# Real-time data processing in autonomous vehicles

Metódy inžinierskej práce 2023/2024

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November 26, 2023

# Introduction

## What is an autonomous vehicle?

- A self-driving car that uses necessary hardware and AI algorithms to navigate without any human intervention

## Why is data processing so important in it?

- **Safety and comfort**
- **Navigation**
- **Maintenance**
- **Effiency and effectivity**
- **Machine learning**
- **Autonomy**


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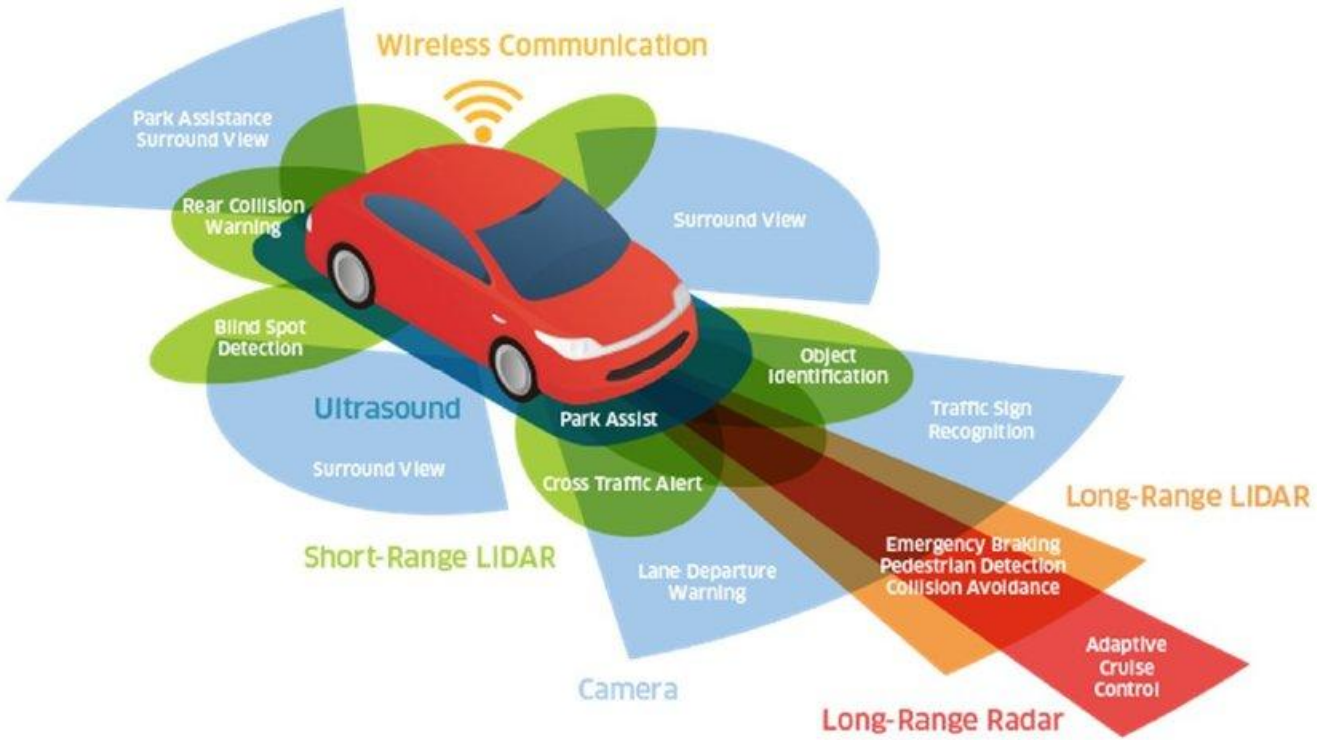
# Sensors

Figure: Sensor coverage in AV[1]




[1] https://www.researchgate.net/figure/Sensors-coverage-diagram-for-an-autonomous-vehicle-taken-from-6_fig1_351407935/

