Autonomous Driving

or highly automated driving

A presentation by Patrick Buchhardt

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Challenges

- Object recognition and tracking
  - Traffic lights
  - Traffic signs
  - Lane
  - cars
  - Pedestrians & cyclists
  - Other obstacles & road users
- Action planning
- Real time

Sensors

- Long-range radar
  - 200-250m
- Stereo cameras
  - Accurate up to 30m
  - 50° field of view
- Ultrasonic systems
  - 6m
  - Small field of view
- LIDAR

Assistance systems

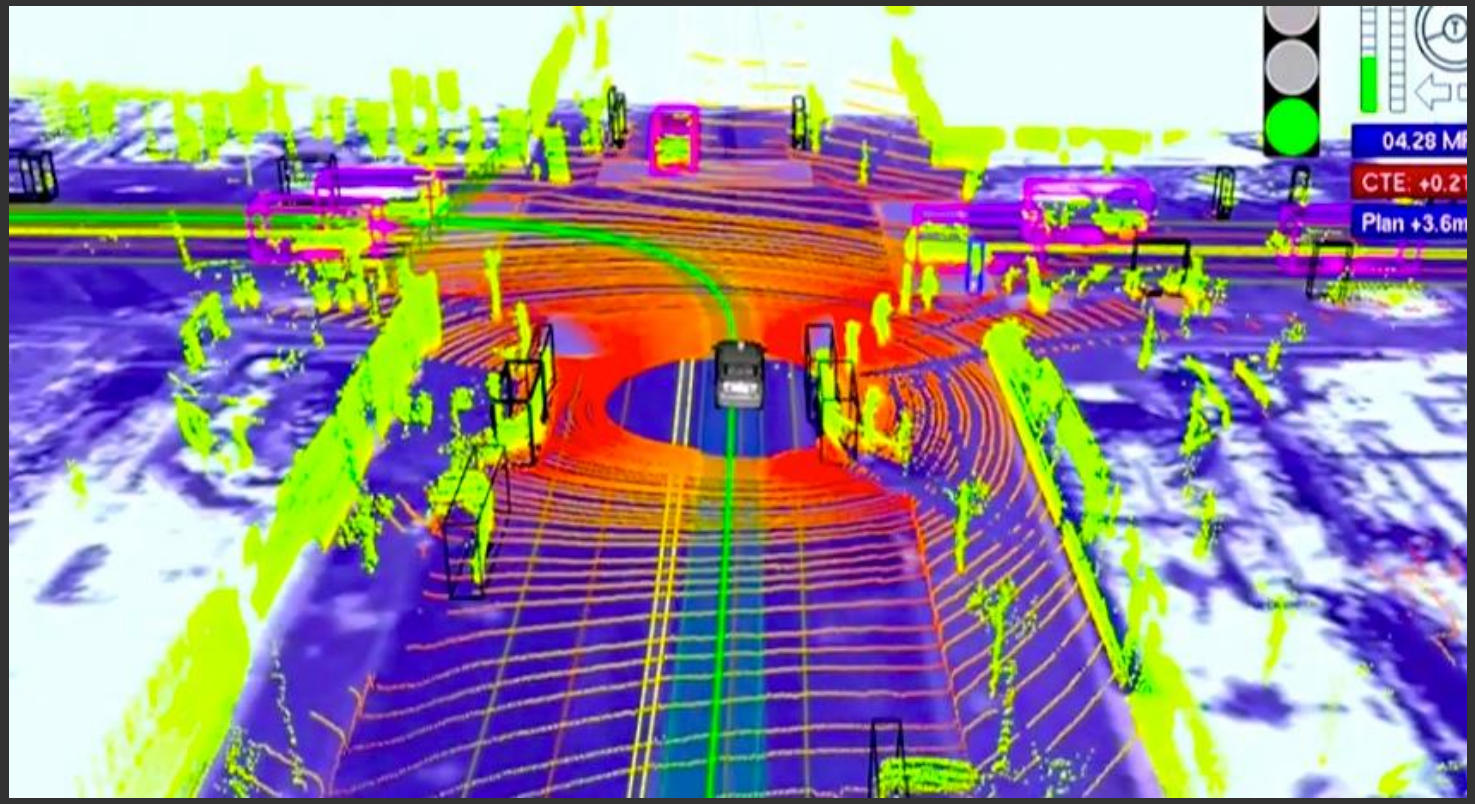
- Adaptive curse control (ACC)
  - Adjusts the speed to maintain a safe distance
  - warning
- Active brake assist (ABA)
  - Can evoke emergency braking
- Parking assist
- Lane change assistance

LIDAR

http://img.hexus.net/v2/internationalevents/DARPA_grand_challenge_2007/velodyne_HD_LIDAR_cropped.jpg

- Cost about $70.000
- Highly accurate up to 100m
- Up to 1.3 million readings per second

