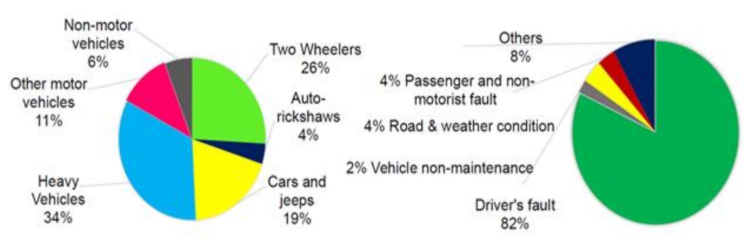
Indian Institute of Technology Madras
Department of Engineering Design

Research Focus

Active Vehicle Safety Systems (AVSS) and Advanced Driver Assistance Systems (ADAS)

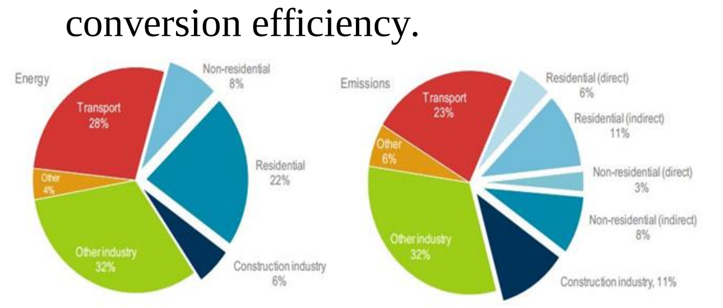
- Over 53 road accidents occur every hour claiming about 17 lives, on an average, in India [MORTH 2017 data].
- AVSS like Anti lock Braking Systems (ABS) prevent wheel lock, reduce the stopping distance, and retain vehicle steerability during emergency braking maneuvers, thus reducing accidents.
- ADAS technologies like Collision Warning and Avoidance systems can help reduce accidents and fatalities by warning the driver of an impending collision and apply brakes automatically to prevent it.



Electrified Vehicles

Issues with engine-driven vehicles

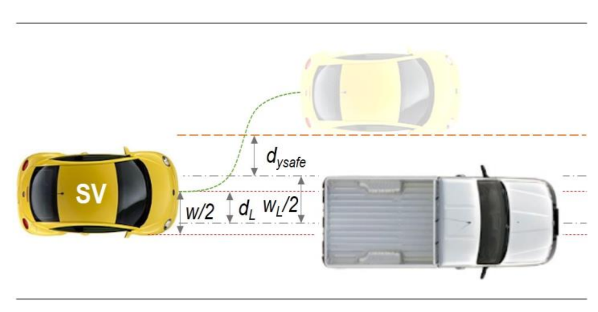
- Growing demand for non-renewable energy resources (Oil and Gas).
- Increasing air pollution and global climate changes.
- Larger deviation from ideal traction characteristics and lower energy conversion efficiency.



(Source: IEA Global status report 2018)

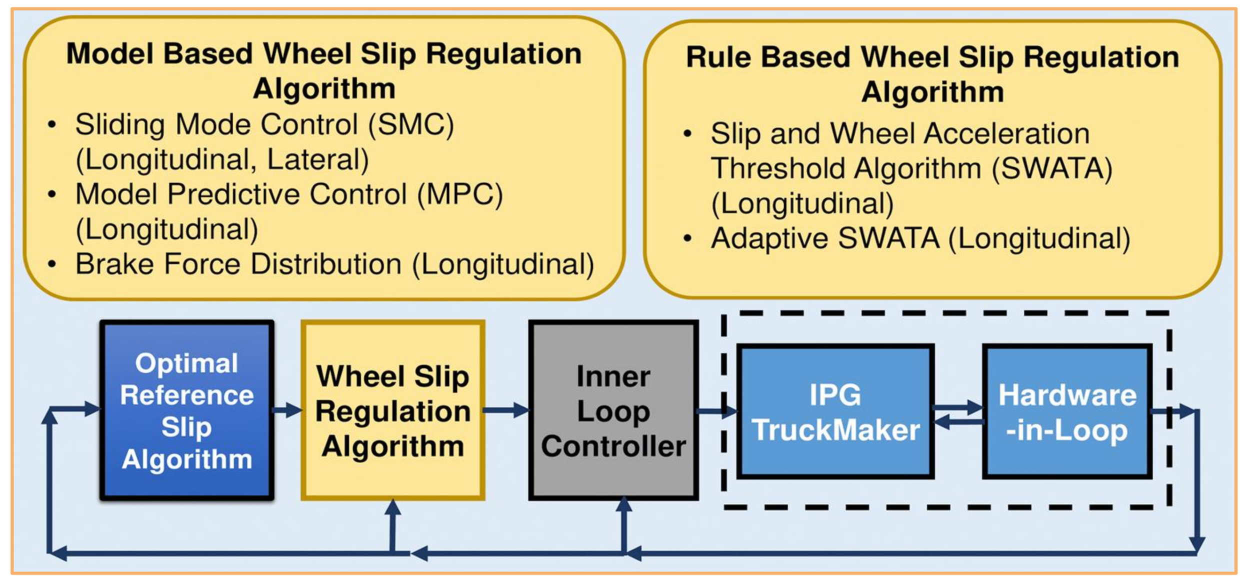
Transportation and Mobility

- This research area aims at modelling the motion of vehicles in mixed traffic at various levels.
- At the microscopic level, this problem involves predicting vehicle trajectories for a safe maneuver, meaning without collisions and without losing vehicle stability.



