

INTELLIGENT ROAD HAZARD DETECTION & REPORTING SYSTEM

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PROBLEM STATEMENT

Table 2 Traffic Accident Data by Region for 2014 [2].

Region	Total	Inside the City		Outside the City	
		No .of Accidents	Percentage	No .of Accidents	Percentage
Riyadh	14,7568	138,974	33.78%	8,594	8.00%
Makkah	126,537	102,607	24.94%	23,930	22.28%
Madinah	19,058	12,137	2.95%	6,921	6.44%
Al-Qasim	24,273	14,295	3.47%	9,978	9.29%
Eastern	88,065	68,280	16.60%	19,785	18.42%
Aseer	32,163	18,806	4.57%	13,357	12.44%
Tabouk	20,638	16,924	4.11%	3,714	3.46%
Hael	8,415	5,378	1.31%	3,037	2.83%
Northern Border	13,076	11,260	2.74%	1,816	1.69%
Jazan	22,229	9,700	2.36%	12,529	11.67%
Najran	3,220	1,989	0.48%	1,231	1.15%
Al-Baaha	4,166	3,079	0.75%	1,087	1.01%
Al-Jouf	9,387	7,968	1.94%	1,419	1.32%
Total	518,795	411,397	100%	107,398	100%

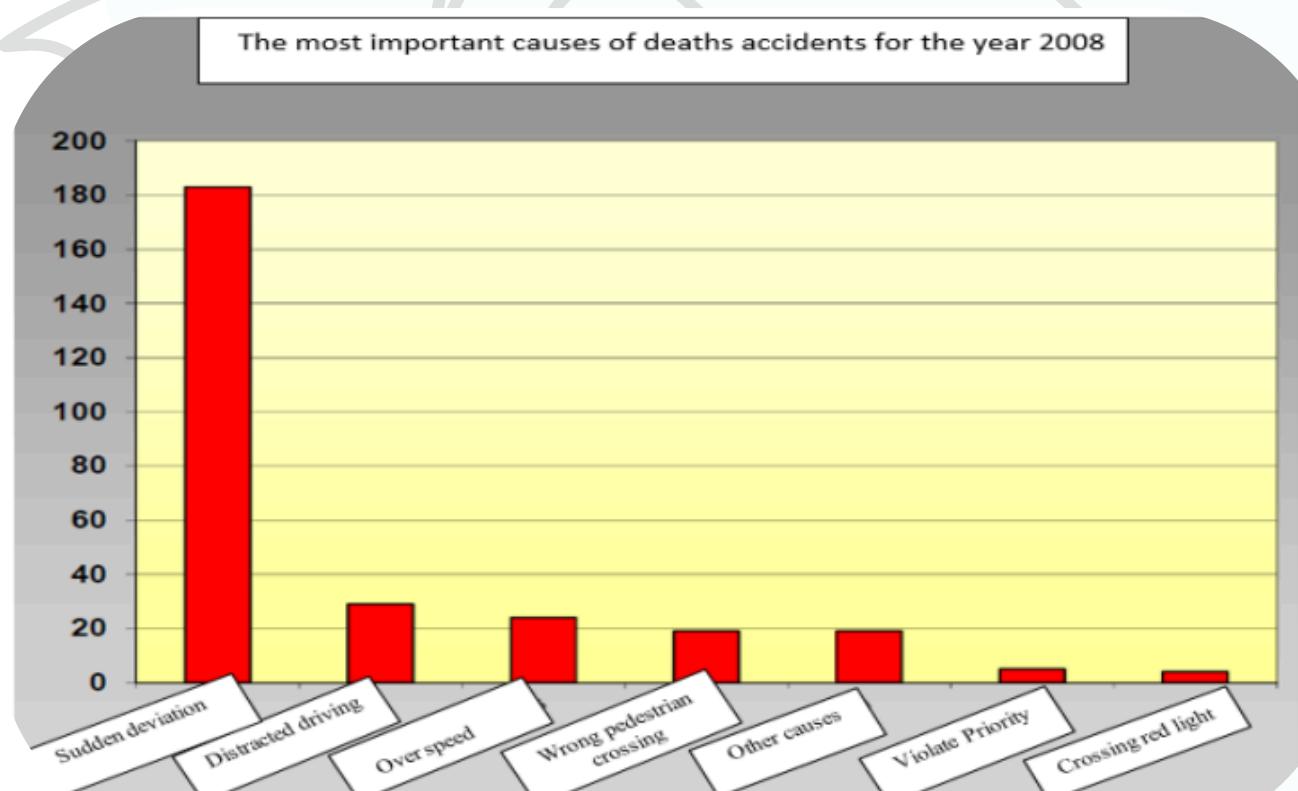


Figure 2 The Most Important Causes of Death Accidents in 2008 [4].

- One of the main reasons for fatal accidents is due to **sudden deviations**. One of the reasons for sudden deviation is **road defects**, which include improper road hump installation. (heightened accident risks)
- These defects not only increase the risk of collisions but also lead to **severe vehicle damage**
- Adding further **economic and safety burdens** on **drivers and municipalities**.

NEEDS

Driver's Needs

Real-time alerts to identify upcoming potholes and speed bumps, reducing accidents and costly vehicle damage (suspension, tires, rims).

