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Preventive Maintenance in Automotive Powertrain (PRE-EMPT)

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ENFORMA
‘Connectedness’ in Auto Industry

Internet integration changing the car ownership model, bringing in connectedness more and more:
✓ creating a new platform for consumers to access content,
✓ leading to fully autonomous vehicles,
✓ reducing carbon emissions via innovative methods that rely on analysing data, and hence;
✓ revolutionising the auto industry.

Part of ‘connectedness’ inherently relates to the use of data processing techniques in maintenance.

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Given data streamed from a vehicle—such as diagnostic trouble codes (DTCs) and other vehicle parameters at the time of occurrence of the trouble codes (e.g., odometer reading, vehicle speed, engine temperature, torque, etc.), can we predict an ensuing repair or a maintenance job on the vehicle?
## Around 3400 DTCs...

### Related to: Fuel and Air Metering
- P0001 Fuel Volume Regulator Control Circuit/Open
- P0002 Fuel Volume Regulator Control Circuit Range/Performance
- P0003 Fuel Volume Regulator Control Circuit Low
- P0004 Fuel Volume Regulator Control Circuit High
- P0005 Fuel Volume Regulator Control Circuit Range/Performance
- P0006 Fuel Volume Regulator Control Circuit Low
- P0007 Fuel Volume Regulator Control Circuit High
- P0008 Fuel Volume Regulator Control Circuit Range/Performance
- P0009 Fuel Volume Regulator Control Circuit Low

### Related to: Misfire Detected
- Cylinder 1
- Cylinder 2
- Cylinder 3
- Cylinder 4
- Cylinder 5
- Cylinder 6
- Cylinder 7
- Cylinder 8
- Cylinder 9
- Cylinder 10

### Related to: Auxiliary Emission Controls, EGR, EVAP etc.
- P0430 Catalyst System Low Efficiency
- P0440 Evaporative Emission (EVAP) System Leak Detected
- P0442 Evaporative Emission (EVAP) System Small Leak Detected
- P0455 Evaporative Emission (EVAP) System Leak Detected
- P0440 Evaporative Emission (EVAP) System
- P0174 Fuel Trim System Lean Bank 1
- P0171 Fuel Trim System Lean Bank 2
- P0420 Catalyst System Low Efficiency
- P0401 Exhaust Gas Recirculation (EGR) Flow Insufficient
- P0174 Fuel Trim System Lean Bank 2
- P0442 Evaporative Emission (EVAP) System Small Leak Detected

### Other:
- Transmission Control System Malfunction

### Top 10 trouble codes from one empirical test

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>P0420</td>
<td>Catalyst System Low Efficiency</td>
<td>- 13.2%</td>
</tr>
<tr>
<td>P0171</td>
<td>Fuel Trim System Lean Bank 1</td>
<td>- 10.4%</td>
</tr>
<tr>
<td>P0401</td>
<td>Exhaust Gas Recirculation (EGR) Flow Insufficient</td>
<td>- 8.4%</td>
</tr>
<tr>
<td>P0174</td>
<td>Fuel Trim System Lean Bank 2</td>
<td>- 6.8%</td>
</tr>
<tr>
<td>P0442</td>
<td>Evaporative Emission (EVAP) System Small Leak Detected</td>
<td>- 6.7%</td>
</tr>
<tr>
<td>P0300</td>
<td>Engine Misfire Detected (random misfire)</td>
<td>- 6.4%</td>
</tr>
<tr>
<td>P0455</td>
<td>Evaporative Emission (EVAP) System Leak Detected (large)</td>
<td>- 6.2%</td>
</tr>
<tr>
<td>P0440</td>
<td>Evaporative Emission (EVAP) System</td>
<td>- 5.5%</td>
</tr>
<tr>
<td>P0141</td>
<td>Oxygen Sensor Heater (H02S) Performance Bank 1 Sensor 2</td>
<td>- 5.1%</td>
</tr>
<tr>
<td>P0430</td>
<td>Catalyst System Low Efficiency Bank 2</td>
<td>- 3.2%</td>
</tr>
<tr>
<td>P0302</td>
<td>Cylinder 2 Misfire Detected</td>
<td></td>
</tr>
<tr>
<td>P0303</td>
<td>Cylinder 3 Misfire Detected</td>
<td></td>
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<tr>
<td>P0304</td>
<td>Cylinder 4 Misfire Detected</td>
<td></td>
</tr>
<tr>
<td>P0305</td>
<td>Cylinder 5 Misfire Detected</td>
<td></td>
</tr>
<tr>
<td>P0306</td>
<td>Cylinder 6 Misfire Detected</td>
<td></td>
</tr>
<tr>
<td>P0307</td>
<td>Cylinder 7 Misfire Detected</td>
<td></td>
</tr>
<tr>
<td>P0308</td>
<td>Cylinder 8 Misfire Detected</td>
<td></td>
</tr>
</tbody>
</table>

### Related to: Vehicle Speed, Idle Control, and Auxiliary Inputs
- P0500 Vehicle Speed Sensor Malfunction
- P0501 Vehicle Speed Sensor Range/Performance
- P0502 Vehicle Speed Sensor

### Other:
- Transmission Control System Malfunction
- Control Module VSS Output
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- Control Module VSS Output

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Methods to be applied for when the car is out in the field. Benefits:

- **Increase customer satisfaction**: Fewer defects, better scheduled maintenance (not just due to odometer reading), less time in the shop.

- **Avoid a recall or initiate it sooner**: Data from connected vehicles, service records, test data on parts that have been replaced, and even social media fed into predictive maintenance model. Problems identified and solved faster.

- **Optimise service delivery**: Service appointments more predictable. Volume of planned and scheduled work increased. Technician provided with a “guided repair” approach. More even workforce scheduling, reduced idle time, and more cost-effective usage of service facilities.

- **Optimise the supply chain**: Predicting required maintenance parts → better supply chain management. No longer keeping cars overnight waiting for parts; better scheduling; space freed-up; increasing satisfaction.

- **Reduce fleet downtime**: A fleet of hundreds or thousands of vehicles experiences real productivity gains, increasing OEM’s value.
Partners

• Partners already involved
  – ENFORMA
  – AVL Turkey
  – OKAN Univ – Automotive Engineering Dept
  – A light commercial vehicle manufacturer

• Missing partners / expertise
  – To complement data set, improve analysis and models, and increase overall impact;
    • EU heavy-duty truck manufacturer
    • EU passenger car manufacturer
  – Company specialising on CAN-BUS data capture
  – University or research institute with specialisation in optimisation in automotive applications
If interested please contact:

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