IN-CAR COMPUTER VISION SYSTEM

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INTRODUCTION

✓ Intro

✓ What car is able to “see” today

✓ Luxoft expertise

Luxoft has 8+ years of successful projects in Automotive business, particularly in field of Navigation.

Disadvantages of “classic” navigation

• Not clear destination representation

• Disorientation on complex junctions and highway exits

• Rendered map may differ in comparison with real world

• Separate screen distracting the driver

Challenges for Augmentation Navigation
COMPUTER VISION AUTOMOTIVE USE CASES

CVNAR

Pattern Recognition

Signs recognition, automatic DB update

Mathematics

COMPUTER VISION

Image Processing

Artificial Intelligence

Physics

Signal Processing

Info-graphics

City Driving Pattern

Help in low visibility mode

Active Park Search

Advanced Adaptive Cruise Control

Augmented Guidance

CVNAR - 2014
COMPUTER VISION & AUGMENTED REALITY

HUD

PUPILS TRACKING
WHAT AUGMENTED NAVI IS
SYSTEM DESIGN

- Camera Data
- CAN Data
- Map Data
- Navigation Data

COMPUTER VISION DATA FUSION & FILTERING

Output is an extendable metadata which describes all the augmented objects/hints and supports natural features ON/OFF.
REPRESENTATION FOR DRIVER

- **Outdated (-10 years)**
  - LCD screen
  - Smart glasses

- **Past (-5 years)**
  - HUD in car/digital cluster (new)
  - Real-depth HUD with wide FOV in car

- **Alternative, fast developing market (today)**

- **Future (+5 years)**
COMPUTER VISION UNDER TARGET PLATFORM

- Computer Vision – essential part of System
- Algorithms are computationally expensive
- Target platform has low computational resources
- Resources are partially utilized by navigation, voice recognition, RSE data exchange etc.
- Real time augmentation system has strict requirements on latency
- Need reliable results

Mentioned above is reality of automotive market today

Current prototype works under real in-car embedded platform
Intel Celeron 1296MHz - 1024 Mb RAM - 256 Kb L2 Cache
LUXOFT COMPUTER VISION FRAMEWORK

BASIC ALGS
- Derivative
- Morphologic
- Integral image

CV ALGS
- Face detection
- VP detection
- Image segmentation

APPLIED ALGS
- Road recognition
- Facades detection
- Vehicles detection

PIPLINES
- Arrows Pipeline
- Facades Pipeline
- Markings Pipeline

SOLUTIONS
- Augmented Guidance
- CVNAR
CORRECT PROBLEM FORMULATION: 3 STEPS

- Fully automatic – minimizes false positives
- With operator – minimizes true negatives
✓ Optimization for best optimization criteria formulation
✓ Lanes detection – angular function
✓ Close camera detection – textures, Fourier, histograms
AUTOMATIC BOOSTING FOR OBJECTS DETECTION
CONSTRAINED SLAM

- Feature points detection
- Filtering-tracking-filtering
- Bundle adjustment via dogleg algorithm (Powell) based on goal function with constraints
- Integration into continuous pipeline

- Hartley R., Zisserman A. Multiple View Geometry in Computer Vision
- Is Levenberg-Marquardt the Most Efficient Optimization Algorithm for Implementing Bundle Adjustment? Manolis I.A. Lourakis and Antonis A. Argyros
DOGLEG FOR NON-LINEAR OPTIMIZATION

Gauss-Newton

grad

Gauss-Newton

grad

Gauss-Newton

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ADDITIONAL USE CASE
ADDITIONAL USE CASE

Application usage demo challenge with glance screen and lack of features

Tracking robustness demo in car

Click on image to play the video
Quantum algorithms in general case for practical subset of CSP problems (via Grover's technique): $T_Q \rightarrow \sqrt{T}$ (http://www.cs.utep.edu/vladik/slides/sac06quantum.pdf)

More?