To have proper visibility at night, when many residents are on the road. Unmarked or poorly painted humps are often missed, increasing sudden deviation risks.

Safer, smoother driving experience, especially in urban areas with high traffic density.

Government's Needs

Data-driven insights for Riyadh Municipality and the Ministry of Transport & Logistic Services on the exact location, severity, and frequency of road defects.

Smarter infrastructure planning and budget allocation, prioritizing repairs where defects are most concentrated.

Lower long-term maintenance costs by addressing hazards early before they worsen.

IDENTIFIED GAPS IN EXISTING LITERATURE

01

Camera-only systems –
Recognize hazards visually
but cannot measure
severity (depth/size).

02

LiDAR-Camera fusion
(VIDAR) → No speed-bump
recognition, driver alerts, or
dashboards for authorities.

03

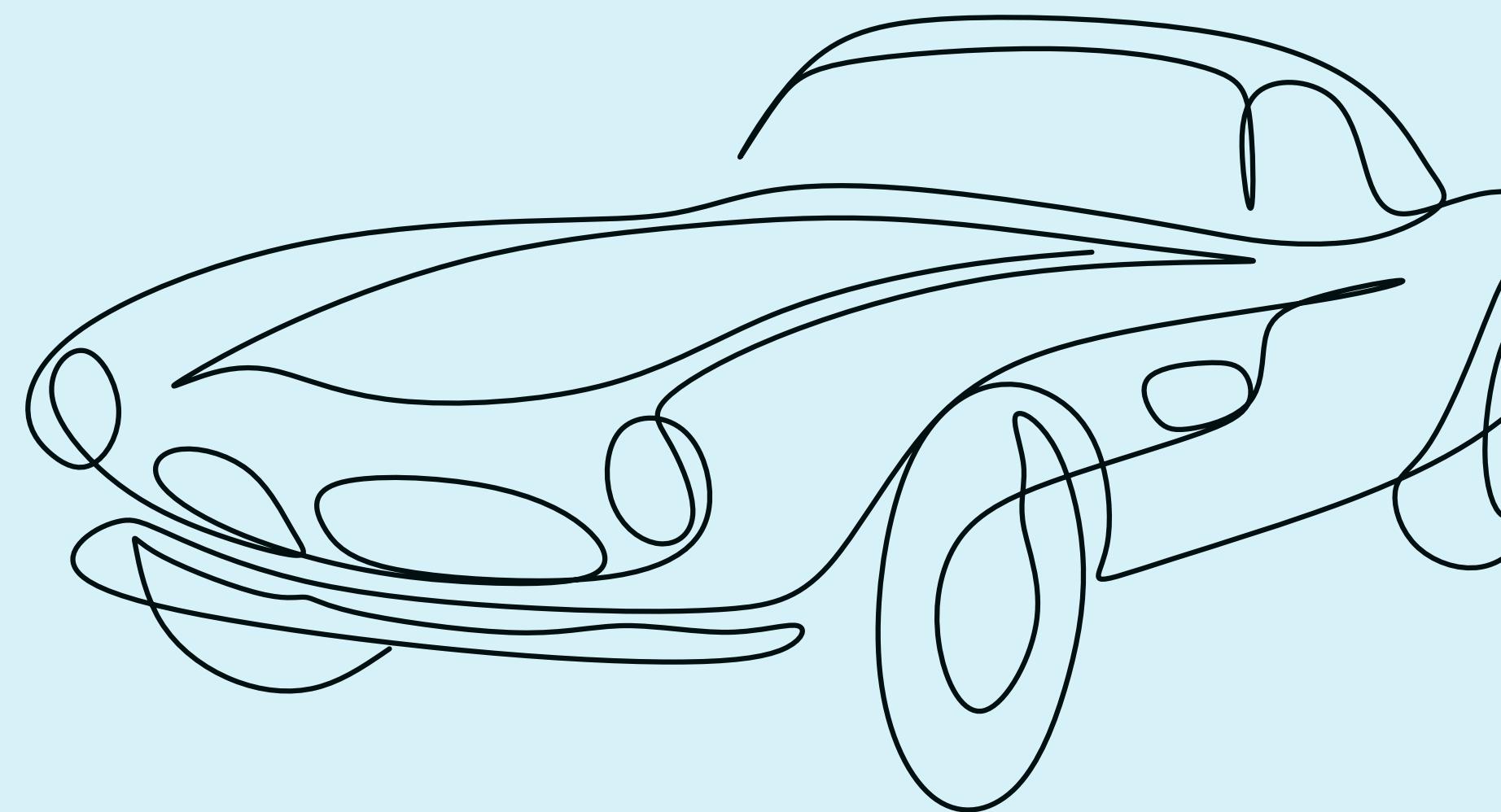
Offline/manual
approaches → Depend on
delayed processing or
uploads; unsuitable for
real-time municipal use.

04

LiDAR-only systems –
Detect potholes but lack
camera fusion for richer
classification & speed-
bump detection.

PROPOSED SOLUTION

- Vehicle-mounted system with **LiDAR + Camera + GPS** to: Detect potholes and speed bumps in real time.
- Alert driver via interactive **LED/sound system** (green/orange/red).
- **Log pothole's exact GPS coordinates, severity (depth/size).**
- Data uploaded to a cloud server/**dashboard accessible by authorities.**



SYSTEM ARCHITECTURE

IoT-Based Distributed Embedded System & Hybrid edge-cloud model

Data Acquisition

- Sensors & on-vehicle embedded system collect raw data.

