Analysis and Categorization of Wireless Communication at Urban Crossroads

Analyse und Kategorisierung von Funkkommunikation an städtischen Kreuzungen

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Outline

Crossroad Categories

Car2X Channel Sounding

IEEE 802.11p Transmission Simulation

Fitting and Modeling

Results
Motivation

Project Goal
Value benefit analysis of accident avoidance techniques at urban crossroads

Opponent detection using car-to-car communication

Task of HHI
Evaluation of communication performance at urban crossroads
Initial Crossroad Categories

1. 

2. 

3. 

4.
Crossroad Category 1

- Massive obstruction
- No large surfaces available for reflections "to destination"
- Occasional opportunities for reflection, for example individual vehicles, individual house wall
Crossroad Category 2

- Line-of-Sight (LoS) obstruction by parked vehicles or vegetation
- No large surfaces available for reflections "to destination"
- Occasional opportunities for reflection, for example individual vehicles, individual house wall
Crossroad Category 3

- Massive LoS obstruction
- Large surfaces available for reflections "to destination"
- Reflection surfaces e.g. through walls of houses or parked vehicles
Crossroad Category 4

- LoS obstruction by parked vehicles or vegetation
- Large surfaces available for reflections "to destination"
- Reflection surfaces e.g. through walls of houses or parked vehicles
Measurement Campaign in Berlin
Car2X Channel Sounder

Time-variant Channel Impulse Response
Processing of Channel Sounder Data

- Subtract Noise: NoiseFloor + 6.5dB
- Bandlimiting: 1 GHz → 10 MHz
- FFT Interpolation: 200μs → 1 MHz
IEEE 802.11p Transmission Simulations

• Carrier frequency: 5.9 GHz
• Bandwidth: 10 MHz
• Packet size: 200 Bytes
• Frequency offset: 1 ppm
• Tx Power: 20 dBm
• Antenna Gain: 2 dB
• Noise Power: -94 dBm
• Rx Power Threshold: -82 dBm
• Viterbi decoder: hard decision, terminated
Transmission Simulation Results

- No Communication
- Communication
- Approaching vehicles

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Transition from NLoS to LoS

No intervisibility: Non-Line-of-Sight

Transition NLOS → LOS

Intervisibility: Line-of-Sight

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Superposition of Crossroads Results

**Line of Sight**
Quasi-location-independent communication performance

→ Arithmetic Average

**Non Line of Sight**
Different sizes of crossroads challenge superposition

→ ?
Transformation of Coordinates

Advantage
→ No deformation of results
Disadvantage
→ Neglect of results

Advantage
→ No neglect of results
Disadvantage
→ Deformation of results
Group Simulation Results
Revise Categories

1. 3. 2. 4.

K1 K2 K3
Superimposed Results

Assumption:
Symmetrical behavior
Fitting and Modeling

Fitting using a modified *ridge estimator*, where bias is toward smoothness.
Superimposed Only vs. Fitting and Modeling
Final Results

PDR(LOS) = 0.92

PDR(LOS) = 0.98

PDR(LOS) = 0.95
Room for Improvement

Repeater at intersections with high accident probability

More reliable communication with MIMO techniques
Thank you!