LIDAR output visualisation



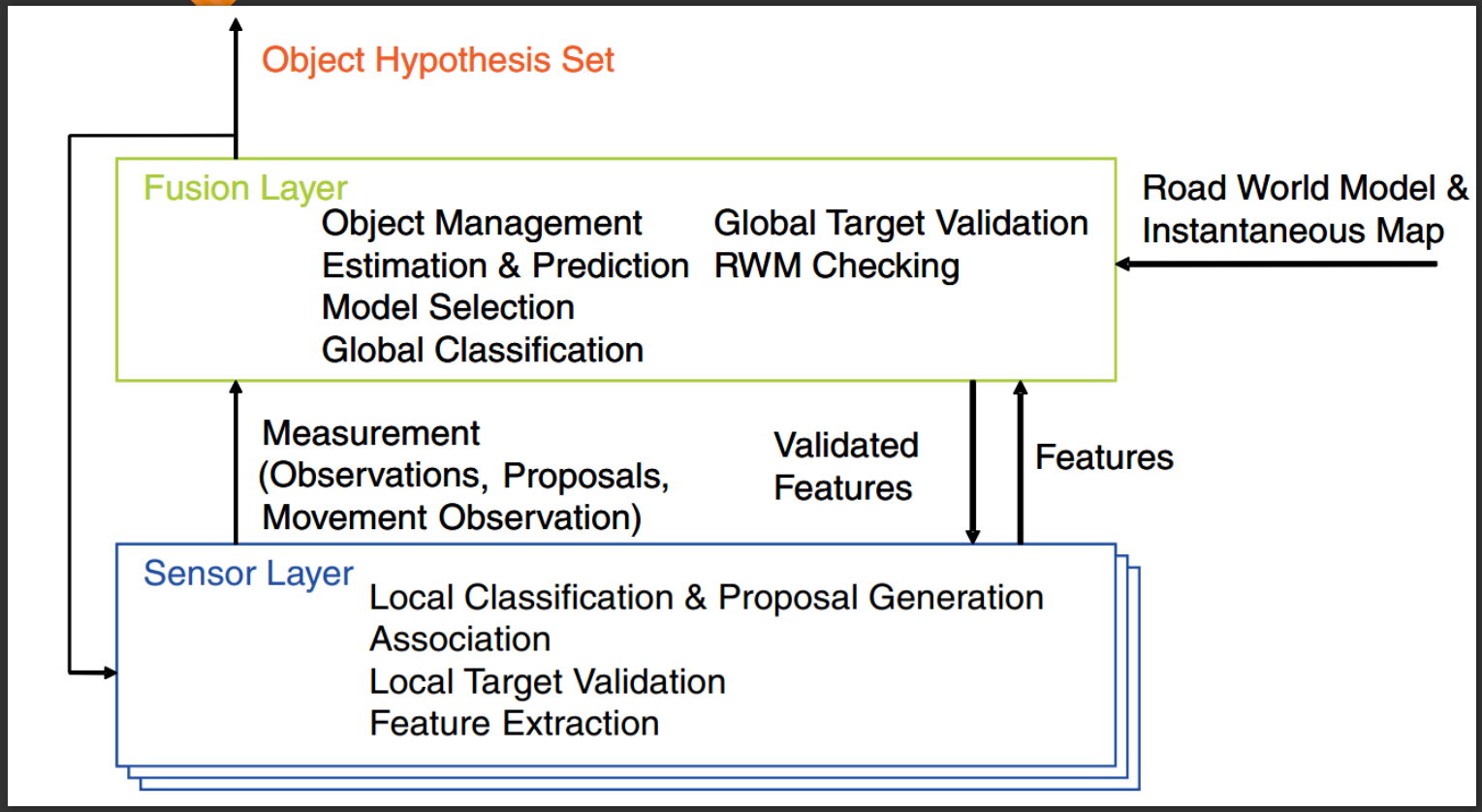
Perception

From "Autonomous Driving in Urban Environments: Boss and the Urban Challenge

Moving Obstacle Detection and Tracking

- Classification of objects
- Moving or not moving
  - By velocity
- Observed moving or not observed moving
  - Moving in the last few seconds
- Objects can be filtered for specific contexts
  - e.g. trees are not relevant for distance keeping

Architecture



One specialized sensor layer for each sensor type

Detection

- Sensor layers request prediction from fusion layer
- Feature extracting
- Validation to distinguish between static obstacles and moving vehicles
  - → validated features (potentially from vehicles)
- association with predicted object hypotheses
- feature interpretation matches with the object hypothesis → old object hypothesis can be replaced by a new one
- Result is a proposal: set of new object hypothesis

Detection

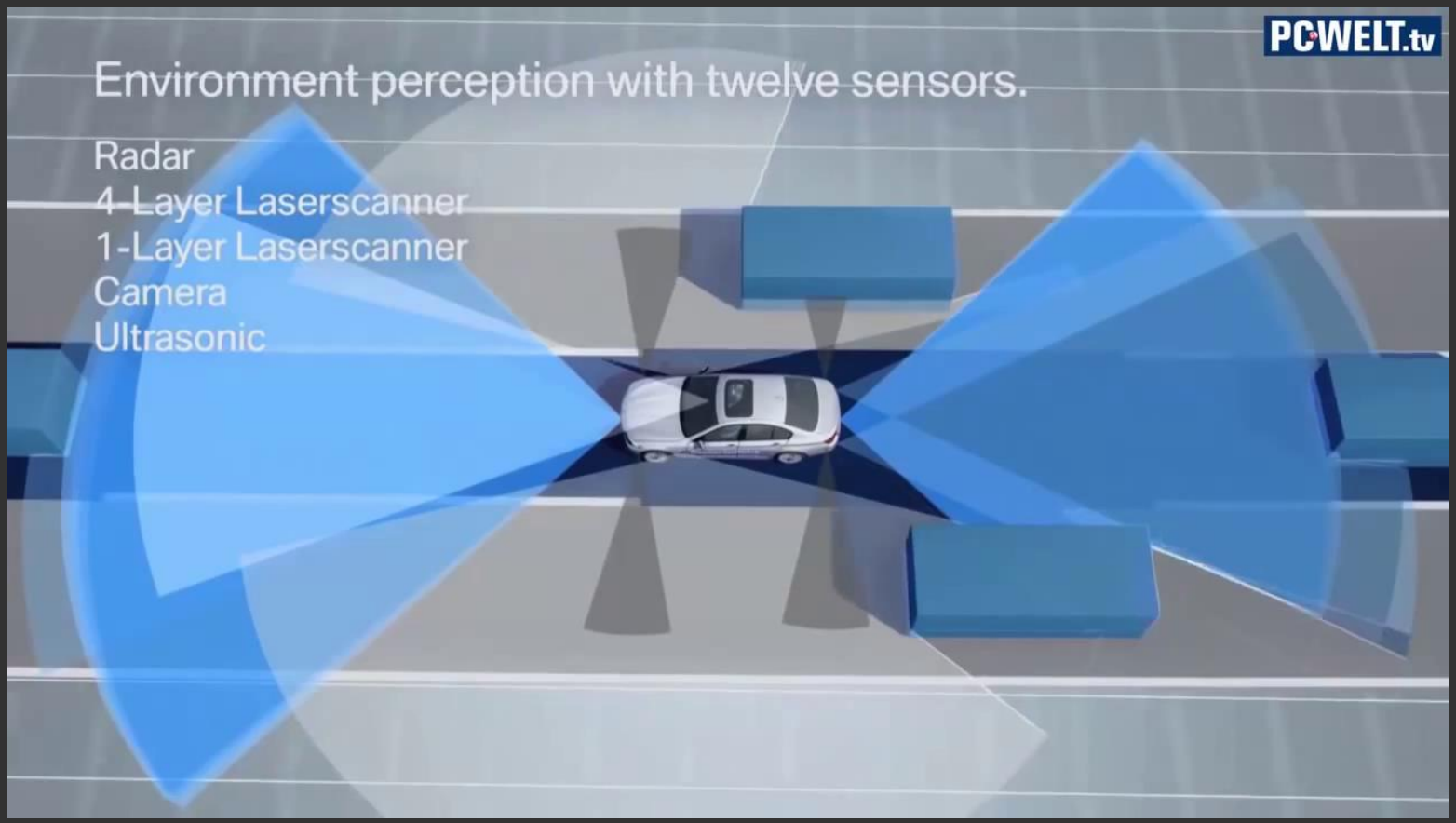
- Generation of observation using the best interpretation
- Observation holds all necessary data to update the state estimation
- Some sensors also provide movement observation for extracted features
- Fusion layer updates the object hypothesis list using the proposals, observations and movement observations
- For unassociated features: adding best proposal to the list of object hypothesis
- Result: updated list