Edge Processing (Onboard)

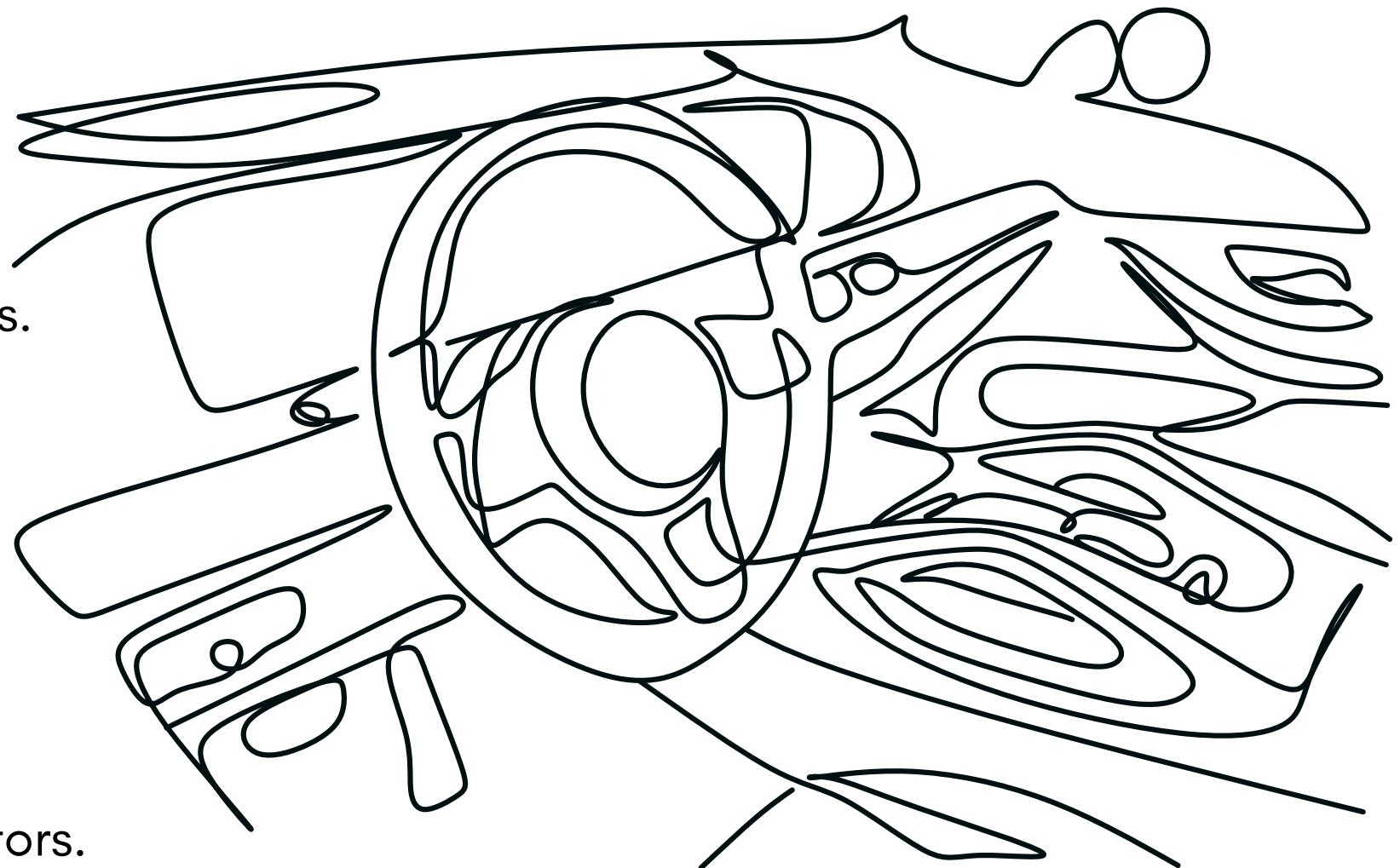
- Preprocessing algorithms (filtering, noise removal).
- Feature extraction & fusion from multiple sources.
- Classification model (ML/Rule-based) to detect road anomalies.
- Real-time decision layer → driver alert system.

Cloud Layer

- Data packaging & transmission via IoT protocol.
- Storage & indexing in distributed database.
- Analytics pipeline for trend detection and reporting.