# Sensors



Figure: Advantages and disadvantages of sensors

| Sensors | Pros | Cons |
|---|---|---|
| Cameras | "- best for recognition<br>- less power intensive<br>- high-resolution imagery<br>- cheap<br>- advanced AI and deep learning research" | "- light and visibility dependent<br>- easily affected by shadow or reflection" |
| Radar | "- captures direct distance and velocity<br>- day and night reliability<br>- weather resilient<br>- long-range detection<br>- cheap" | "- object boundary is not great<br>- limited classification capability<br>- poor resolution<br>- inability to detect small objects" |
| LiDAR | "- direct 3D mapping of the enviroment<br>- day and night reliability<br>- very high precision<br>- high resolution<br>- advanced AI research" | "- ineffective under rain and fog<br>- lower range compared to radar<br>- very expensive" |
| Ultrasonic | "- all-material sensing capability<br>- best close-range object detection (parking)<br>- not affected by weather conditions<br>- extremely cheap" | "- can be affected by wind<br>- highly sensitive to vapors<br>- difficulties in distinguishing between soft, curved, thin, and small objects" |
| GPS | "- provides global coverage<br>- precise location information<br>- adaptable to change<br>- cheap" | "- signal interference in places with signal obstructions (tunnels)<br>- latency issues<br>- dependent on accurate maps and data processing capabilities" |

# Algorithms

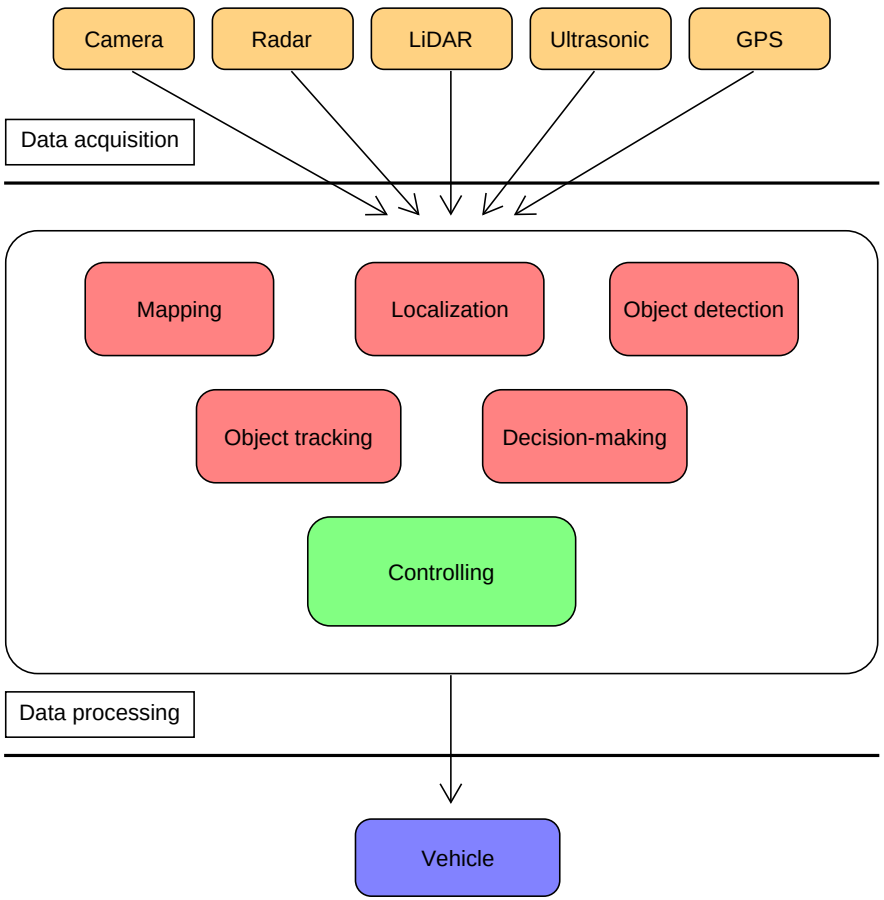
## AV divides data processing into 4 stages:

- **Mapping** - creating a detailed representation of the enviroment
- **Localization** - determining the precise position of the vehicle
- **Object detection** - identyfing objects
- **Object tracking** - monitoring objects
- **Decision-making** - utilizing processed data to make adaptive decisions