Current Progress

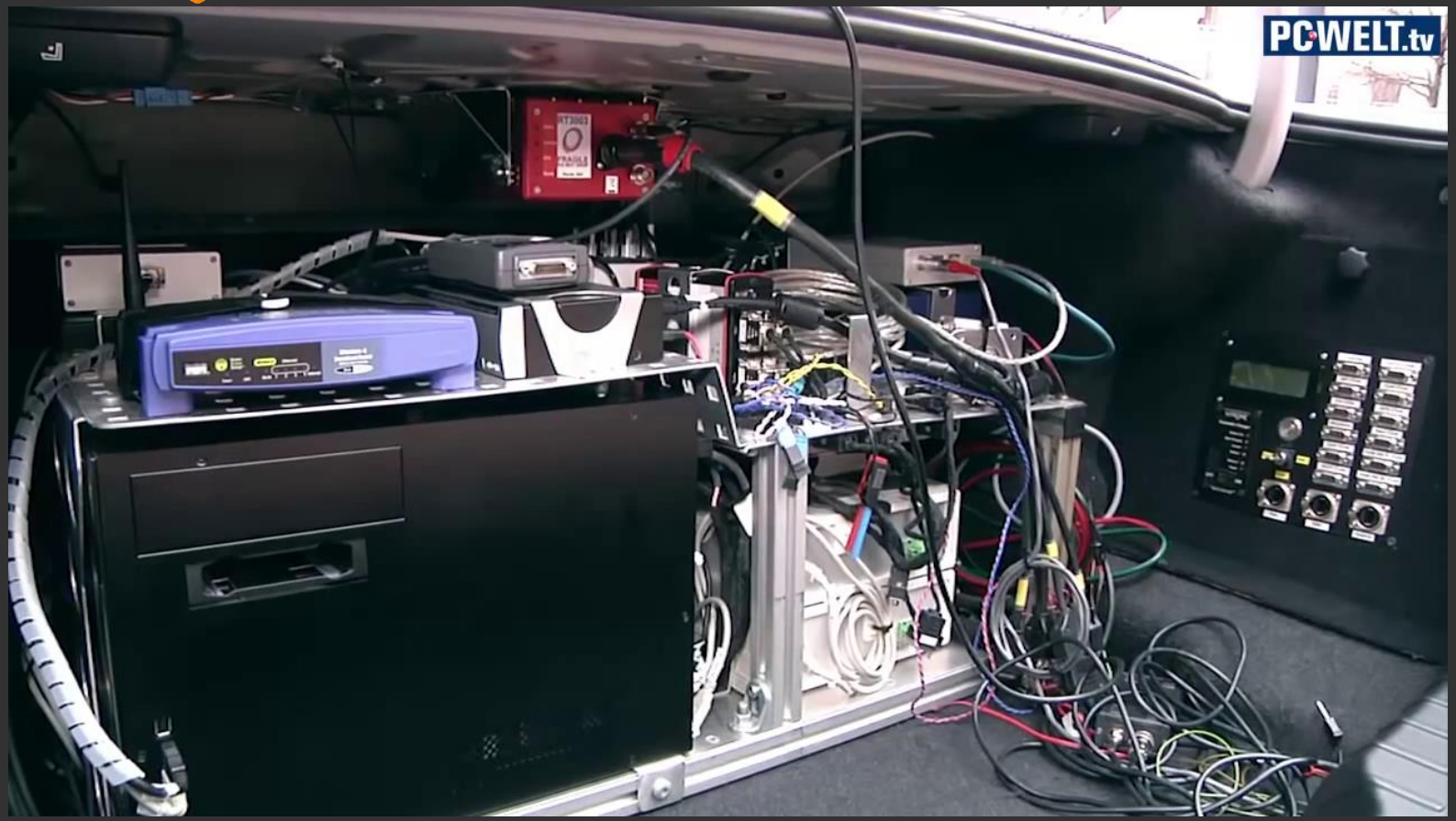
BMW

- high-precision maps
- Long-range radar at front and back
- Ultrasonic on both sides
- 4-layer-laser at the front bumper
- Laser scanner on both sides and back bumper
- Front stereo camera
  - Classify objects
  - Detects lights and signs
- redundancy