Application / Dashboard Layer

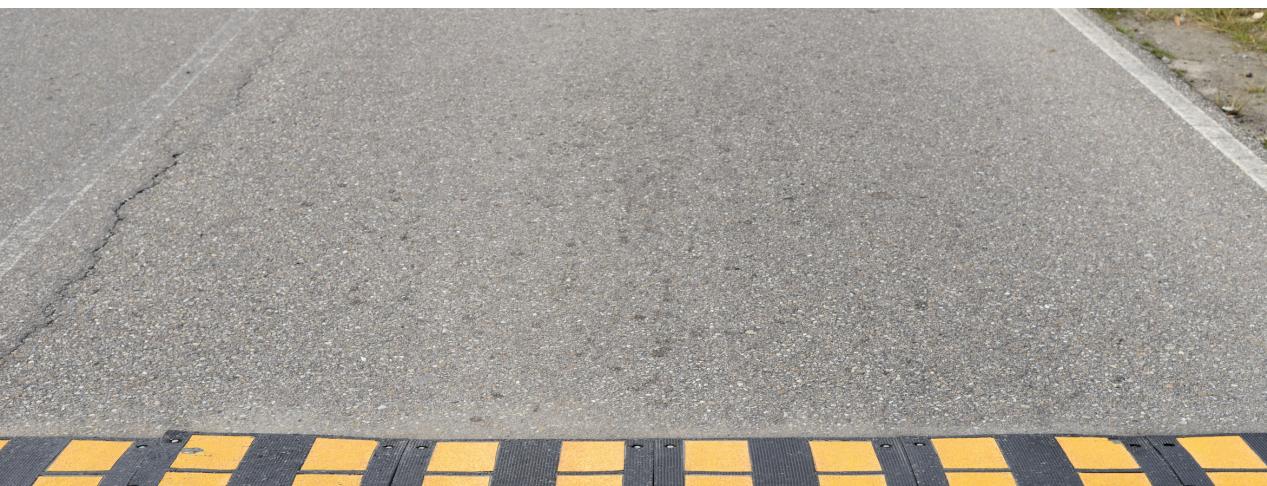
- Visualization algorithms: map-based heatmaps, severity indicators.
- Query & filtering tools for stakeholders.
- Multi-user access for government & city planners.



THE SPEED-BUMP/ POTHOLE DETECTION METHOD

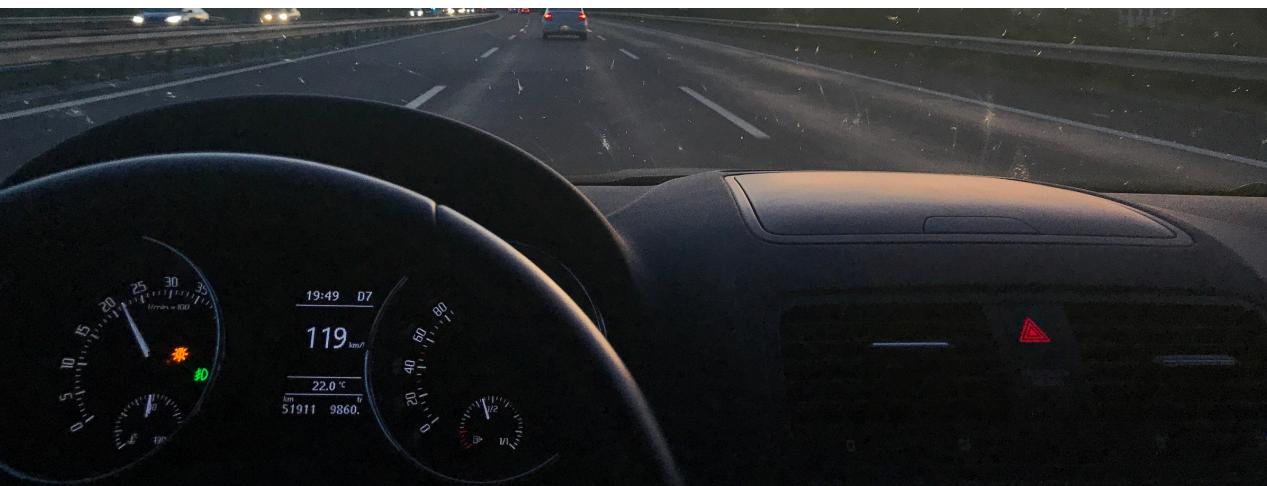
CANDIDATE REGION EXTRACTION

- The algorithm first **scans the road image** to find regions that look like possible speed bumps **based on their visual pattern** (e.g., rectangular shape, contrast with the road surface).
- These candidate regions reduce noise by **focusing only on areas that resemble bumps.**



VERIFICATION WITH DISTANCE INFORMATION

- Once a **candidate region is identified**, the system uses distance data (from LiDAR, stereo camera depth maps, or other sensors) to confirm whether the object is **physically raised from the road** surface/ physically recessed in surface.
- This step helps distinguish actual speed bumps from painted markings, shadows, or flat road textures.



FINAL DETECTION & OUTPUT

After confirming, the algorithm provides three outputs:

- **Area of the bump/ pothole** → the exact region on the road where the bump exists.
- **Classification result** → confirming that the object is indeed a speed bump /pothole (vs. noise or other road feature).
- **Height information** → estimated bump height, which is critical since overly high or irregular bumps cause more damage and discomfort.