# Algorithms



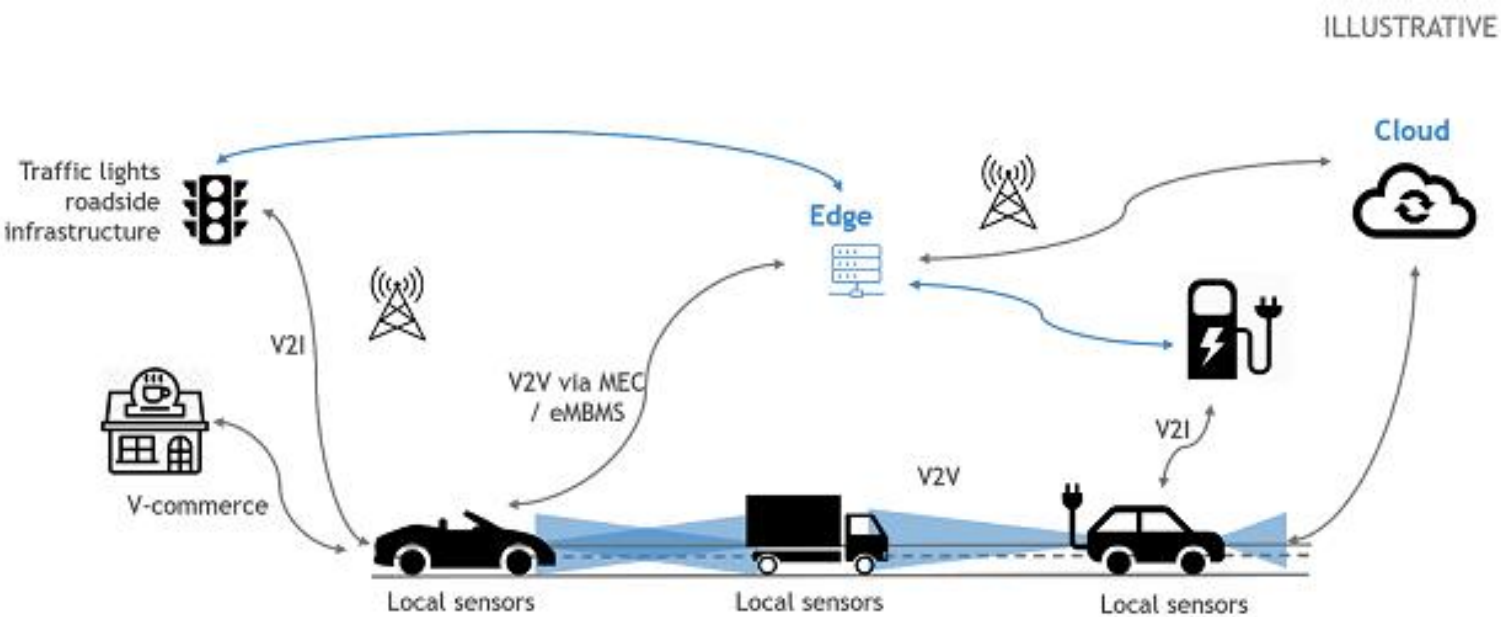
Figure: Data acquisition and processing scheme



# Data processing architecture



Figure: Mobile edge computing and vehicle communication[2]