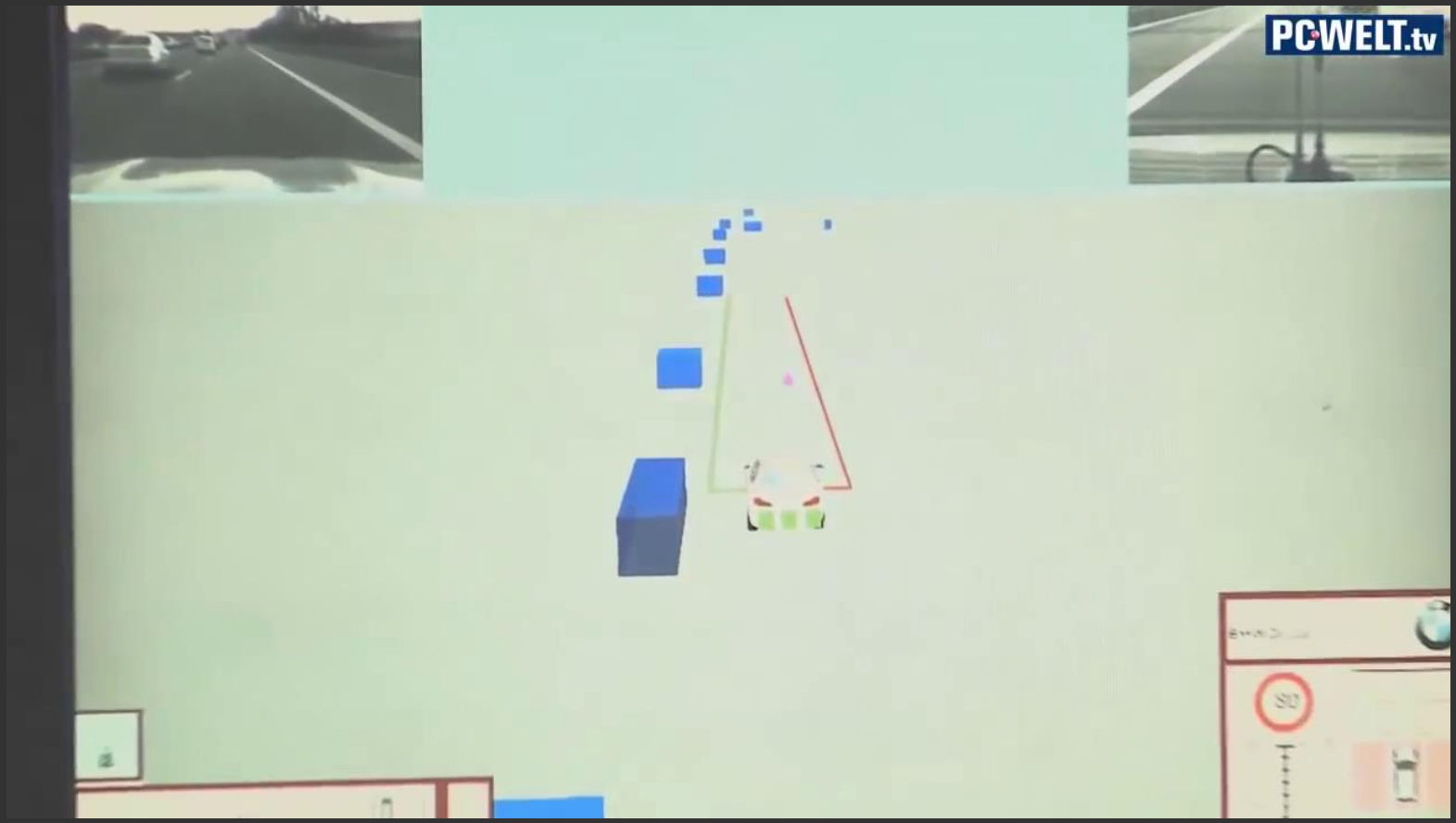
BMW driverless car



BMW driverless car



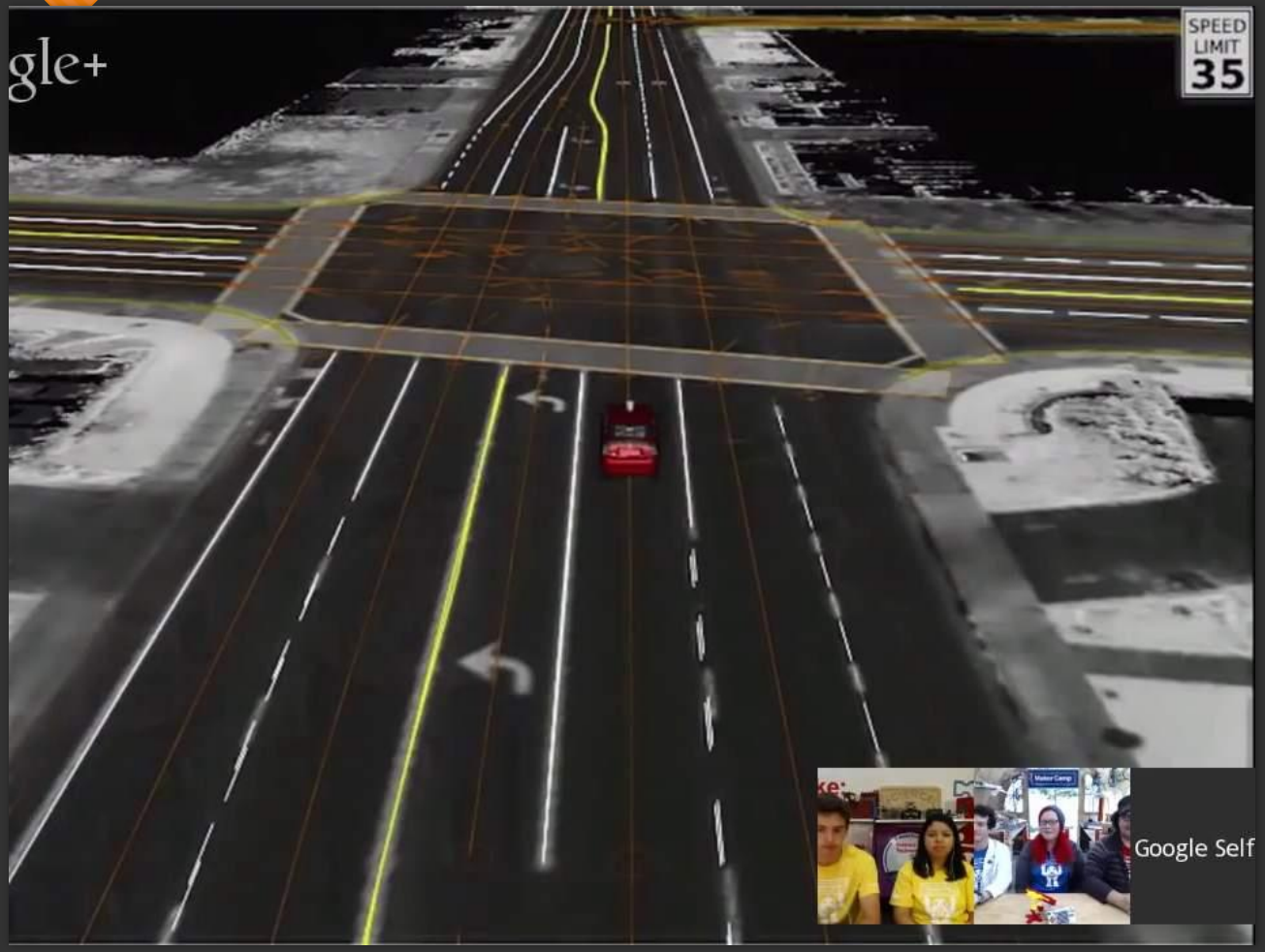
BMW driverless car



Google driverless car

- high-precision maps
