Innovation

Tyre Diagnostics is contributing to vehicle safety

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Tyre Diagnostics in PTI

The role of tyres in critical driving situations

Share of tyre failures in accidents in Germany: ~36% (similar to brakes)

<table>
<thead>
<tr>
<th>Sources of and responsibilities for tyre failures reported in passenger car accident investigations</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insufficient/wrong maintenance (by owner/user, e.g. inflation pressure, tread wear, over-aged tyres)</td>
<td>36.8</td>
</tr>
<tr>
<td>Failures related to tyre mounting/repair</td>
<td>6.9</td>
</tr>
<tr>
<td>Production-related failure (e.g. retreaded tyres)</td>
<td>14.6</td>
</tr>
<tr>
<td>Damage during operation (e.g. puncture)</td>
<td>14.6</td>
</tr>
<tr>
<td>Not exactly identifiable</td>
<td>27.1</td>
</tr>
</tbody>
</table>

Probability of accidents caused by irregular tyre conditions is very high

Source: TÜV Automotive, Germany
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Proper inspections can prevent accidents

- Out of 2 Mio tyres inspected, about 11% were found defective.

Source: TÜV Automotive, Germany

Tyre defects can be detected in workshops and inspection centers prior to an accident.
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Stopping distance depends on tyre condition

**Summer tyres**
Braking from 100 km/h down to 60 km/h

<table>
<thead>
<tr>
<th>Tread depth (mm)</th>
<th>Stopping distance (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>3</td>
<td>30</td>
</tr>
<tr>
<td>2</td>
<td>40</td>
</tr>
<tr>
<td>1.6</td>
<td>50</td>
</tr>
</tbody>
</table>

**Road condition**
- Dry
- Wet

**Winter tyres**
Braking from 40 km/h down to 0 km/h (Dimension: 205/55 R 16)

<table>
<thead>
<tr>
<th>Tread depth (mm)</th>
<th>Stopping distance (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>18</td>
</tr>
<tr>
<td>6</td>
<td>20</td>
</tr>
<tr>
<td>4</td>
<td>22</td>
</tr>
<tr>
<td>2</td>
<td>24</td>
</tr>
</tbody>
</table>

**Road condition**
- Snow

Source: Continental

Decreasing tyre tread depth, increases stopping distance drastically
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Tyre Wear Patterns

Various patterns possible – hard to detect with standard methods in PTI today

WEAR ALONG THE EDGES
The tire is likely underinflated

WEAR DOWN THE MIDDLE
The tire is likely overinflated

WEAR ALONG THE INSIDE OR OUTSIDE
Usually indicates an alignment problem

UNEVEN PATCHES OR FEATHERING
Could be an indicator of a suspension problem
Tyre Diagnostics in PTI
Wheel Alignment is critical

- Car/Tyres, after 9,550 miles (15T km):
  - Tyre tread depth within the norm!
  - Tyre pressure loss!
  - Extream inside edge wear!

Actual Vehicle Spec measured:
- Tyre tread depth: 3 mm
- Negative Camber: -3.4 degrees
- Toed out by 0.46 degrees

Tyre tread depth checks are not enough – Alignment must be checked as well
Tyre Diagnostics in PTI
Impressions from vehicle testing sites worldwide

Driver & Vehicle licensing Authorities

Vehicle inspection centers

PTI in workshops

Integrated with the standard inspection lane workflow – no additional time needed!
Tyre Diagnostics in PTI

All relevant data, available within seconds

Vehicle ident, tread depth & alignment indication in a single report
Tyre Diagnostics in PTI

How it works

- Color coded light projection
- Robust system
- Works in extrem conditions

Light created by LEDs (1) will be projected (3) through a colored strip foil (2) on an object (Tyre) (4). The picture will be recorded by cameras (5). The resulted 2D pictures will be converted in a 3D points cloud. From this 3D point cloud, the tread depth calculation will be made.
Tyre Diagnostics in PTI
Color coded light projection

- More than 500,000 measured points
- 18,000 qualified measuring points deliver the result

Displacement of the position of the color will allow to calculate the tyre tread depth

0.25 mm accuracy in dry conditions
Tyre Diagnostics in PTI
Integration with any PTI software

- Automated license plate recognition
  - License plate is captured automatically
  - Robust against sunlight or reflections

- PUSH API
  - Recorded data gets pushed to PTI application

Simple integration in any existing PTI application/software
Tyre Diagnostics in PTI

References

Different use cases worldwide
Thank you for your attention.

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