DRIVER SAFETY ALERT SYSTEM (LED GUIDANCE)

RISK ASSESSMENT ALGORITHM

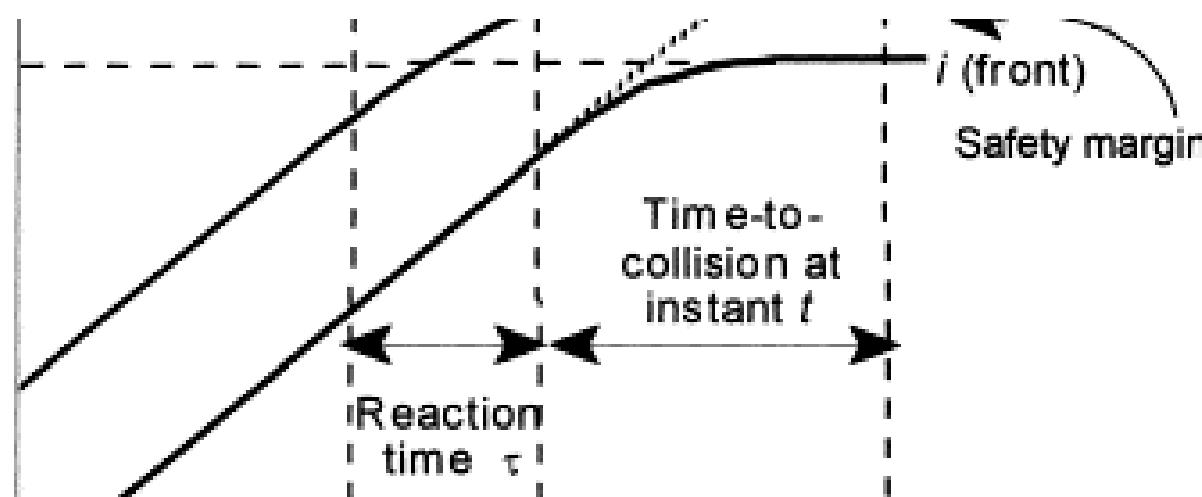
- Uses detection data (height/depth) + speed profile.
- Predicts potential impact severity (comfort → damage risk).
- Applies thresholds for safe, caution, or danger.

LED-BASED ALERT LEVELS

- Green → Safe to pass at current speed (minor bump, shallow pothole, or reduced speed).
- Orange → Caution: moderate bump/pothole. Recommend slowing down.
- Red → Dangerous: high bump / deep pothole at current speed. Immediate action required.

DYNAMIC DRIVER FEEDBACK

- LEDs update in real-time as the car approaches.
- Helps drivers anticipate and adjust safely.
- Can integrate with HUD / dashboard for enhanced alerts.



COMMUNICATION & LOGGING OF POTHOLE INFORMATION

EVENT DETECTION & PACKAGING

- Once the pothole is confirmed, the car's onboard system (OBU) packages the detection result into a lightweight message (location, classification, severity, timestamp).
- This keeps the data small and fast to transmit.



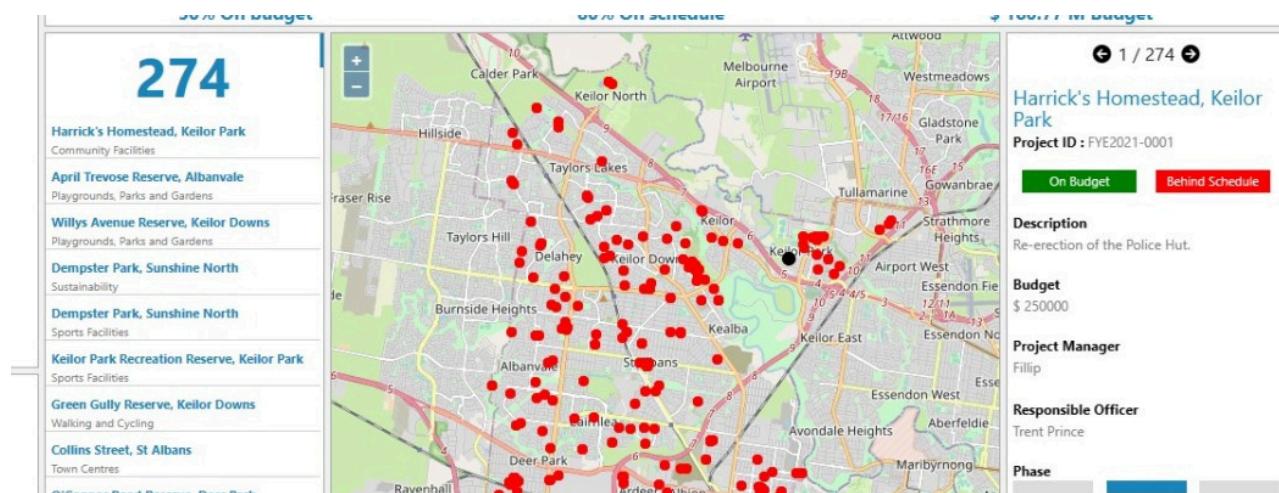
TRANSMISSION VIA C-V2X / CELLULAR NETWORK

- The packaged event is transmitted through cellular V2X (LTE/5G) uplink.
- Data flows either directly to the cloud server (V2N) or via a roadside unit (V2I).
- Multiple vehicles reporting the same pothole increase its "priority flag."



CLOUD AGGREGATION & AUTHORITY DASHBOARD

- The cloud collects and verifies incoming reports.
- Potholes with high confidence (multiple confirmations) are highlighted first on the authority dashboard.
- Dashboard provides:
 - Map location & severity level.
 - Number of cars affected (confidence weight).
 - Option for authorities to mark as "assigned/repair scheduled."





FEATURES

1. DRIVER ASSISTANCE (PART OF THE SENIOR PROJECT)

- Real-time LED warnings (green/orange/red).
- Interactive and intuitive.