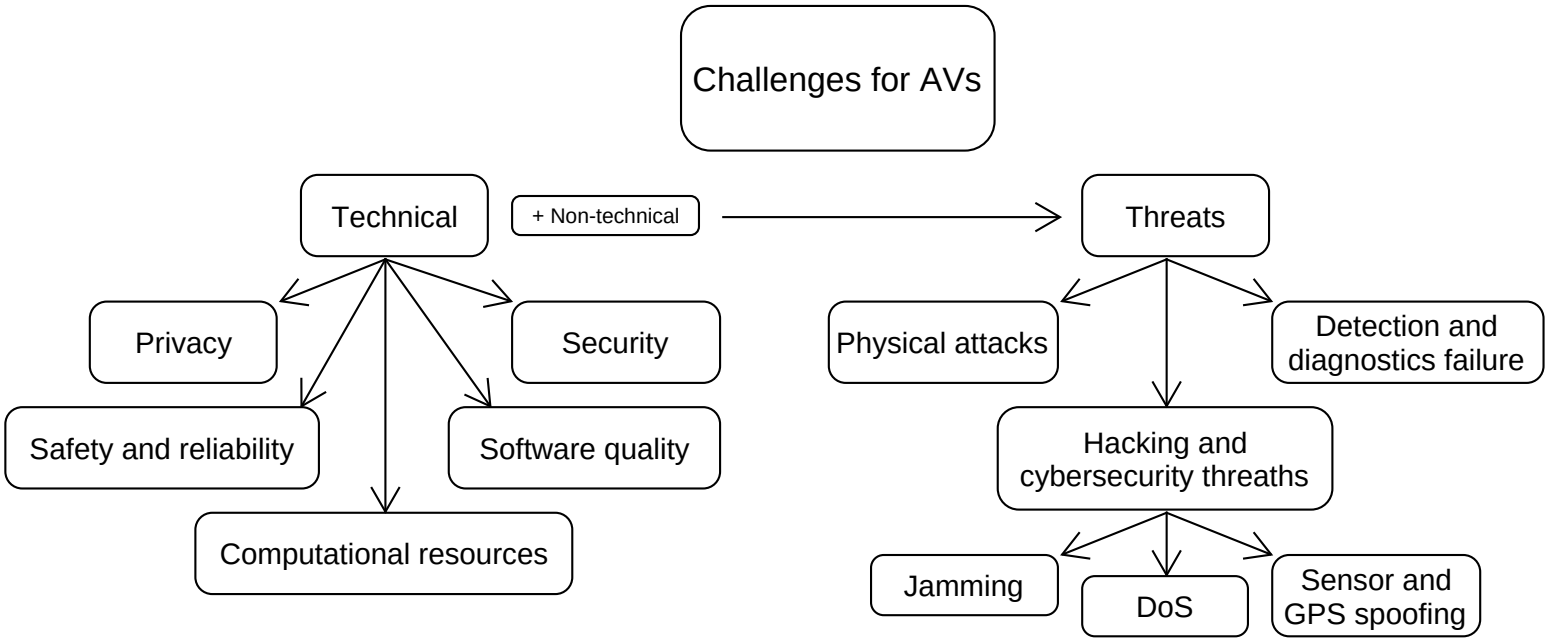



[2] https://www.telematicswire.net/connected-vehicles-and-mobile-edge-computing-a-marriage-of-convenience/

# Safety challenge



Figure: Challenges facing the safety of an AV



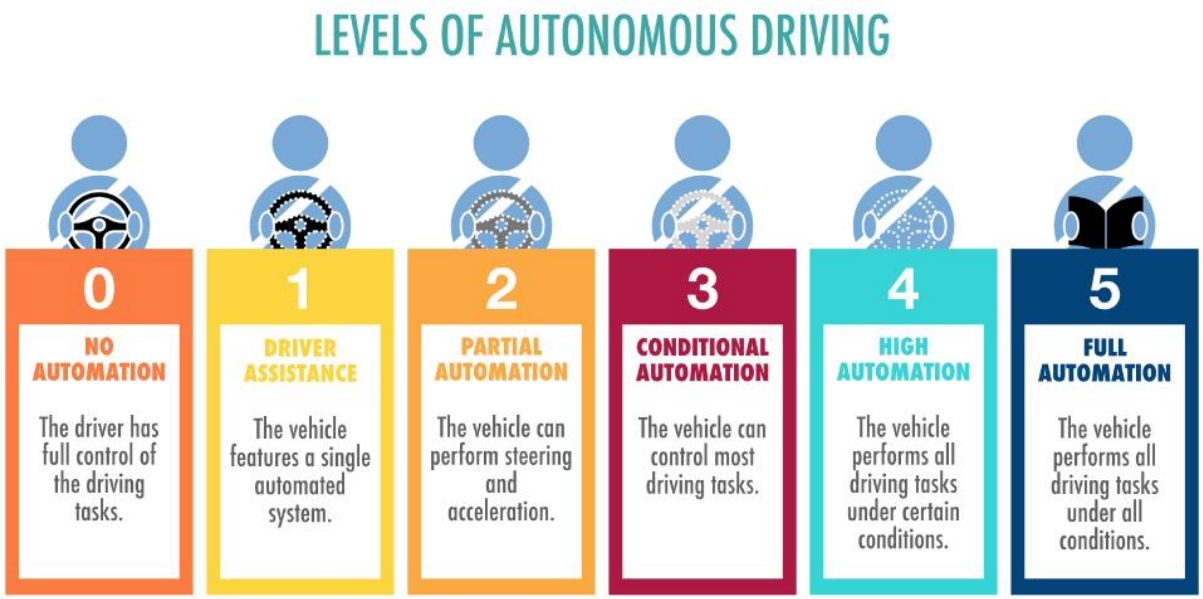
# Future directions

- **Efficiency**
  - AI enhancements
  - Edge computing integration
  - Advanced sensor fusion
- **Connection**
  - V2X communication enhancements
  - 5G connectivity
- **Security**
  - Cybersecurity measures
  - Continuous monitoring
- **Safety**
  - Human behavior prediction
  - Advanced Driver Assistance Systems (ADAS)
  - Predictive analytics

# Conclusion



Figure: Levels of automation[3]




[3] https://www.statista.com/chart/25754/newly-registered-cars-by-autonomous-driving-level/

# Thank you for your attention