Active Vehicle Safety Systems

Anti lock Braking System

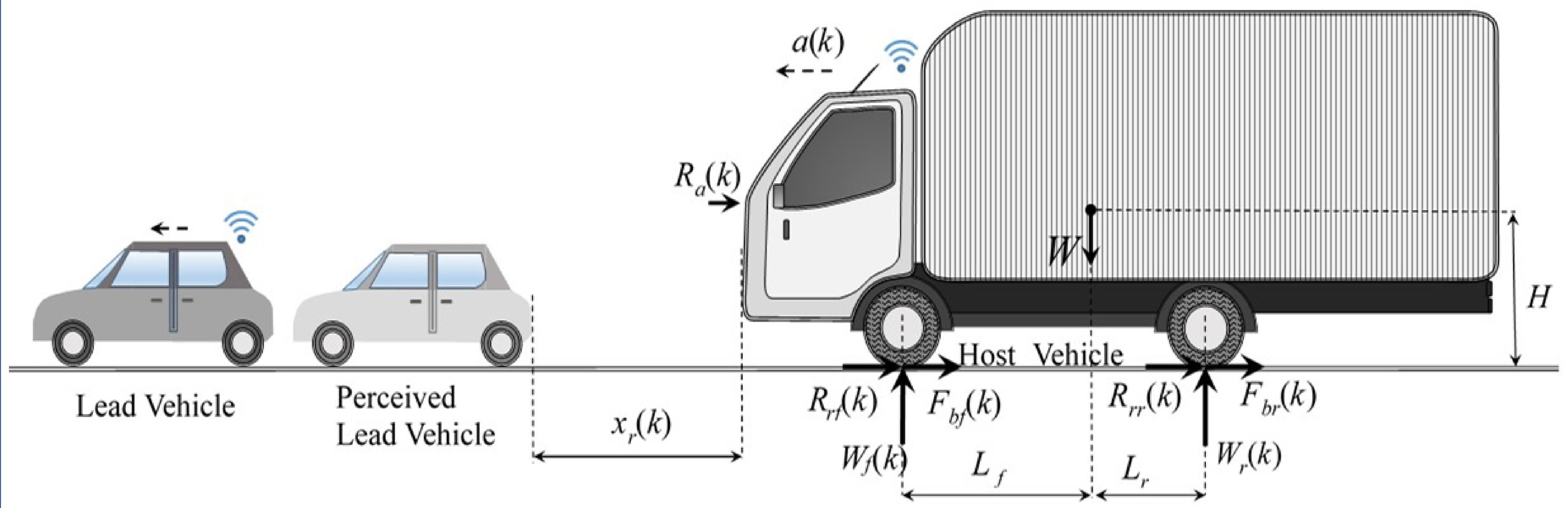


Fault Diagnosis

- Developed an artificial neural network (ANN) based algorithm to predict pushrod stroke based on measurement of brake chamber pressure in Heavy Commercial Road vehicles (HCRVs).
- Developed a condition monitoring algorithm for air brake system using Support Vector Machine (SVM).
- Developed a yaw angle controller for the HCRVs with faulty brake using SMC.

Advanced Driver Assistance Systems

Collision Avoidance



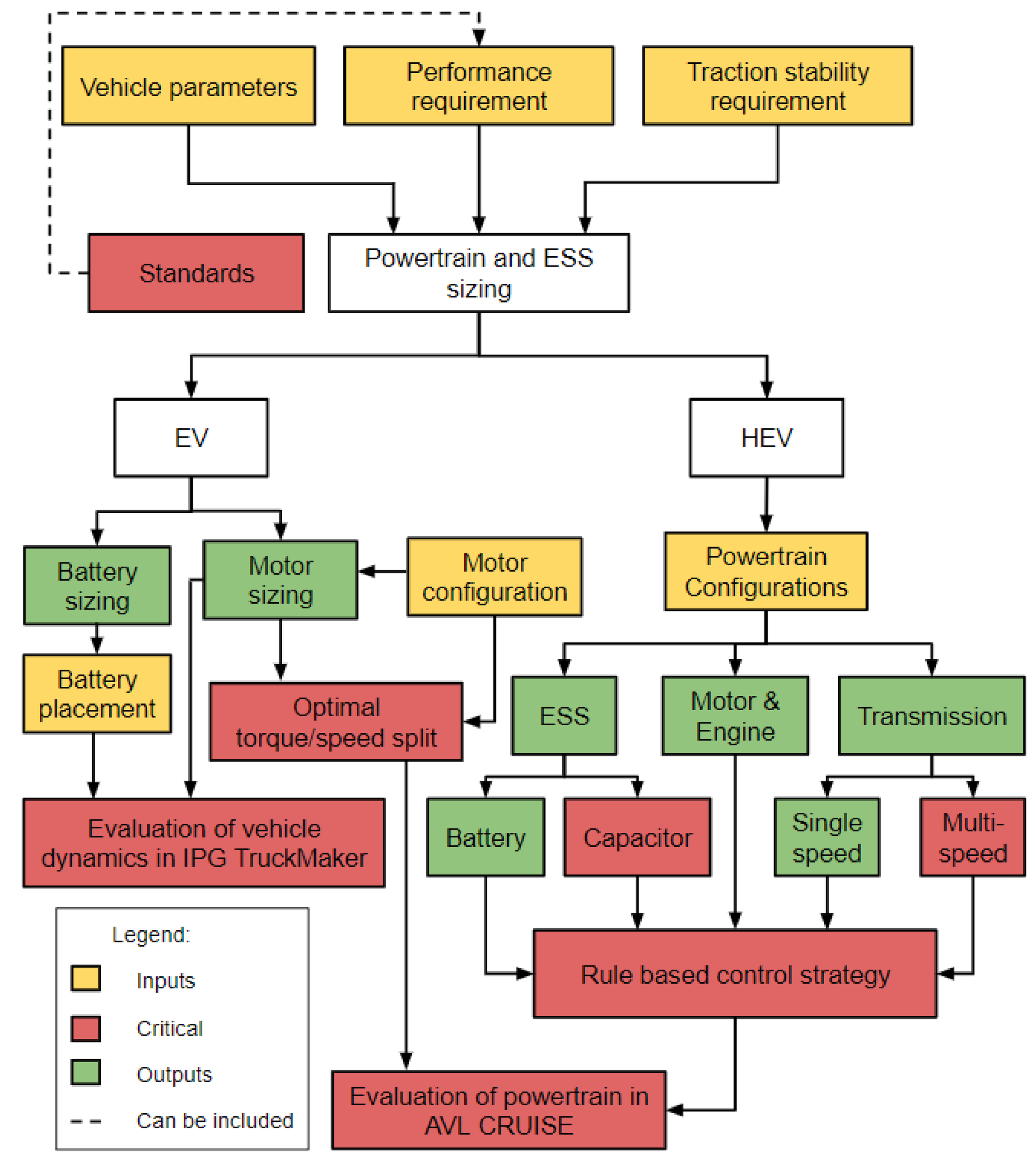
- Developed a Collision Avoidance Algorithm (CAA) that assists the driver in avoiding forward collision by autonomous braking of the HCRV when threat is detected.
  It considers factors like load variations (unladen, laden), brake actuator dynamics and dynamic load transfer.
- This CAA is being modified to work in a vehicle-to-vehicle (V2V) communication environment which has characteristics like communication latency and packet loss.
- The developed CAA would also be integrated with slip-control algorithm to avoid wheel lock and thus, reduce the braking distance of the HCRVs.
- Further, use of low-cost LiDAR for the implementation of the developed CAA is also being done.