2. DATA COLLECTION (PART OF SENIOR PROJECT)

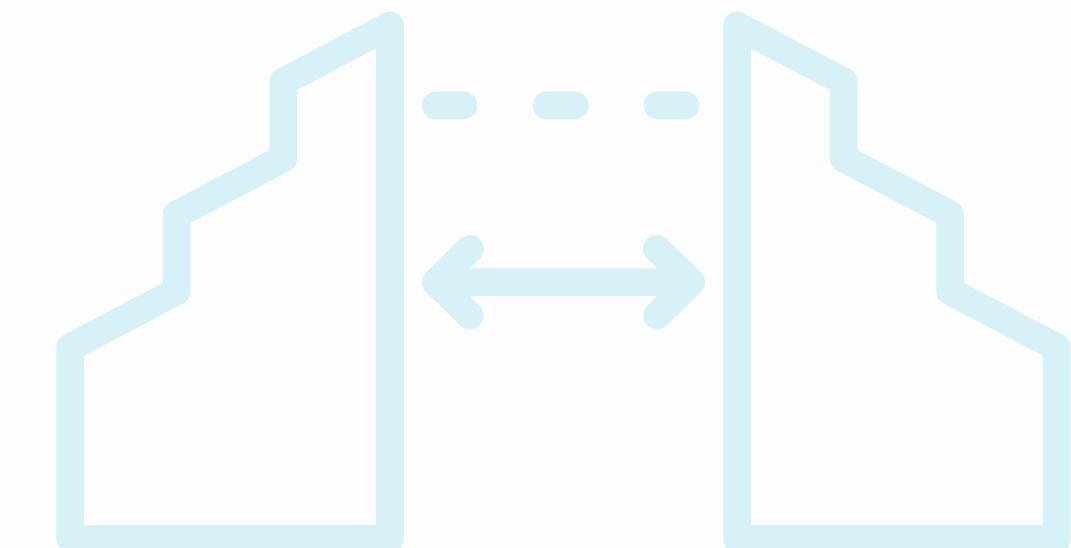
- GPS-tagged potholes automatically uploaded.
- Information includes severity, timestamp, frequency (optional).

3. AUTHORITY DASHBOARD (FUTURE IMPLEMENTATIONS)

- Map view of latest potholes in Riyadh.
- Export reports for Riyadh Municipality, Ministry of Transport, Saudi Data & AI Authority (SDAIA).



FEASIBILITY IN THE MARKET



GROWING DEMAND

Increasing vehicle ownership in Riyadh and across Saudi Arabia higher need for road safety solutions

GOVERNMENT ALIGNMENT

Directly supports Vision 2030 (transport modernization, AI leadership, sustainability).

MARKET GAP

Current pothole reporting relies on manual complaints with slow response, lack of real-time monitoring systems.

STAKEHOLDERS



وزارة النقل والخدمات اللوجستية
Ministry of Transport and Logistic Services



أمانة منطقة الرياض
RIYADH REGION MUNICIPALITY



وزارة الشؤون البلدية
والقروية والإسكان

PRIMARY

- Drivers & Vehicle Owners
- Riyadh Municipality
- Ministry of Transport & Logistics
- وزارة الشؤون البلدية والإسكان



خدمات بلدي
balady services



برنامـج جودـة
الـحـيـاة



Saudi Insurance
التأمين السعودي



SECONDARY

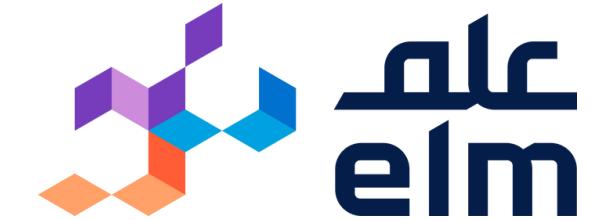
- Traffic Police
- Insurance Companies
- Private Road Contractors
- خدمات بلدي
- برنامج جودة الحياة



CEER

LUCID

SCAI



INDUSTRY COLLABORATION

- Ceer Motors
- Lucid Motors (KAEC)
- SCAI & ELM

FUTURE INVESTORS & STRATEGIC ALIGNMENT

- Smart Cities → Riyadh Smart City, NEOM
(The Line, Oxagon, Trojena)
- Sustainable Infrastructure → Red Sea Global, AMAALA
- Vision 2030 Programs → Transport & Mobility
Modernization
- AI & Tech Leaders → SDAIA, ALAT, STC, Aramco
Digital, Elm
- Innovation Ecosystem → Startups in AI, IoT, Smart
Mobility