- Long-range radar at front and back
- Ultrasonic devices
- Front stereo camera
- LIDAR
- redundancy

Google Chauffeur



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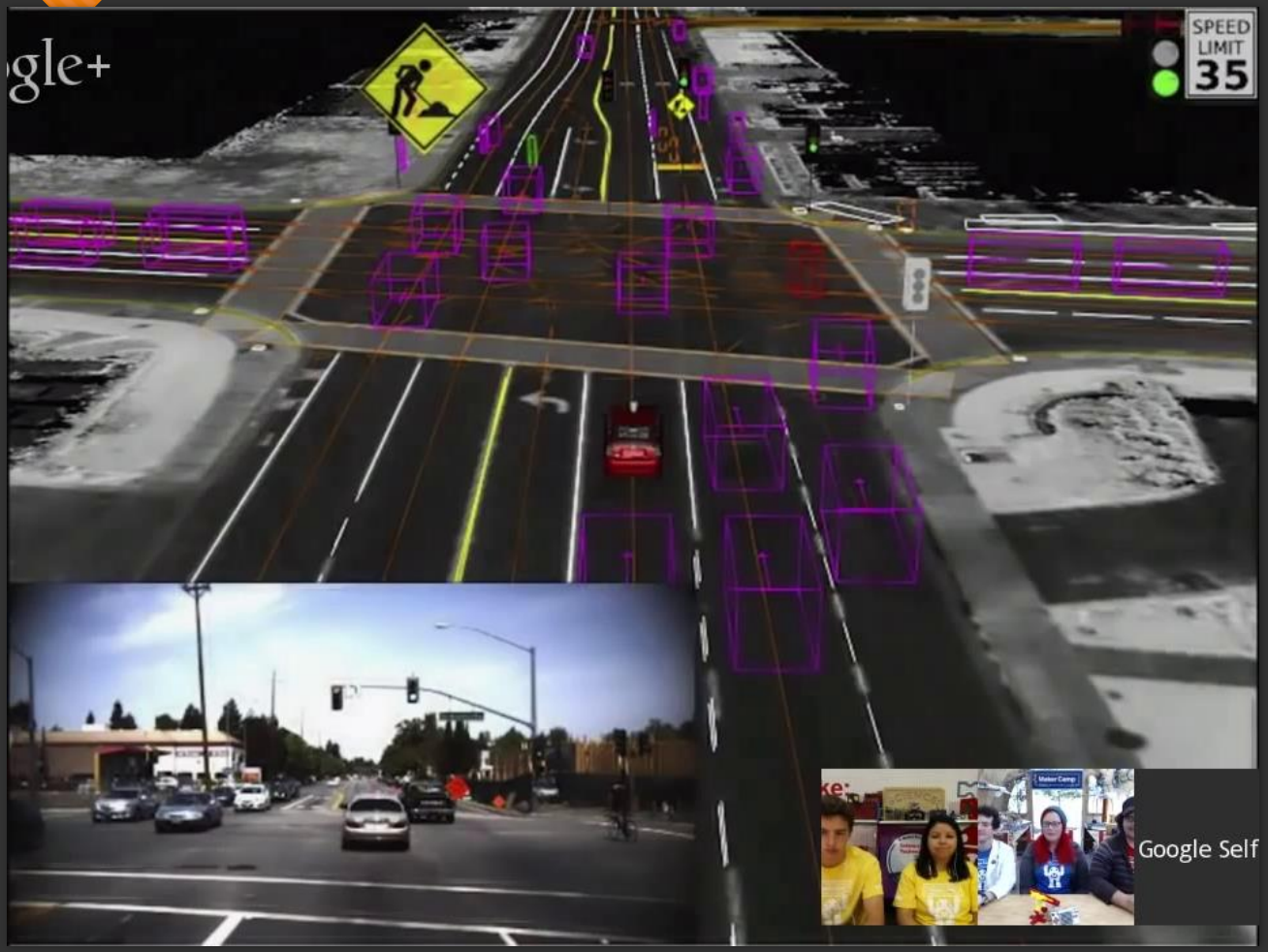