Vehicle Platooning

- Developed a Variable Time Headway (VTH) policy-based SMC controller for string stability of an HCRV platoon considering the actuator dynamics.

Electrified Vehicles

EV and HEV Powertrain Sizing and Evaluation



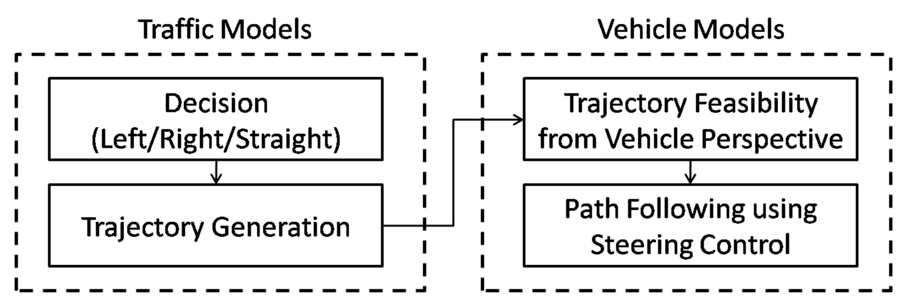
Handling Performance of Electrified Vehicles

- Compared the handling performance of a engine-driven vehicle and a hybrid electric vehicle with respect to change in static mass distribution using Mimuro plot.

Transportation and Mobility

Vehicle Motion Modelling in Mixed Traffic

- Developed a simulator with disordered heterogeneous traffic scenarios to predict vehicle trajectories and vehicle maneuvers using steering control.



Model Based Estimation and Control of Indian Traffic

- Developed models to capture heterogeneous and lane less traffic based on area occupancy and strip based approach.
- Developed an Adaptive Kalman filter scheme to estimate traffic density which is a good measure of traffic congestion for varies traffic scenarios.
- Developed a model based control scheme to control traffic signal so as to maintain optimum density in a section.

Important Outcomes

- Sizing methodology for EV and HEV for satisfying performance.
- Analysis of vehicle dynamics for EV and HEV.
- Analysis of variation of motor ratings with standard test conditions.
- Accidents due to forward collision will be reduced.
- Wheel slip regulation with real time identification of the tire-road interface.
- The vehicle can communicate with each other and send their position, speed and acceleration.
- Development of fault diagnostic scheme for air brake system.
- Development of a mixed traffic simulator with predicted vehicle trajectories for testing autonomous vehicles.
- Development of a model based estimation and control scheme to control traffic signal for Indian traffic.

Key Publications

- P. Gaurkar *et al.*, **Wheel Slip Regulation for Heavy Commercial Road Vehicles Using Model Predictive Control Subsumed with Auto-Regressive Time Series Modelling**, *ASME-IMECE*, 2019 (accepted).
- A. Challa *et al.*, **Sliding Mode Control For Dynamic Brake Force Distribution Towards Heavy Commercial Road Vehicle Safety**, *ASME-IMECE*, 2019 (accepted).
- R. Raveendran *et al.*, **Artificial Neural Network Approach for Pushrod Stroke Prediction in Heavy Commercial Road Vehicles**, *Proc. IMechE Part D: J. Automobile Eng.*, 2019.
- V. R. S. Yellapantula *et al.*, **Effect of Packet Loss on a Connected Heavy Vehicle Collision Avoidance Algorithm**, *IEEE ICCVE*, 2019 (accepted).
- K. B. Devika *et al.*, **Control of Heavy Road Vehicle Platoons Incorporating Actuation Dynamics**, *IEEE TENCON*, 2019 (accepted).
- V. Kumar *et al.*, **Vehicle Tracking for Heavy Vehicle Collision Avoidance with an Economical Solid-State Laser Sensor**, *IEEE ITSC*, 2019 (accepted).
- D. P. Kumar *et al.*, **Design and Evaluation of a Coupled Motor Drive Powertrain for an Electric Bus**, *IEEE ITEC* 2019 (accepted).
- V. Randive *et al.*, **Component Sizing of Single and Dual Drive Series Hybrid Electric Powertrain for Military Tracked Vehicles**, *IEEE VPPC*, 2019 (accepted).
- R. George *et al.*, **Traffic Density Estimation under Lane Indisciplined Conditions using Strips along Road Width**, *COMSNETS* 2019.

Contact

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Indian Institute of Technology Madras
Department of Engineering Design

Centre of Excellence for Tyre and Vehicle Mechanics

Prof R Krishna Kumar

Research focus

- To improve tire design to enhance tire durability, vehicle handling characteristics and fuel economy.
- To apply cutting edge technology to develop smart vehicle dynamics control systems.
- To innovate and conceptualise tire designs to meet the ever changing dynamic requirements of automotive industries.

