly, impact of elastomers and plastics was evaluated through observed changes in properties like mass, volume, tensile strength, elongation, impact strength and hardness.

Impact of E20 on metals tested was found to be insignificant based on the corrosion rates. Polychloroprene, SBR, HNBR and Fluoroelastomer were found to perform similar or better in most of the properties with E20. Impact of E20 on NBR-PVC and Epichlorohydrin was more as compared to commercial gasoline. Similar changes in properties of PA12, PBT and Acetal were observed in both the fuels. Impact of E20 on tensile strength and volume change properties of PA66 was found to be more than commercial gasoline. The vital information generated can be utilised by design engineers for selection, modification of materials for various components of fuel-system of vehicles.

KEYWORDS: E20 fuel; Material compatibility; Ethanol; Biofuels; Fuel system; Alternate fuels.

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Impact of PGM loading in DOC for Off Road Engine to meet CEVIV Norms

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ABSTRACT

Experimental study was done for evaluation of different type of PGM loading in Diesel oxidation catalyst (DOC) for off road vehicle. The main purpose of DOC is to reduce the hydrocarbon and carbon monoxide from exhaust line and increasing the DOC outlet temperature, which used in soot oxidation in DPF and increased conversion efficiency of SCR. It is very challenging to meet the emission norm with minimum loading of DOC for low cost and durable approach for non-auto application. Test results highlights impact on emission with different PGM loading in DOC.

This paper focused on the calibration of DOC model with different loading and observed that behaviour on THC and CO in exhaust system. Minimum Temperature constraint was come in NRTC rather than NRSC. With low, exhaust gas temperature white smoke observed, when unburned HCs was adsorbed on DOC. Data taken to understand thermal effect on DOC with different loading in aged condition. It observed that maximum DOC loading, conversion efficiency went up to 98% in THC after heating up. DOC loading is also responsible for conversion of NO to NO_2, which is used in conversion of SCR efficiency. Detailed comparison and analysis was done to understand the impact of PGM loading in DOC for NO_2 formation, exotherm, HC & CO light off temperature behaviour.

KEYWORDS: Diesel oxidation catalyst (DOC), off road vehicle, CEVIV Norms, emission, NO2/NOx, PGMGM

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Study of impact of Engine and Vehicle Level Parameters for Reduction in Engine Oil Consumption for Advanced Emission Architecture Commercial Vehicles

Navneet Gautam, Tushar S Kanikdale, Ajay Khare, Sachin Paygude, Arshad A Shaikh

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ABSTRACT

Automotive industry has seen implementation of advanced emission regulations like BS-VI in India along with growing market demand for increased product performance and reduction in total cost of ownership. This has made the engine architecture more intricate leading to complex interaction among engine and vehicle level parameters. This poses technical challenge for achieving critical product attributes like increased power density, higher fluid economy and reduced oil consumption (OC).

The current paper focusses on reducing engine oil consumption across diverse duty cycles using simulation tools, vehicle data analytics and test cell Design of Experiments (DOE). The contribution of oil consumption mechanisms viz. oil evaporation, oil throw and oil transport have been understood across different loads and duty cycles patterns. The critical parameters at engine and vehicle levels are identified affecting low load and high load oil consumption. Vehicle testing is conducted, and the real time data analytics was used to identify correlation of vehicle duty cycle parameters like percentage of Idling, Thermal Management Operation, Coolant Temperature, etc. with measured oil consumption. Piston ring dynamics simulation has been used to optimize critical ring parameters impacting oil consumption through directional trends. DOE was conducted in engine test cell environment to assess effect of critical parameters like combustion temperature and oil ring tension for high load oil consumption.

