AUTONOMOUS VEHICLE LOCALIZATION BY LEVERAGING CELLULAR CONNECTIVITY

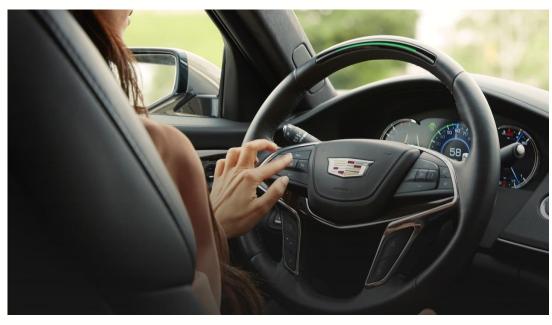
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8 MARCH 2018



CADILLAC SUPER CRUISE





- 2018 Cadillac CT6 Sedan
- Launched Q3 2017 in US and Canada
- Optional Feature
- Safe & Reliable Hands-Off Operation on North America highways
- Level 2 Automation: Driver Assist Feature (0 to 85 mph)

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VIDEO

https://youtu.be/_rxW68ADldI

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CADILLAC SUPER CRUISE TECHNOLOGY

High definition redundant cameras (front, side, rear)

Lane marker identification

Long range and short range radar

Object detection

6 DOF MEMS Inertial Measurement Unit

Vehicle orientation and motion

LIDAR-surveyed precise map (<10 cm absolute accuracy)

Remotely updated over-the-air through 4G LTE

Single-frequency, GNSS corrections through 4G LTE

- Precise satellite clocks, orbits, atmospheric delay
- GPS/GLONASS
- Trimble RTX service
- 1.8 meter (95%)





CADILLAC SUPER CRUISE MY2018 CONNECTED FEATURES

- Precise map updates
 - Construction areas
 - Fresh road surveys
- Continuous GNSS corrections
 - Reduces errors in GPS/GLONASS signals
 - Supplements camera for lane identification
 - Active whenever ignition is on
- Continuous Super Cruise diagnostics
 - Vehicle system monitoring
- OnStar emergency call
 - Automatic call if driver becomes incapacitated while using Super Cruise
- Over-the-air software updates for critical vehicle controllers





CONNECTIVITY AND AV - FUTURE ROADMAP

V2X Capabilities

- Vehicle-to-Vehicle communication for lane merges and traffic awareness
- Issues under consideration:
 - DSRC 802.11p vs. Cellular V2X
 - Importance of accurate vehicle location
 - Vehicle-to-Infrastructure use cases and infrastructure deployment

Precise map creation concept:

- Deliver camera images via cellular to map server
- Precise road segments computed at server and delivered to vehicle
- Vehicle localizes itself to precise road information
- Could potentially provide more timely map updates (requires favorable data transport costs)

5G

High bandwidth, low latency

CONNECTIVITY AND AV - ENGINEERING CHALLENGES

RF Complexity and Interference

- GNSS, cellular bands, DSRC/C-V2x vs. Wi-Fi
- RF noise from nearby electronics (Ethernet, LVDS video, wireless charging)

Fast pace of technology change vs. lengthy automotive development

- Forcing automakers to maximize speed-to-market through new partnerships
- Growing dependence on emerging technology and startups
- Greater use of HIL simulation & modeling
- Add or update Apps through unique General Motors App Framework at scale and with speed

Safety cannot be compromised

- Requires ASIL certification of HW/SW components
- Redundancy will continue to be critical for autonomous vehicles
 - Redundant sensors (camera, Lidar, IMU, GNSS, maps)
 - Redundant communication (multiple carriers, supplement cellular with satellite)
- Leverage GM experience with connected services and technology integration to continue to provide sensor and communication redundancy going forward