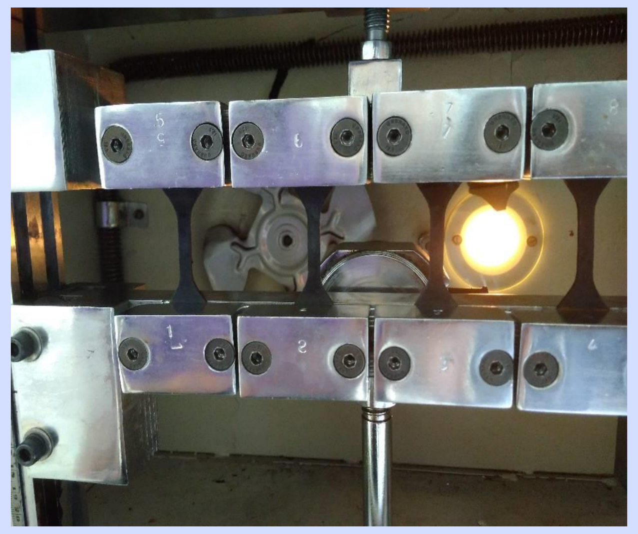
Research Areas

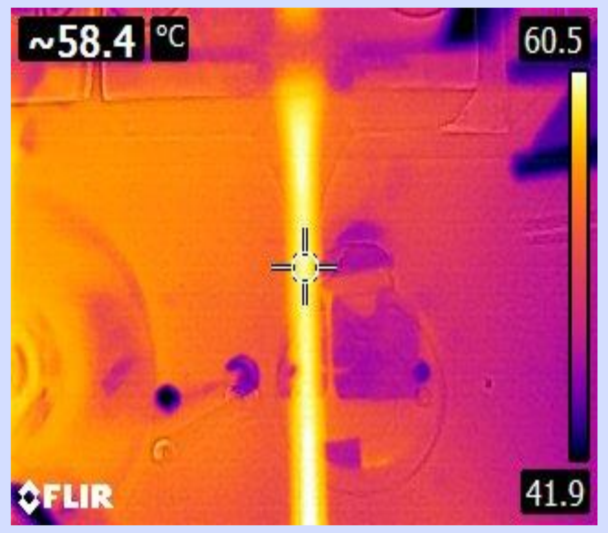
- Material Characterisation
- Finite Element Analysis
- Vehicle Dynamics
- Parameter estimation and Sensitivity Analysis
- Tyre Mechanics
- ADAS
- Virtual tyre and vehicle testing