**Red Sea
Global**



نيوم NEOM





EXPECTED OUTCOMES

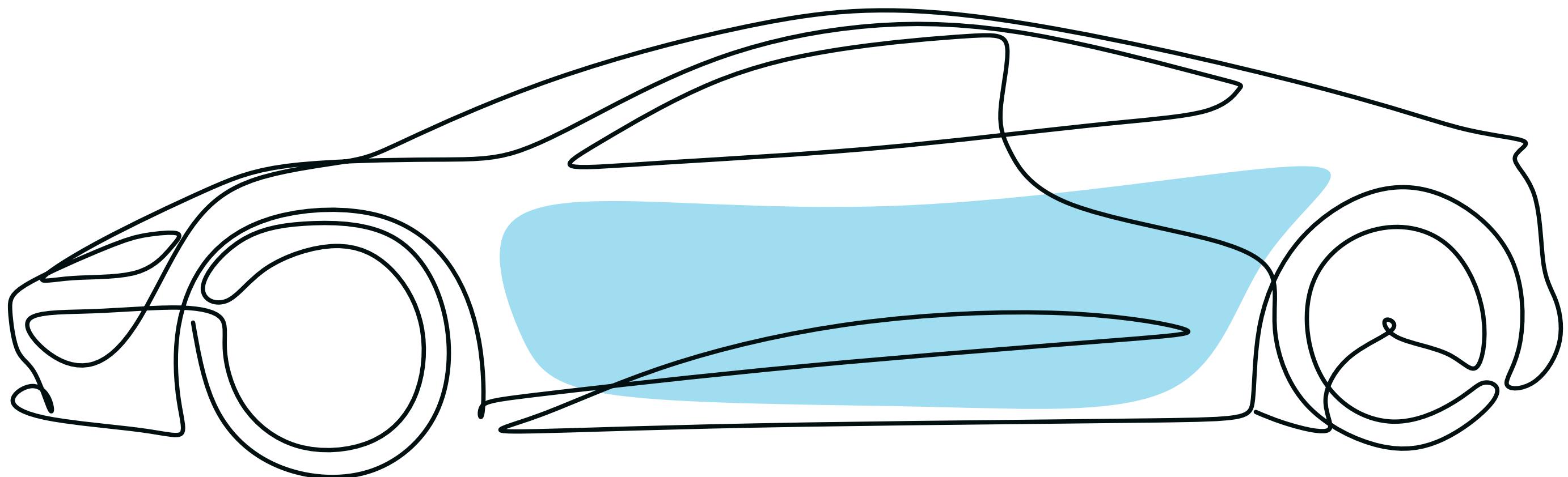
01 Safer driving experience.

02 Reduced maintenance costs for citizens.

03 Faster government response to road issues.

04 Scalable solution that can be integrated into smart city infrastructure (IoT).

THE TEAM



TAYNAM ALZAMEL

Senior Software Engineering and Artificial Intelligence | Robotics & Embedded Systems

- **VEX U ROBOTICS**

Saudi Robot Federation & Saudi Olympic Games
Innovation Award

- **SUMO ROBOT**

Best Code & Best Strategy 2024 & 2025

- **AUTONOMOUS AGRICULTURE ROBOT**

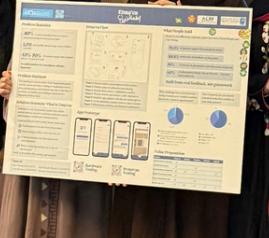
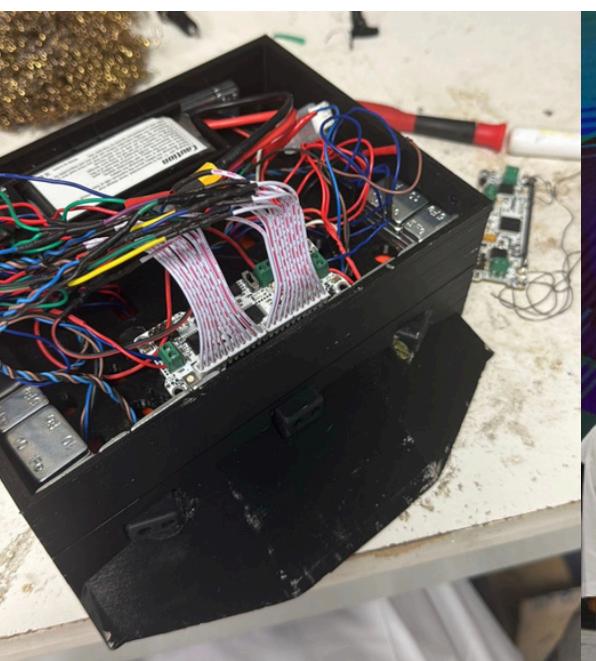
ICSDI Conference
Recognized by Saudi Ministry of Agriculture

- **SHELL ECO MARATHON 2025**

Co-Driver & Technical Innovation Team

- **PSU AI HACKATHON**

1st Place Winner



ALJOWHARAH ALJUBAIR

Senior Software Engineering and Artificial Intelligence | Computer Vision & Embedded Systems

- **SARI POCKETQUBE**

Saudi Space Agency

National winner (TOP 2 teams from 480 teams)

- **SAUDI 4IR HACKATHON**

ministry of communications and information technology

TOP 5

- **SUMO ROBOT**

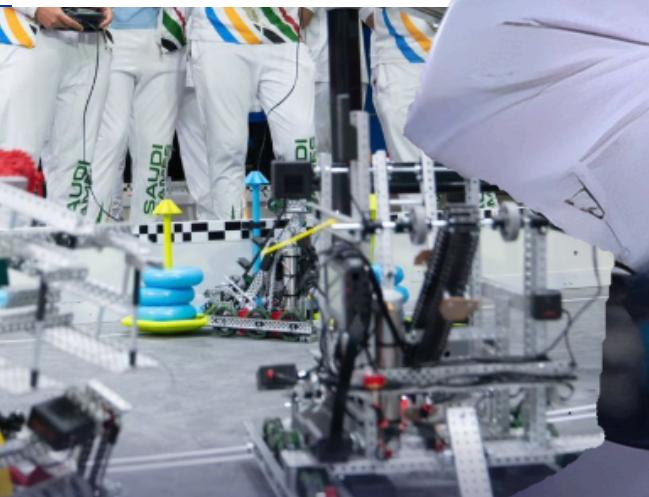
1st Place Winner

- **PSU AI HACKATHON**

1st Place Winner

- **SHELL ECO MARATHON 2026**

Technical Innovation Team



JUMANA ALMUSHCAB

Senior Software Engineering and cybersecurity track | Product Building & Sustainability

