



## **PRESS RELEASE**

### **IIT Mandi researchers develop algorithms to predict the functioning of vehicular Internal Combustion Engines**

#### **The developed algorithms will improve engine performance and lower vehicular emissions**

**MANDI, 5<sup>th</sup> April 2021:** Indian Institute of Technology Mandi researchers, along with Robert Bosch Engineering and Business Solutions Private Limited, Bangalore, have developed algorithms to predict the functioning of vehicular Internal Combustion (IC) engines so that their operation can be optimized for maximum fuel efficiency and minimum emissions.

**A research team lead by Dr. Tushar Jain, Assistant Professor, School of Computing and Electrical Engineering, IIT Mandi, has published this research in the International Journal of Systems Science, Taylor & Francis.** The paper is co-authored by Dr. Jain and his research scholar, Ms. Vyoma Singh, along with Dr. Birupaksha Pal from Robert Bosch Engineering and Business Solutions Private Limited, Bangalore.

The IC engine that is fuelled by petrol and diesel powers about 99.8% of global transport and, in doing so, generates about 10% of the world's greenhouse gas (GHG) emissions. While alternatives including battery electric vehicles (BEVs) and other fuels like biofuels and hydrogen are slowly gaining ground, as of now, they are often used in conjunction with conventional IC engines. It is therefore imperative that IC engines designs are optimized in order to ensure the best fuel economy and minimal emissions over the entire lifespan of the engine.

*"At any point of time, the working condition of the engine and other devices/systems inside the vehicle should be precisely known, for which, we need the information on several important engine parameters,"* **said Dr. Jain.** If the information of all the relevant parameters were known, then by continuous monitoring and computation of these parameters, the driver could use the usual driving manoeuvres such as changing the gear appropriately to improve the vehicle's performance.

From the technical viewpoint, designing the optimum performing engine depends on the precise knowledge of the system states and the engine parameters; for example, in petrol engines, an air-fuel ratio (AFR) value of 14.67 translates to complete combustion of the fuel, and thus minimal emissions and maximum power. While new vehicles out of the assembly line meet many of the requirements, as they age, the operational parameters change, and the vehicle's operation becomes less than optimal.



*“Due to the high frequency moving parts and operating conditions of the engine, it is difficult to place or install the sensors that are available in the market to measure all the key parameters continuously. We have developed a new algorithm for their online estimation, which will be used to develop advanced, sophisticated controllers for better engine performance,”* **explains the lead researcher.**

The proposed algorithm is based on the unscented Kalman filter and recursive least-squares mathematical techniques to accurately estimate the engine dynamics and parameters. The researchers have benchmarked the performance of their methodology by comparing it with that of the state-of-the-art estimation methods. The numerical stability and robustness of their proposed methodology are analyzed through rigorous Monte Carlo simulations and found to be superior to other methods.

The researchers have estimated the spark-ignition engine dynamics, namely the intake manifold pressure, engine speed, and the airflow rate past the throttle, along with the estimation of the engine parameters that determine the said dynamics accurately. The developed algorithm can be programmed and be a part of the Electronic Control Unit (ECU) installed in the vehicles.

The algorithm developed by the IIT Mandi team will help in on-board monitoring and control for IC engines. The application of the developed algorithm can be extended to determine other variables such as the State-of-Charge (SoC) in battery-operated vehicles in real-time as well.

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### **About IIT Mandi**

Since the first batch of 97 students joined in July 2009, IIT Mandi has grown to currently host 125 faculty and 1,833 students who are enrolled in various programmes of studies in undergraduate, postgraduate and research programmes, and 1516 alumni. IIT Mandi is a fully residential campus with 1.4 lakh sq. m. buildings completed. It has a guest house with 88 rooms, a 750-seater Auditorium, campus school, sports complex and hospital.

IIT Mandi has four Academic Schools and three major Research Centers. The Schools are: School of Computing and Electrical Engineering, School of Basic Sciences, School of Engineering, and School of Humanities and Social Sciences. The Centers are: Advanced Materials Research Centre (AMRC; set up with an investment of Rs. 60 crores), Centre for Design and Fabrication of Electrical Devices (C4DFED; has Rs. 50 crores worth of fabrication tools), and BioX Centre (has acquired research equipment worth Rs. 15 crores). In 2017, the Department of Biotechnology, Government of India, selected IIT Mandi to lead the prestigious Rs. 10 crore FarmerZone® Project.

To cater to the growing and changing needs of the Indian industry and the aspirations of students, IIT Mandi has introduced 7 B.Tech., 7 M.Tech., 5 M.Sc., 4 Ph.D., 1 I-Ph.D and 1 M.A programmes in the past 10 years. The unique, project-oriented B.Tech. curriculum is centred



around its 4-year long Design and Innovation stream. From August 2019, IIT Mandi started 3 new and unique B. Tech. programmes in Data Science and Engineering, Engineering Physics, and Dual Degree in Bioengineering.

Since the inception of the Institute, IIT Mandi faculty have been involved in over 275 Research and Development (R&D) projects worth more than Rs. 120 crore. In the past 10 years, the Institute has signed a Memorandum of Understanding (MoU) with as many as 11 international and 12 national universities.

IIT Mandi Catalyst, the first Technology Business Incubator in Himachal Pradesh, has helped over 75 startups since 2017 and is changing both the industry profile and entrepreneurial mindset in the state. So far, Catalyst has secured external funding of Rs. 24 crores from various funding agencies. Enabling Women of Kamand Valley (EWOK) is another innovative programme run by IIT Mandi, which focuses on imparting skills training to rural women to enable them to start village-scale businesses.

IIT Mandi has been ranked no. 31 in the Engineering Institutions Category in the [India Rankings 2020](#) released by National Institutional Ranking Framework, Ministry of Education, Govt. of India. Apart from this, IIT Mandi is the only second-generation IIT to be featured at rank no. 7 in the Atal Ranking of Institutions on Innovation Achievements, of the Innovation Cell, Ministry of Education, Govt. of India.

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