Sponsors

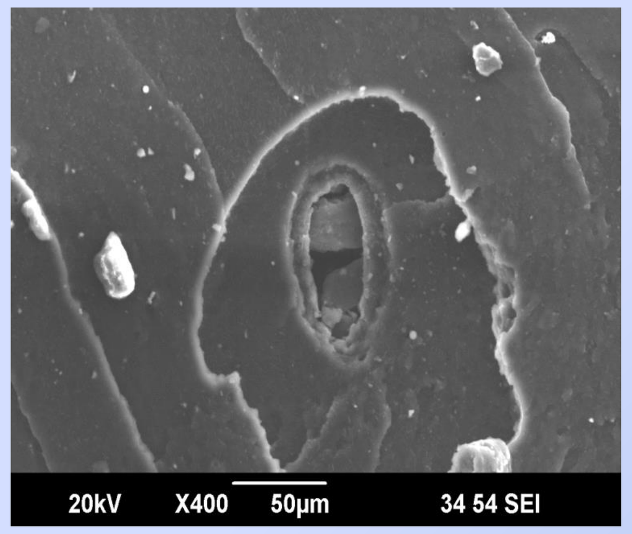
JK TYRE
TOTAL CONTROL

Rubber Characterisation

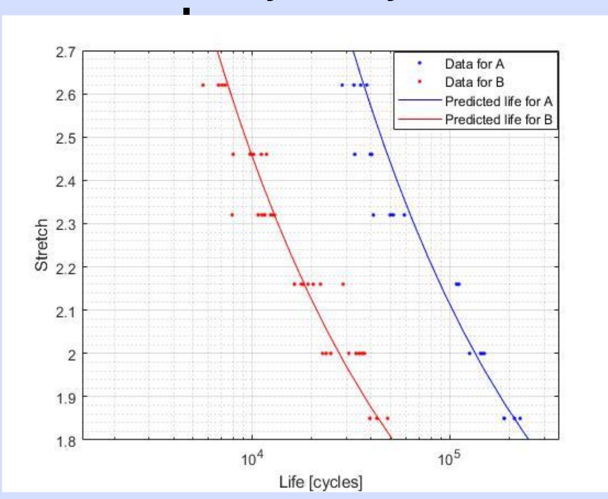

Durability Analysis

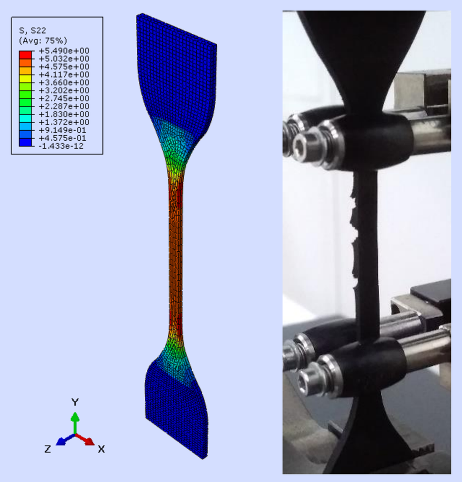


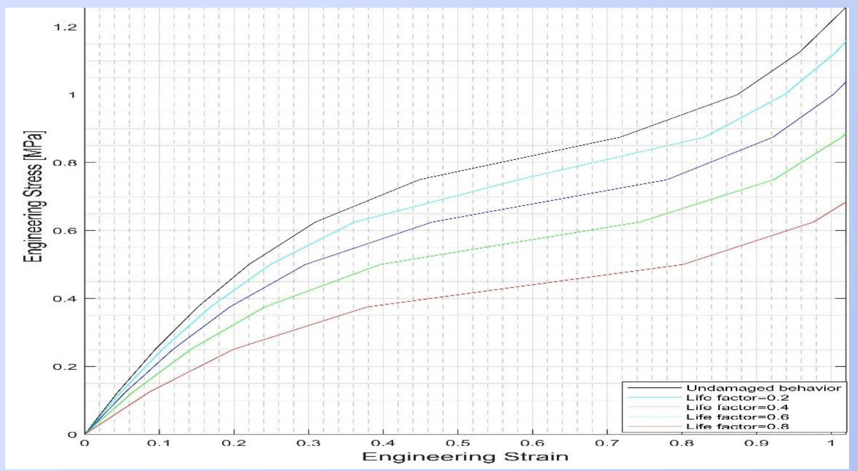
Thermo-Mechanical Analysis



Microscopic Analysis


Fatigue life prediction

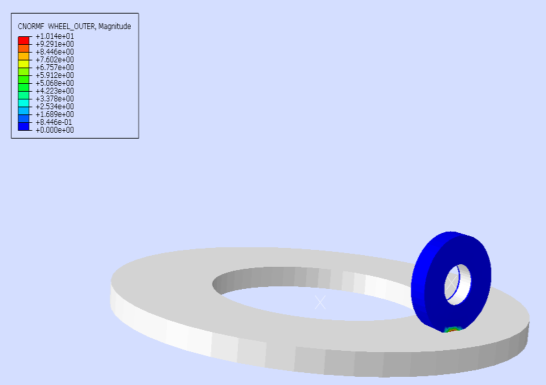

Constitutive Modelling and FEA


Material Damage Response Simulation

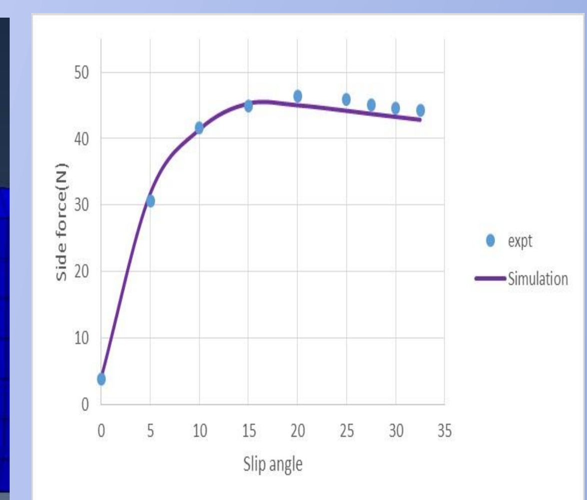

Laboratory Abrasion Tester


Side Force Experiment on Wheel


Surface Texture Observation

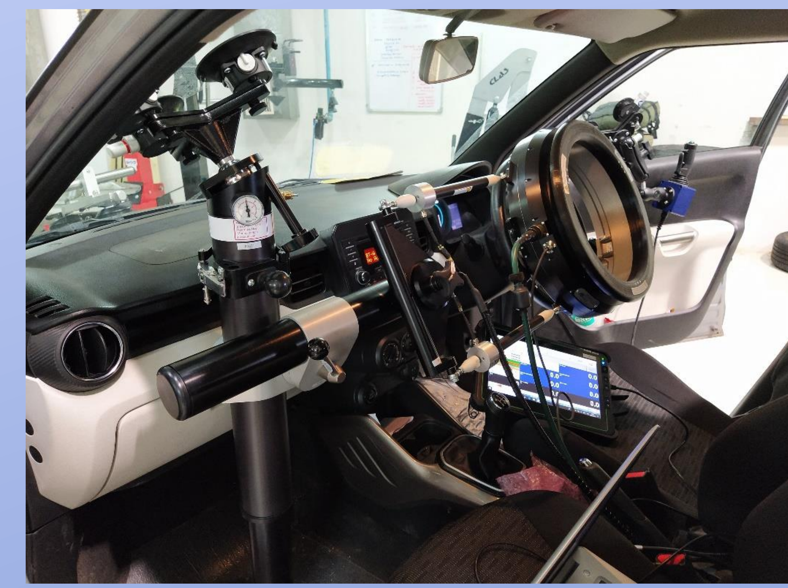

Laboratory Abrasion Tester Simulation

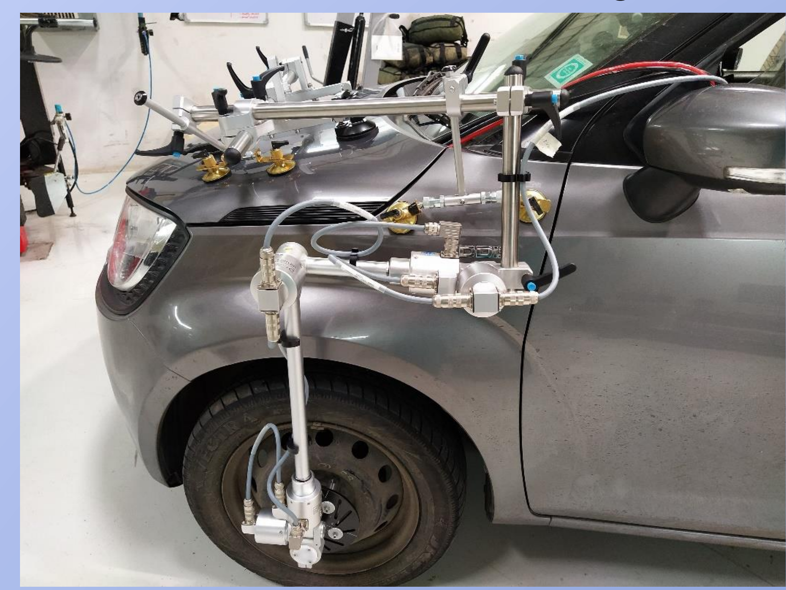
Slip Velocity Distribution on contact surface