- **SOLAR CAR COMPETITION**

1st Place Winner

- **POWER SUSTAINABILITY MOBILITY HACKATHON**

1st Place Winner

- **ICSDI 2022 COMPETITION**

1st Place Winner

- **EXPLORING THE POTENTIAL OF 3D PRINTING TECHNOLOGY FOR SUSTAINABLE PLASTIC ROADS**

Research paper published in a Q1 Journal



SARAH ALKAHWAJI

Computer Sciene , Artificial Intellegence & Data Scince Track

- **PSU AI HACKATHON**

1st Place Winner

- **HACKERRANK**

Coding Challenge

3rd Place Winner

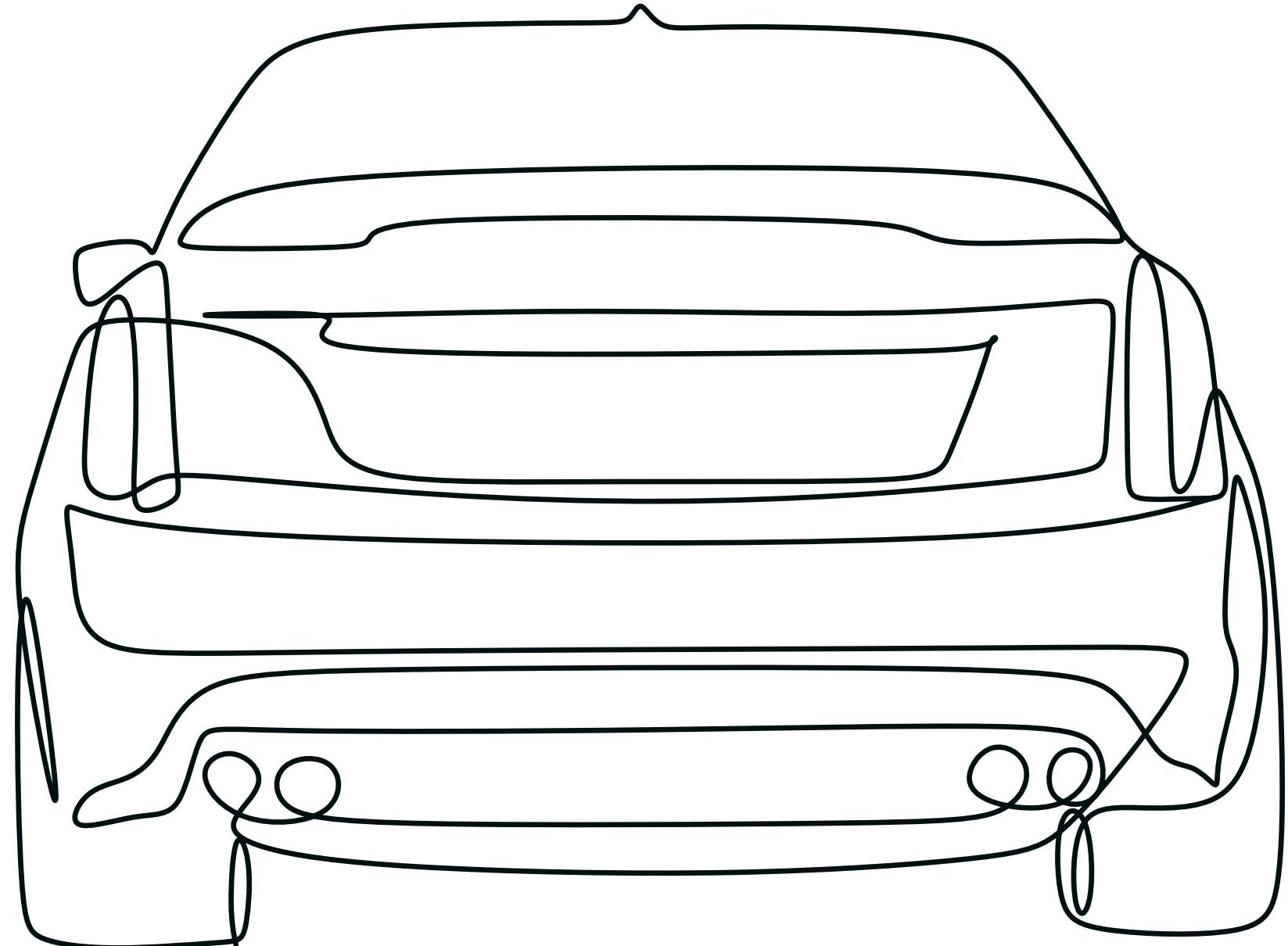
- **DEANS LIST**

Certificate of Academic Excellence by Prince Sultan University

- **RESPONSIBILITY & INNOVATION AWARD**

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THANK YOU!