The new test cycles for verifying oil consumption at various loads are described. Results of interaction and main effects for individual factors are discussed. The parameters having weaker co-relations are also highlighted. The proposed solution is a combination of piston ring pack geometry features, thermal management calibration strategy and vehicle idling controls. The demonstration of final recipe of solution at vehicle level showed substantial improvement in oil consumption over baseline as well as over global industry benchmark. The improvement is demonstrated in the actual vehicle applications for mining tippers and tractors

KEYWORDS: Engine, Vehicle Level Parameters, Oil Consumption, Emission, Commercial Vehicles, Design of Experiments (DOE)

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Light Weighting of Buses using Aluminium with Safety and Durability Considerations

M. A. Patwardhan, P.A. Nirmal and R.S. Mahajan

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ABSTRACT

Automobiles, while making living easy and convenient, have also made human life more complex and vulnerable to toxic emissions Transport sector is huge contributor in polluting air in the entire world in the tune of around 23%. Mass transport uses buses as the medium for generalized and convenient means for commutation from one place to other. Similar pattern is observed in India for mass transportation mainly in the cities. However, commuting through buses comes with penalty of environmental pollution. City buses are larger contributor in GHG emission and can be considered as prime candidates for making any kind of changes which will help in reducing environmental pollution. Immense potential lies in existing bus designs for weight optimization which has direct impact in improving fuel economy and hence will have sustainable impact in reducing carbon emissions.

This paper outlines systematic approach used for development of lightweight buses using Aluminium addressing safety, durability and necessary regulatory requirements. Effective use of aluminium in development of lightweight bus structure is demonstrated in this project. While designing lightweight structure for weight optimization due care is taken for addressing prevailing regulatory norms related to AIS:052 bus body code, AIS:153 outlining safety requirements and Urban Bus Specification issued by Ministry of Road Transport and Highways specifying strength and safety requirements of bus structure.

Aluminium bus designs developed shows more than 30% weight reduction compared to steel structured buses of similar class. Fuel efficiency improvement in the tune of minimum 8% and maximum 10% are observed during field level trials.

KEYWORDS: Aluminium; Lightweighting; Fuel Economy; Public Transport; Safety and durability.

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Performance Evaluation of Self-Piercing Riveted and Resistance Spot Welded Dissimilar Steel Joints

Akhil Kishore V T[1], Brajesh Asati[2], Nikhil Shajan[2] and Kanwer Singh Arora[2]

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[2]Research and Development, TATA Steel, Jamshedpur, India.

ABSTRACT

Self-piercing riveting (SPR) is a mechanical joining process that has the potential to replace resistance spot welding (RSW) and is being adopted inthe automotive industry.In this study, a dissimilar stack configuration widely used in the automotive industry was used. Joining was performed using self-piercing riveting and resistance spot welding processes. Welding parameters in spot welding were optimized to produce anugget with a diameter similar to the rivet shank. Tensile and fatigue attributes of these joints were assessed to evaluate the joint performance. Additionally, microstructure-property correlation was performed to evaluate the failuremode and susceptible region in the joint that can lead to crack initiation and failure.

KEYWORDS: Self-piercing riveting, Resistance spot welding, Fatigue, DP590 steel, IF steel, Tempered martensite.

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Performance of Thermal Barrier Coating on Exhaust System Component

Dhanasekaran Radhakrishnan[1], Libin George Alexander[2], Raja R.[3] and Srikari Srinivasan[3]

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ABSTRACT

Thermal management in automobiles is important to keep the passenger cabin and heat sensitive components away from thermal effects. Hence various types of insulation methods are used to reduce the thermal effects. Heatshields are the most common method of thermal insulation. They can be classified into various types based on their construction architecture and insulation materials. Some of the heat shielding systems contain fibre materials that are hazardous to health due to their carcinogenic effects and hence not recommended. With increasing space constraints in the compact vehicle architecture designs, packaging space is premium, limiting the size of heatshields. In addition, from durability aspect, heatshields alone are not adequate to withstand high temperatures during the service life of exhaust systems. Hence the role of Thermal Barrier Coating (TBC) as an alternative solution comes effective.