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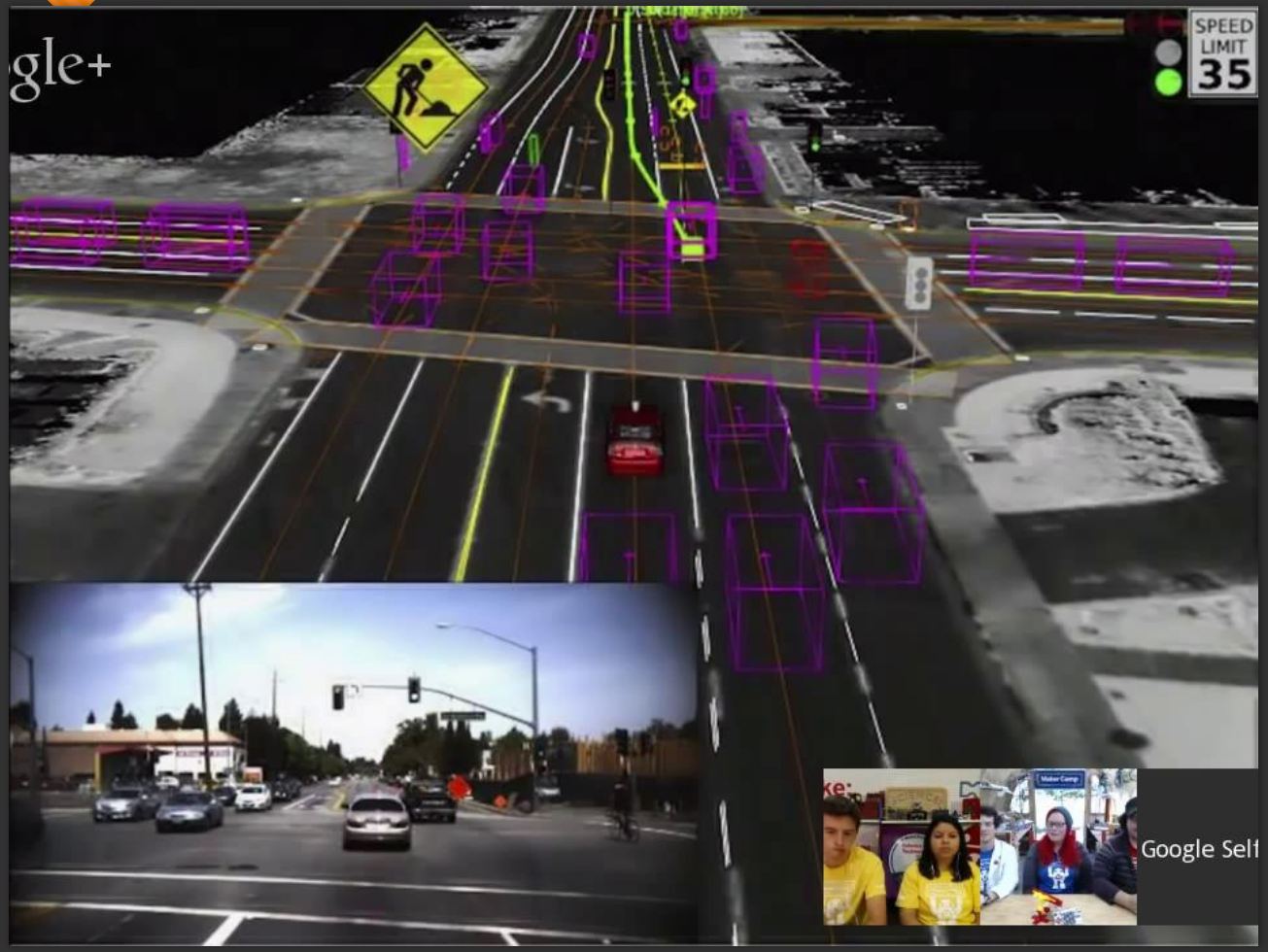

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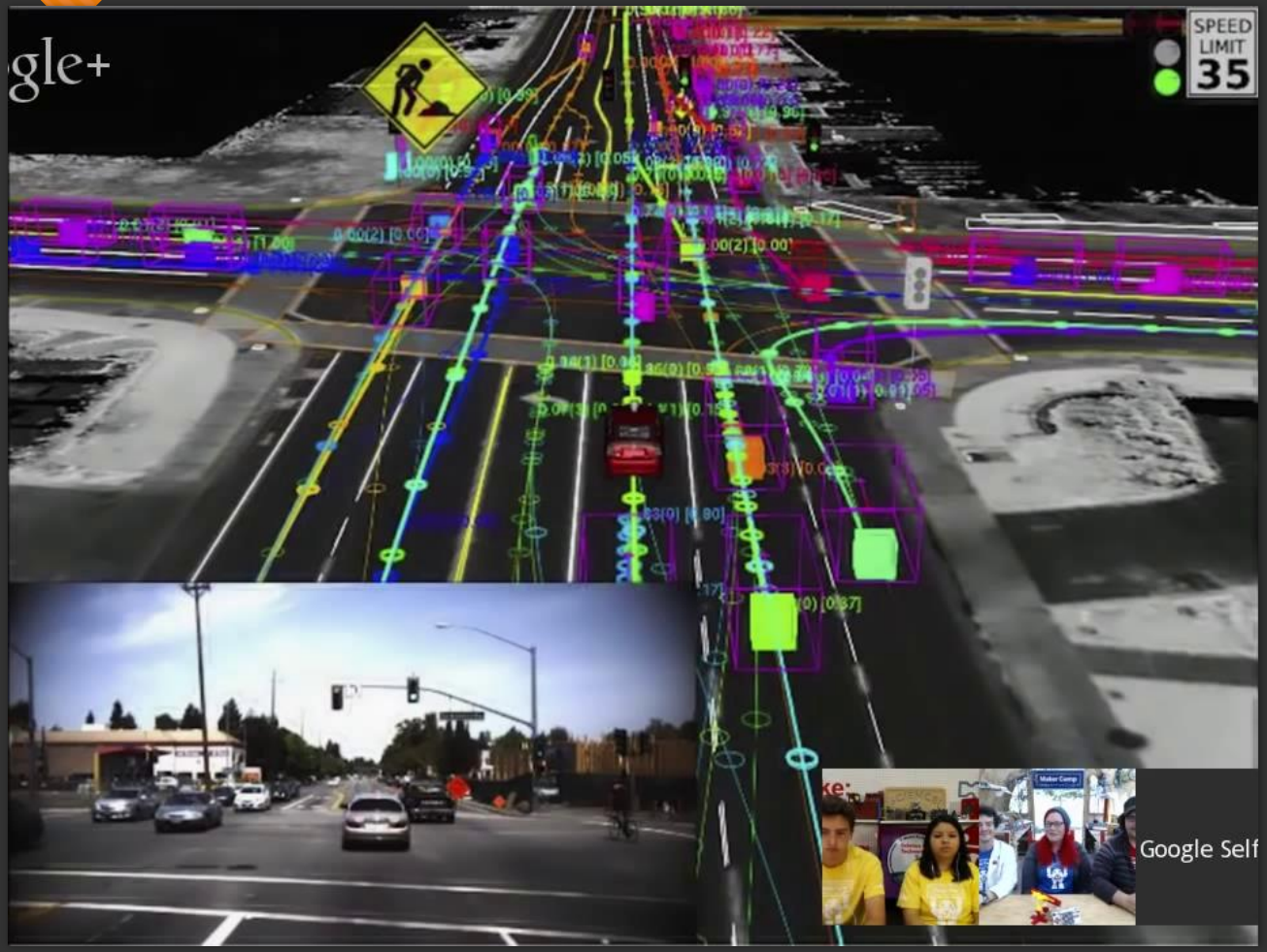