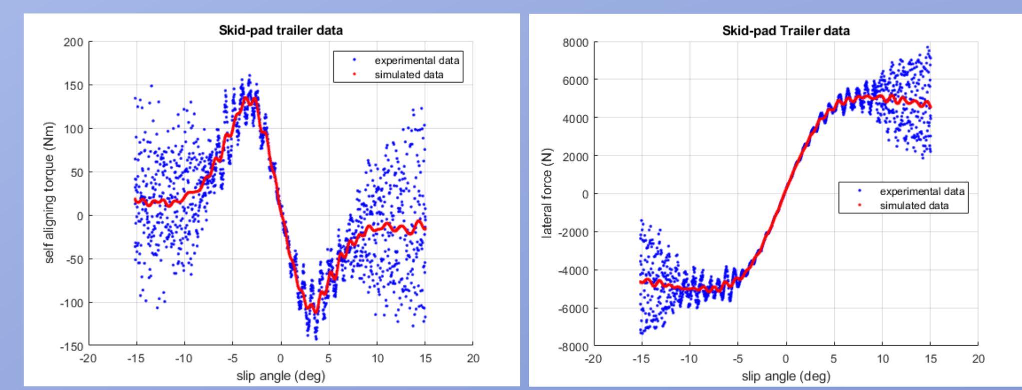

Experimental and simulated side force variation

Vehicle Dynamics

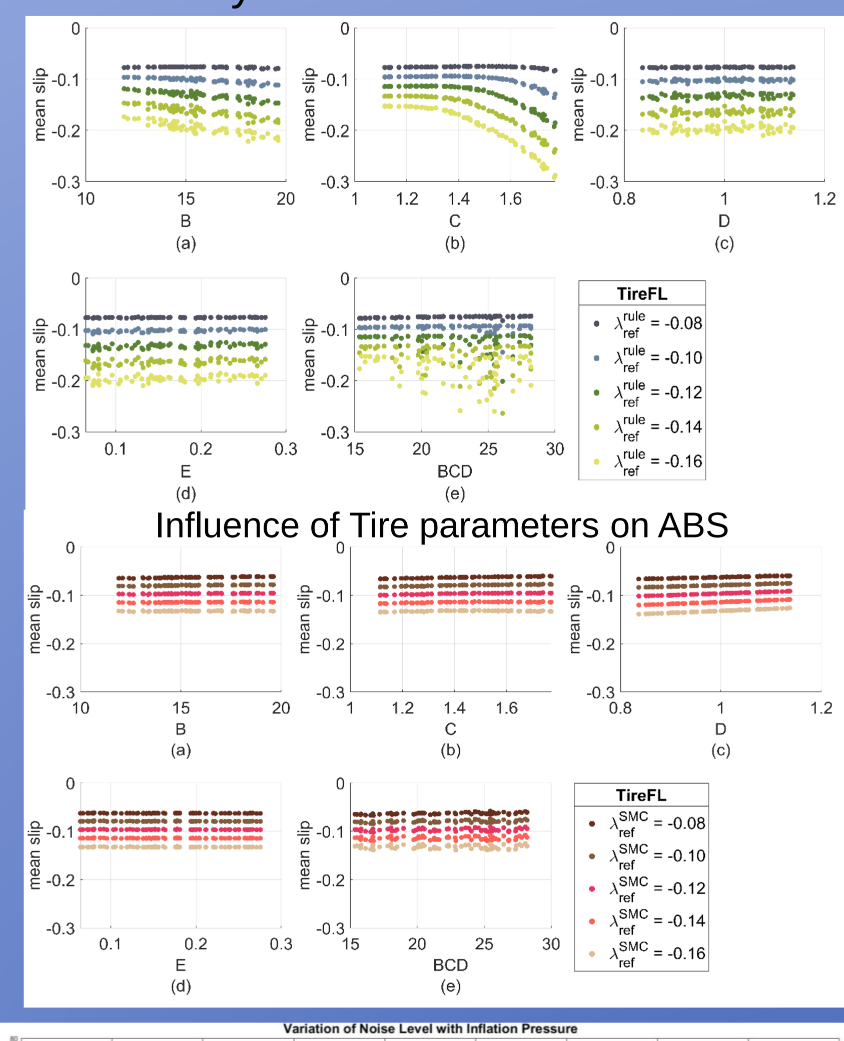

Virtual Proving Ground

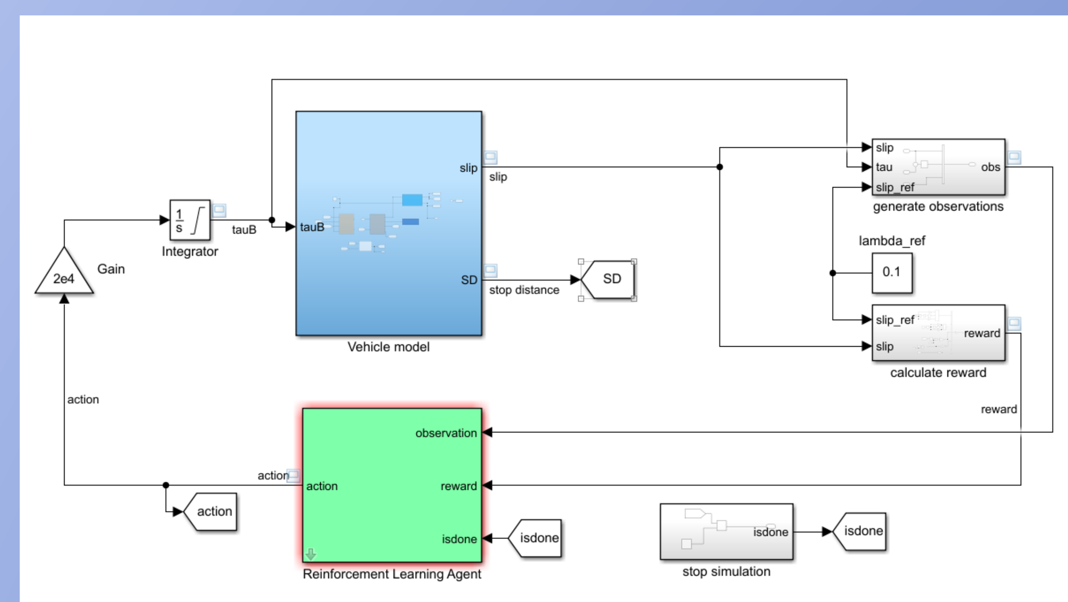

Instrumented Steering


Instrumented Vehicle

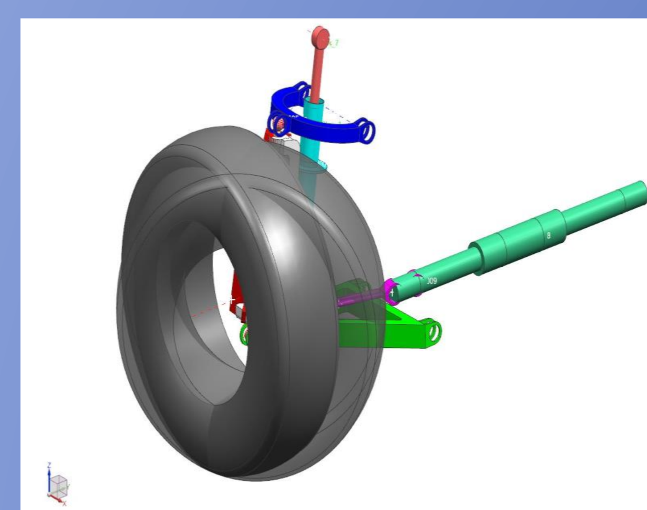


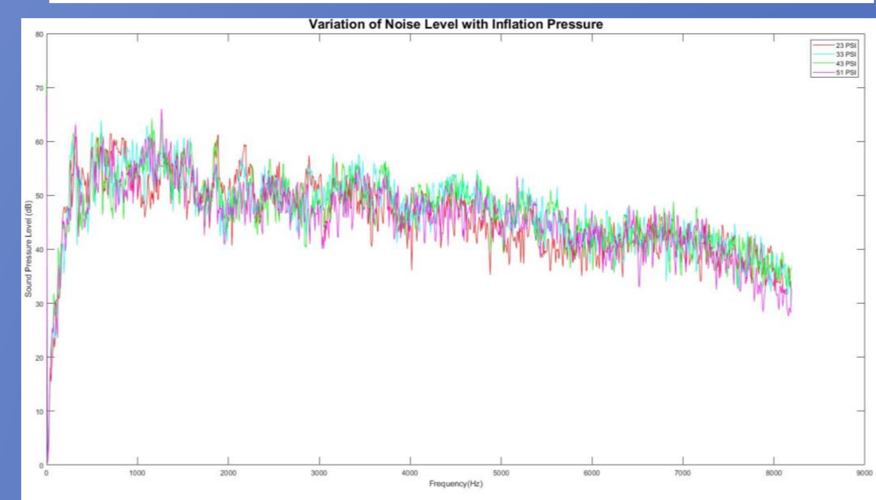
Skid-pad Trailer data for tyre characterisation