TBC's are ceramic coatings which can take care of extended heat loads and temperature differences. This coating not only provides thermal insulation but also improves the fatigue life of substrate material. Hence in this paper, the application of TBC on exhaust system components with respect to thermal insulation and thermo mechanical fatigue are studied. Virtual analysis and physical test are carried out to validate the results. TBC coating on exhaust component shows promising results.

KEYWORDS: Thermal barrier coating; Atmospheric plasm spray; Thermo mechanical fatigue analysis; Thermal Test; Yttria stabilized zirconia.

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Driving Safety through ADAS: An Indian Perspective

Ujjwala Karle

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ABSTRACT

Analysis of the National Motor Vehicle Crash Causation Survey, conducted by the National Highway Traffic Safety Administration (NHTSA), shows that driver error is a factor in 94% of crashes. Although it is important to remember multiple factors contribute to all crashes, the largest portion of driver error issues involve the driver failing to recognize hazards, including distraction. Around 3,700 people die in traffic every day around the world, and 100,000 are injured. The automotive industry is striving to make driving safer. ADAS in India is comparatively in a nascent stage. However, it is gradually gaining pace. The government's upcoming safety regulations and consumer awareness will give further impetus to this movement.

So, Advanced driver-assistance systems (ADAS) is equipping cars and drivers with advance information and technology to make them become aware of the environment and handle potential situations in better way semi-autonomously. High-quality training and test data is essential in the development and validation of ADAS systems which lay the foundation for autonomous driving technology.

In addition to this, ADAS systems need to be very safe and robust, with the ability to perform in a variety of driving scenarios, and be very secure, being immune from any external cyber-attacks. In order to make ADAS systems safer, the AV will be required to drive more than a billion miles on real roads, taking tens and sometimes hundreds of years to drive those miles, considering even the most aggressive testing assumptions. Every small update to the AV will require another billion miles of testing to be approved for real world use. Moreover, the more advanced the technology becomes, the more miles will need to de driven. Real word testing plays a very crucial role in ADAS and AV development and testing. Nevertheless, relying only on real world testing will significantly slow down the development and testing of such technologies. This is where simulation comes into play.

With the primary objective of road safety improvement, ADAS functionalities will definitely play a big role for automotive industry. In order to tackle Indian specific road infrastructure conditions, and thus improving the safety, a complete tool-chain for developing, deploying and validating ADAS functionalities need to be developed. The presented work shares insights of each and every aspect of this tool-chain with experimental results and real world correlations.

KEYWORDS: Advance Driver Assistance System (ADAS), Driving Safety, autonomous driving, safety

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Thermal Modelling of Battery Pack of an Electric Vehicle Using Computational Fluid Dynamics

Ch Sainath Reddy, Bokam Surya Sashikanth, K. Ravi

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ABSTRACT

As Today, conventional engines are being replaced by electric vehicles due to environmental concerns and concern about the exhaustion of fossil fuels. Li-ion cells are often used in EV's because of their high energy density. The thermal behaviour of the batteries is crucial not only for safety operation but also for their capacity and life. This article focusses primarily on the effect of inclusion of conductive material and conditioned air on the battery module. A three-dimensional flow and thermal analysis of an air-cooled module that contains prismatic lithium-ion cells fitted in aluminum structure. The flow and thermal simulation is carried out at the peak discharge of the batteries i.e. 2C rating [17] using a commercial CFD package. The results are compared with the base line model analysis which is performed with same parameters. The temperature is decreased by 7.2^{o}C on average for the addition of fins to the battery module. The increased load on the AC unit is calculated as well when the air is directed to battery module and sufficient modifications for the system are suggested.

KEYWORDS: Battery thermal management, Li-ion batteries, CFD, air-cooling, HVAC cooling.