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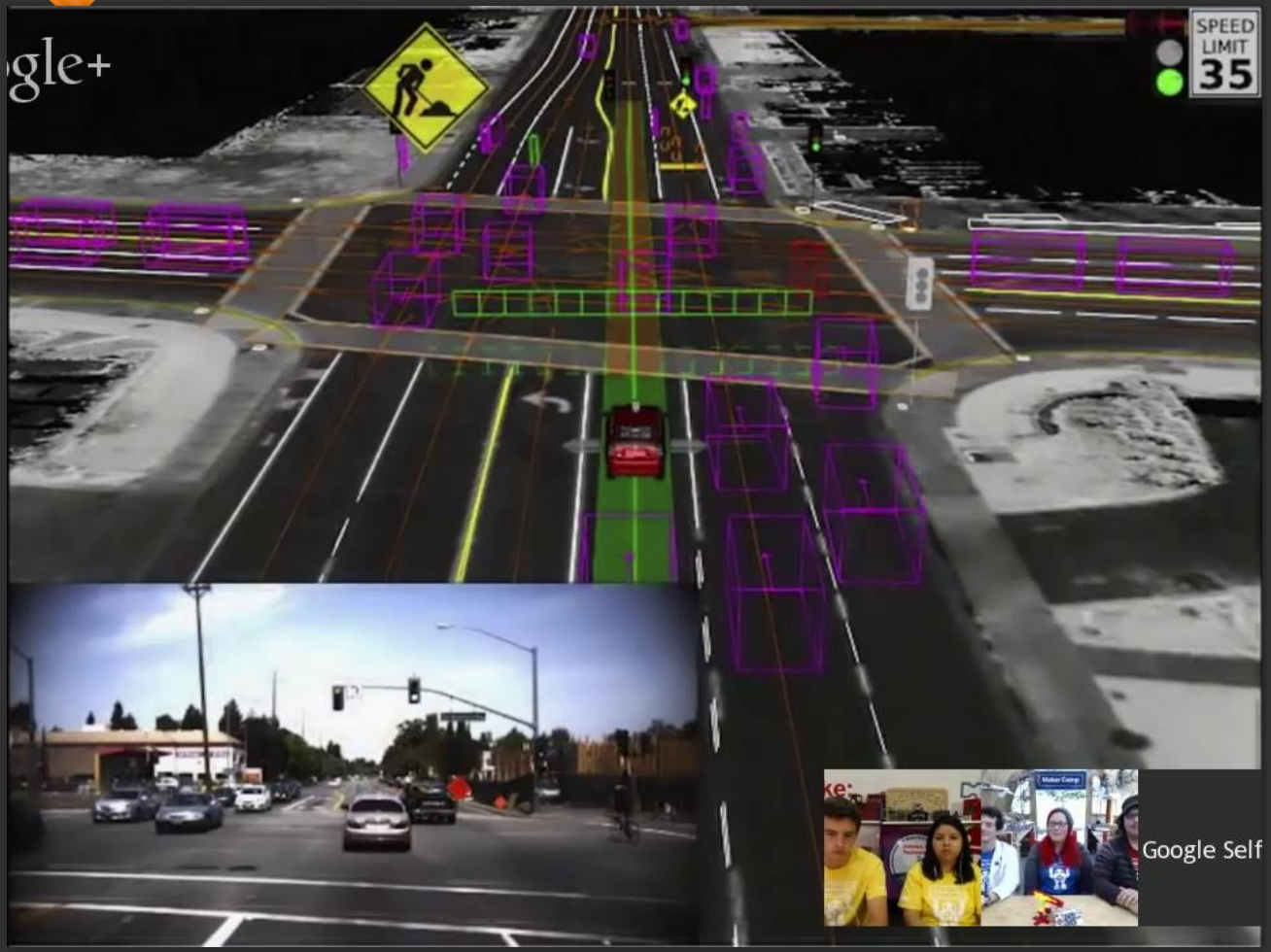