Influence of Tire parameters on ABS


Reinforcement Learning for smart ABS


Tire Noise Measurement


Simulation of test cases for Sound Pressure Level



Simulation of Tyre Noise

Indian Institute of Technology Madras
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Research Focus

RBG Labs research focuses on various problems of disruptive innovations in product and process developments. New product development and innovations for driver comfort and fatigue monitoring, ubiquitous cardiac monitoring, solutions for improving pedestrian safety, implementing a structured trauma care and data driven initiatives in enforcement with GoTN.

RBG Transportation Safety framework was devised to provide a structured approach to road safety. Research in TSF spans across four dimensions, namely, Infrastructure Engineering, Human Factors, Trauma Care - TAEI and TN Accident Registry (TAR). Data driven research are carried out in each of these dimensions to bring down road accidents and deaths.

Establishment of structured trauma care in TN (TAEI) in working with National Health Mission has significantly reduced road accident deaths in TN.

From our crash data studies in TN we have identified road safety gaps and collaborated with nodal agencies to implement interventions towards meeting the set goals

Research Areas

Transportation Safety

Human Factors in Transportation

Design Thinking

Lean Operations

Medical Devices and Implants

Technology Management

Public Policy

Important Outcome

Launch of Intelliseat™ for driver fatigue monitoring

Reflective strips installed between vehicle headlights by the traffic police of TN to improve vehicle identification during low light

International Workshop on Trauma Care Systems jointly organized by IIT Madras and NHM. Launch of TAEI App by TN Health Minister for trauma data reporting

Pilot Study and training of Transportation Accident Reporting App (TARA) at Kancheepuram and Dharmapuri for structured accident data reporting

Driver Fatigue Studies

Intelliseat™ is developed on a joint collaboration with M/S Harita Seating System Limited (HSSL)

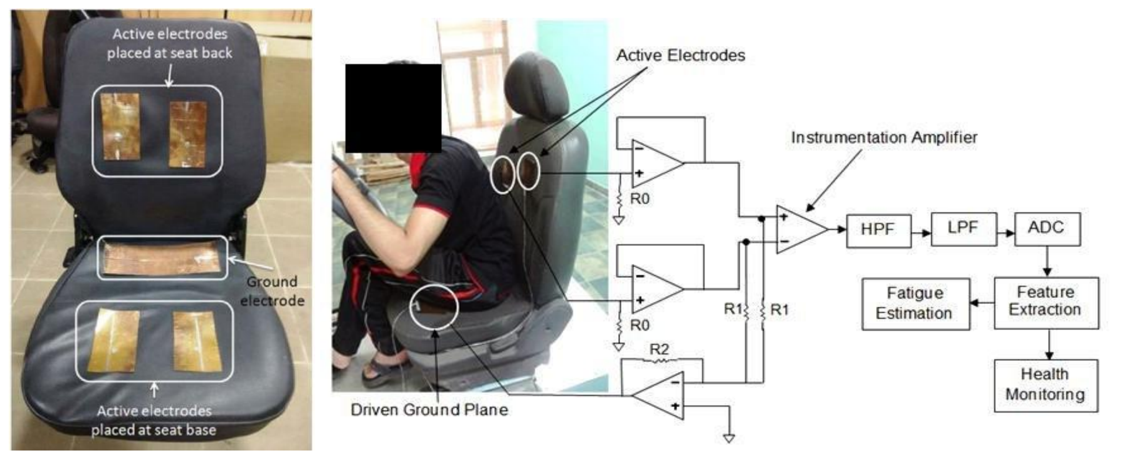
Intelliseat™ uses pressure sensors in the seat to monitor behaviour, posture and fatigue of drivers by studying their posture

Pedestrians' Perception and Response during Road-Crossing at Night time

Poor visibility in the night is one of the reasons for vehicle-pedestrian crashes

Time to recognize the vehicle was fastest when LED strip was fixed between headlights of a four–wheeler

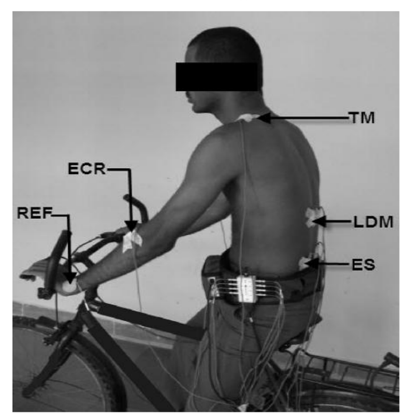
Design and development of a non-contact method of ECG acquisition system called capacitive ECG (cECG)



cECG was validated to detect non-contact ubiquitous driver performance monitoring based on HRV in simulated conditions

Bicycles were evaluated for comfort and muscle fatigue using surface electromyography (sEMG)