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A Systematic Approach to Evaluation of Various Cooling Strategies for EV Battery Pack Prismatic Cell Using Analytical and Numerical Methods

Yogesh P Dol, Vivek Anami, Yogesh Jaju

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ABSTRACT

Technology to maximize energy density and life of Lithium-ion batteries at a gradually reducing cost is evolving day by day. Fast charging of the battery pack has become one of the major requirements of electric vehicles. Such a requirement invariably poses certain challenges to the cells of the EV battery pack. One of them is to achieve an efficient and an optimal thermal management of the battery pack to maintain uniform operating temperature of the cells and within the manufacturers' allowable range to ultimately increase the lifespan and reliability of the battery pack. The current work discusses the design strategies of cell cooling, heat load estimation & features of different cooling strategies. A MS Excel spreadsheet-based design tool was developed to quickly estimate the cell temperature gradient. The results from the spreadsheet based tool, which was based on fundamental equations, correlated well with 3D CFD simulation results. The results were analysed and the cooling strategy for the battery pack was decided based on the analytical and numerical values obtained from the analysis of various cell parameters.

KEYWORDS: Thermal management, Design strategies of cell cooling, heat load estimation, spread sheet, Temperature gradient, 3D CFD simulation.

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Prognostics and Health Monitoring of Lead Acid Battery

R. Ashwin, A.N. Suryanarayana Prasad

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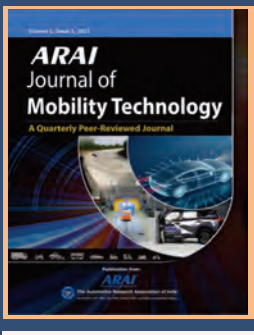
ABSTRACT

The ever-increasing number of electrical loads in the commercial vehicle emphasizes the significance of lead acid battery used for starting and the powering of electrical systems in a commercial vehicle. In order to monitor the health of the battery, parameters SOC (State of Charge) and SOH (State of Heath) are introduced. The existing methods to calculate these parameters use impedance monitoring based approach which requires anexpensive current sensor. This paper describes a smart algorithm and the experimental verification of the algorithm that uses only voltage values for predicting the failure of the battery.The voltage waveforms during a cranking event is studied by the ECU (Engine Control Unit) and the health of the battery is determined based on it. A parameter, SOH measure is obtained from the algorithm and the value of this parameter reduces with increase in life of the battery. If the value of the SOH measure reduces below a threshold, then the failure of the battery is predicted before the actual failure.The algorithm is validated with the help of real time data obtained from the vehicles. This method of calculating the SOH is resourceful and cost-effective as it exploits the data that's already available in the ECU namely battery voltage and ambient temperature. Thus, it does not warrant an addition of sensor to the system in place.

KEYWORDS: Lead acid battery, ECU (Engine Control Unit), SOH, Prognostic, engine cranking.



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To cater to the needs of Professionals, Academia & Industry and to further the dissemination of original research in all fields of automotive technology, ARAI is publishing a Technical Journal, "ARAI Journal of Mobility Technology", in collaboration with BSP Books Pvt. Ltd. One of the objectives of this Journal is to provide a platform for the publication of articles covering a wide range of automotive and its allied subjects. Manuscript published in this Journal will receive very high publicity and acquire a very high reputation in the automotive and research communities.

This journal topics include, but are not limited to the following:

- Advance Driver Assistance Systems (ADAS)
- After treatment system
- All-terrain Vehicle Technology
- Alternate Fuels
- Artificial Intelligence
- Automotive Electronics
- Automotive Lightweight Technology
- Automotive Safety
- Autonomous Connected Vehicles
- Computational Fluid Dynamics
- Computer-Aided engineering
- Computer-aided Design
- Control Systems
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- Vehicle Dynamics

The majority of the articles will be published on the aforementioned topics.

Call for Papers

Authors are cordially invited to submit papers in the ARAI Journal of Mobility Technology (AJMT). Manuscript published in this Journal will receive very high publicity and acquire a very high reputation in the automotive and research communities. We request you to please give it wider publicity by circulating it to Automotive Professionals, Faculty members, Research Scholars of your Institution / Organization and encourage their active participation and submission of their research papers.

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