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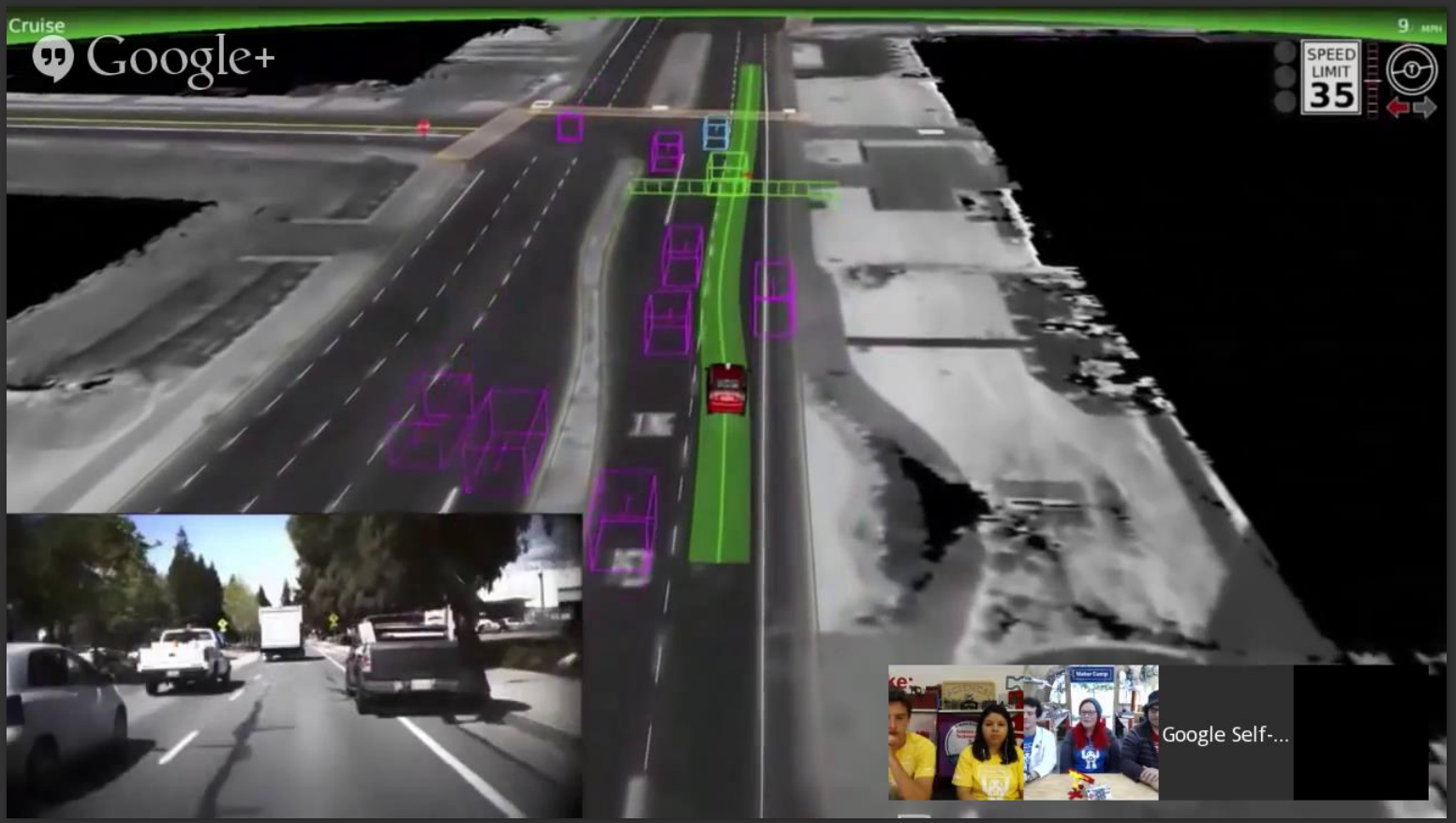
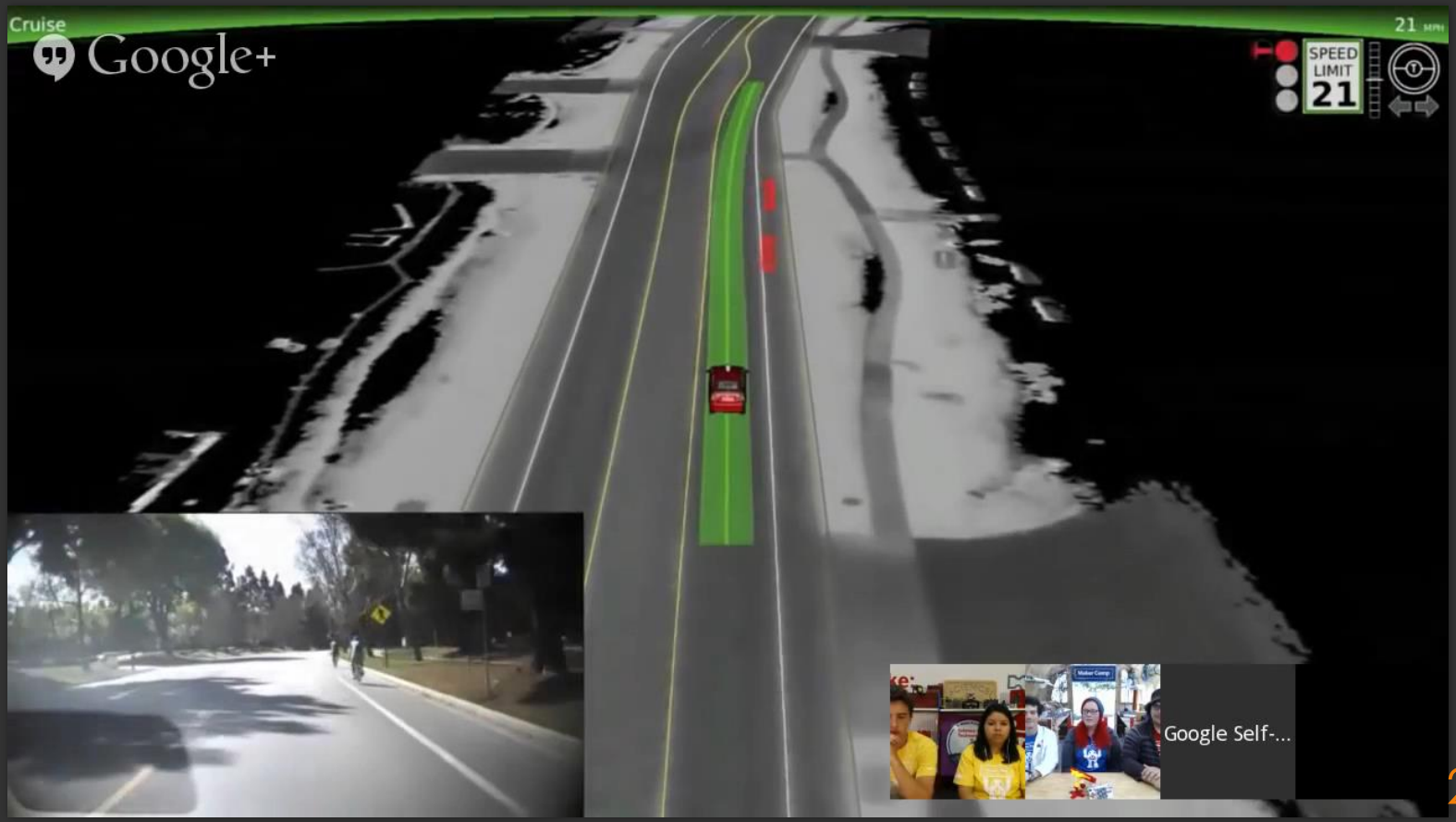


Gesture recognition



Problems

- recognition of objects behind others
- Range
- weather

Videos

References

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