Evaluate muscle fatigue based on different saddle heights and frames

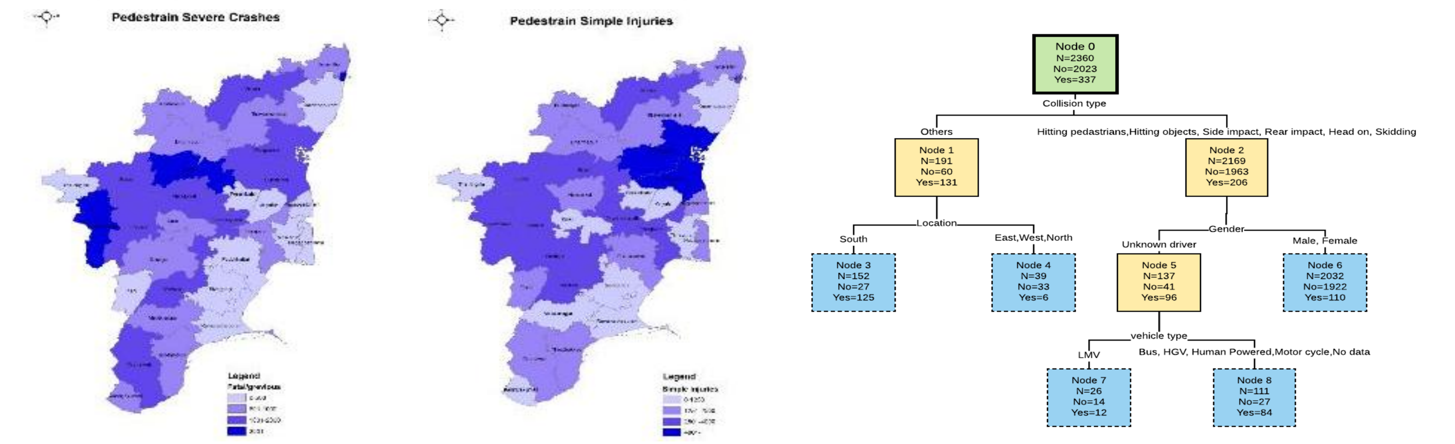


ECR - Extensor Carpi Radialis
TM - Trapezius Medial
LDM - Latissimus Dorsi Medial
ES - Erector Spinae

Crash Data Analysis

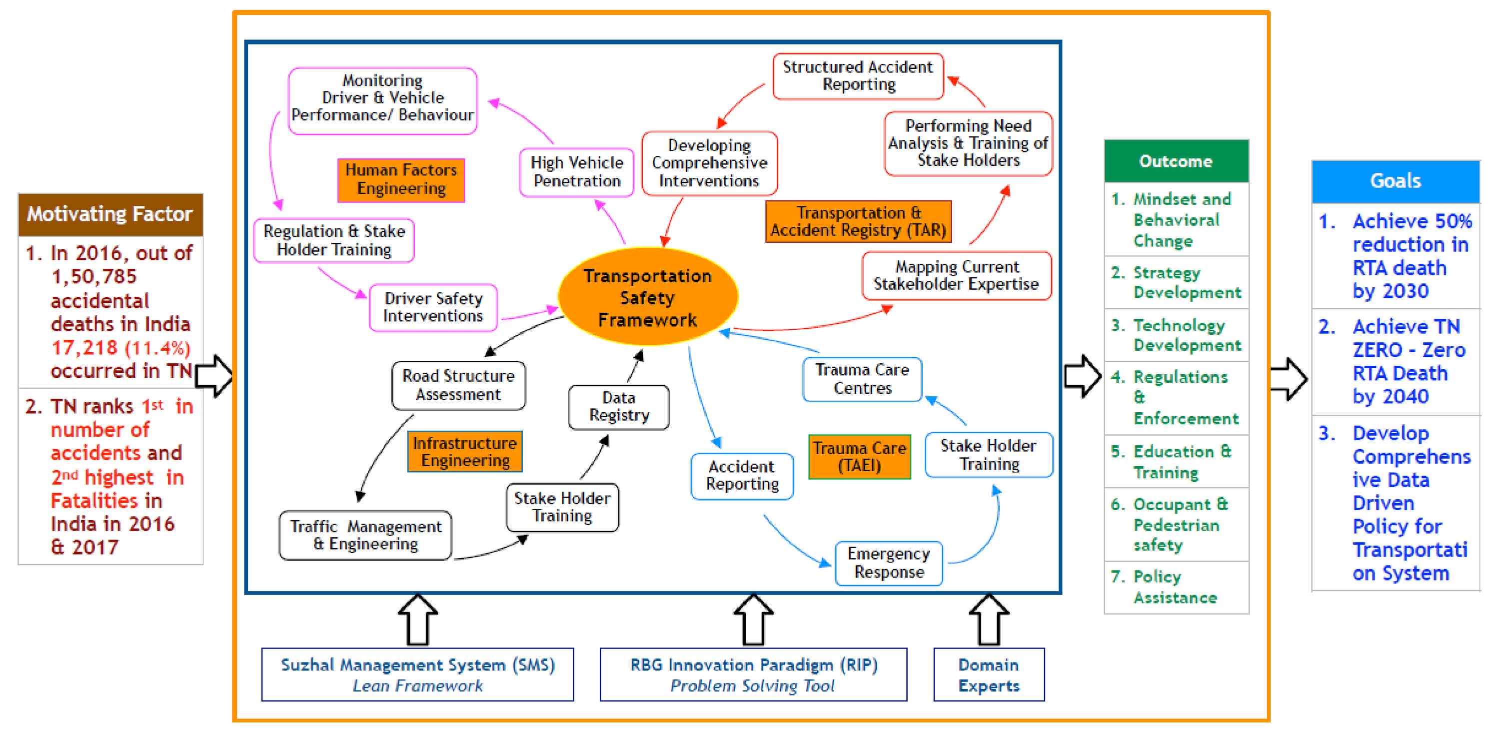
Human factor issue is the single largest (84%) contributing factor for road traffic crashes (MoRTH,2017)

Data driven Supervised and Unsupervised Machine Learning approaches in identifying causal factors for road accidents and propose interventions to prevent future crashes



Design and development of mobile/ web applications (TAEI and TARA) for field data collection towards continuous process improvement

Developed a structured approach to drive innovation in road safety, stakeholder involvement (health and police) to reduce accident deaths



Some of Key Publications

1. Venkatesh Balasubramanian, Rahul Bhardwaj. Pedestrian's perception and response towards vehicles during road crossing. Accident Analysis and prevention, 2017, pp.128-135
2. "Viability of Cardiac Parameters Measured Unobtrusively using Capacitive Coupled Electrocardiography (cECG) to Estimate Driver Performance," R. Bhardwaj and V. Balasubramanian, in IEEE Sensors Journal.
3. Venkatesh Balasubramanian and Sathish kumar Sivasankaran (2019): Analysis of factors associated with exceeding lawful speed traffic violations in Indian metropolitan city, Journal of Transportation Safety and Security
4. V. Balasubramanian, M. Jagannath and K. Adalarasu, "Muscle Fatigue Based Evaluation of Bicycle Design," Applied Ergonomics, 45 (2), Part B, 339-345, 2014

Contact: Prof. Venkatesh Balasubramanian, Rehabilitation Bioengineering Lab, https://ed.iitm.ac.in/~vb/#/