Video-Based Vehicle Classification and Detection
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Vehicle Classification Subsystems

- Volumetric and shape based
  - Length, width, height, height profile
- Trailer detection
  - Cars with trailers, single trailer truck vs. single unit truck, double trailer truck
- Axle counting
  - Total axles, axles with ground contact, double wheels, wide wheels, height over axles
- Weight based
  - Maximum gross weight, current weight, axle pressure
- Type
  - Bus vs. truck, commercial bus vs. city bus, light commercial vehicles, taxis, RVs etc.
  - Tanker trucks, Container trucks, Flatbed trucks etc.
  - Trams(!)
Classification sensor types

> Inductive Loops
> Fiber Optic Treadles
> Laser scanners (LiDAR)
> And many more
  - Radar
  - IR photo cells
  - Magnetometers
  - Piezoelectric
  - Etc.
Video-based classification sensors

> Some limitations for normal video cameras
  - Light conditions
  - Fusing many cameras
> Often used in combination with other sensors
  - For specific tasks or for sensor fusion
> Or in use cases with lower performance requirements
  - ALPR cameras with classification
  - Enforcement
  - Access systems
  - ITS
> Stereo video
  - Avoids many problems and adds exact measurements
  - Perfect fit for the high requirements and classification flexibility needed in tolling
Advantages with video

➢ Tracking
  ▪ Front and rear triggers with single gantry geometry
  ▪ Improved tag correlation
➢ Specific classes
  ▪ Bus/truck
  ▪ Maximum gross weight
  ▪ Light commercial vehicles
  ▪ Container trucks
➢ Ability to filter out noise
  ▪ Rooster tails from vehicles
  ▪ Rain, snow
Video technology development

- Camera quality
  - Increase in resolution
  - Increased dynamic range
  - Higher light sensitivity

- Image analysis algorithms
  - Explosion of open source algorithms
  - Machine learning very efficient for classification
  - Autonomous driving is pushing development

- Stereo video
  - Stereo video adds another level of accuracy
  - Exact 3D measurements and no shadow problems
  - 3D information is merged from all available sensors
  - Kapsch has over 20 years of experience with stereo video
First deployed in the 90s. Now in 4th Generation

- Detects vehicles
- Triggers ANPR cameras
  - Front and rear cameras from single gantry geometry
- Track vehicles
  - Correct associated tag, front and rear plates
- Classify vehicles
  - Based on axles, volumetric and type
- Speed and headway measurements
- High performance in stop and go traffic
- High performance in all weather conditions
- Bi-directional traffic
  - Good for HOT Lanes and smaller roads
Classification with nVDC

> Volumetric – Length, Width and Height
  - For towing vehicle and trailer
> Axle counting
  - Total axles, raised axles, height over axles
> Type
  - Bus vs. Truck
  - single trailer truck vs. single unit truck
  - Maximum permissible gross weight
  - Light commercial vehicles
  - High number of requests on new types!
Selected references

> US Projects
  - All Electronic Tolling
  - NYSTA – In revenue service April 2018
  - Rhode Island Truck Tolling
  - MDTA
  - HOT/ Managed Lanes
  - I-77
  - I395
  - SANDAG

> International References
  - Sydney Harbour Bridge, Australia
  - Austrian Truck Tolling (GoMaut)
  - Autopista Central, Chile
Conclusions

- Video technology is evolving very fast and will most likely be used more and more in classification.
- Video-based classification can distinguish classes previously impossible.
- Still a lot of challenges for normal video sensors.
- Stereo video is a very well suited technology for vehicle detection and classification.

![image of vehicle detection using stereo video technology]
Thank you!

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