INSTITUTE FOR RESEARCH IN APPLICABLE COMPUTING

A New Approach to Solve Angular Dispersion of Discrete Ray Launching for Urban Scenarios

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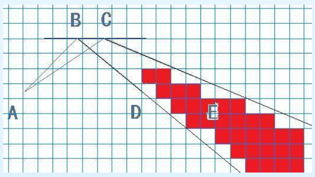
INTRODUCTION

Ray launching suffers from angular dispersion.

Distant pixels are often missed when rays disperse.

A fast discrete ray launching model is developed to validate the use of this approach.

It has enabled the practical use of this model in other scenarios (indoor, indoor-to-outdoor)



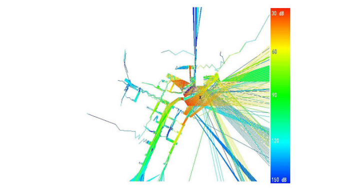


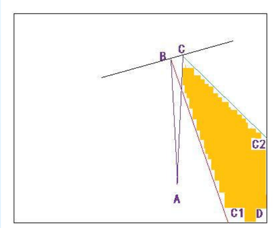
Fig. 3. scenario Vigo; angular dispersion problem; three reflections and two diffractions

OBJECTIVES

- To solve angular dispersion of discrete ray launching
- To improve the accuracy of ray launching propagation models
- To speed up ray launching
- To extend the principle to indoor, indoor-to-outdoor propagation prediction

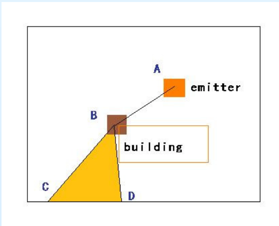
SOLUTIONS

- Fill the gap between reflection rays
- Fill the gap between diffraction rays
- Avoid double marking the same pixels



Algorithm 1 avoid pixels missing (reflection)

$v_1 \leftarrow$ Reflection Ray 1 (C-A)
$v_2 \leftarrow$ Reflection Ray 2 (C-B)
$c_1 \leftarrow$ Boundary Cube that v_1 hits
$c_2 \leftarrow$ Boundary Cube that v_2 hits
for all $C \in$ Cubes between c_1 and c_2 **do**
  Launch Reflection Rays from A(or B) to C
end for



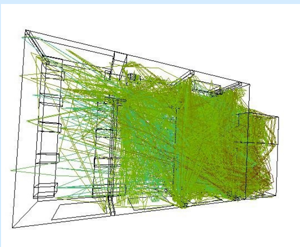
Algorithm 2 avoid double marking

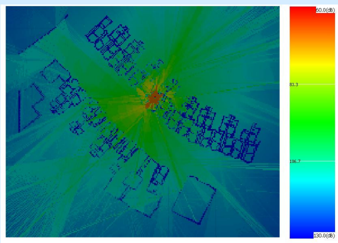
$M_r \leftarrow$ 3D counter matrix for reflection
$M_d \leftarrow$ 3D counter matrix for diffraction
$C_r \leftarrow$ Initial reflection counter
$C_d \leftarrow$ Initial diffraction counter
Inc(C_r) if reflection shadow area is being handled.
Inc(C_d) if diffraction shadow area is being handled.
if M_r[current cube] $\neq C_r$ **then**
  handle_reflection(current cube)
  M_r[current cube] $\leftarrow C_r$
  collect current cube for next reflection
end if
if M_d[current cube] $\neq C_d$ **then**
  handle_diffraction(current cube)
  M_d[current cube] $\leftarrow C_d$
  collect current cube for next diffraction
end if

RESULTS

- A fast and accurate discrete ray launching model for outdoor, indoor and indoor-to-outdoor has been developed.
- Significant speedup through parallelism via POP-C++

APPLICATIONS





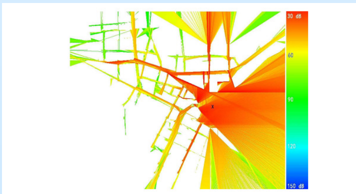
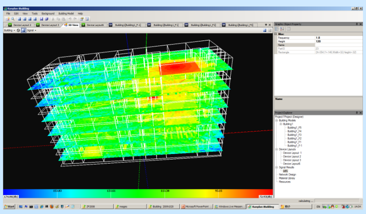


Fig. 8. scenario Vigo; angular dispersion problem solved; rays propagate further

TABLE I
NETWORK CONFIGURATIONS FOR BOTH RUNS

Area	8.1 km^2 (2.4km X 3.4km X 100m)
Buildings	2088
Antenna Type	Omni
Emitter Frequency	GSM 947MHz
Resolution	5 X 5 X 5
Maximum Reflection	3
Maximum Horizontal Diffraction	7
Maximum Vertical Diffraction	**Unlimited** *
Maximum Transmission	**Unlimited** *

* until signal strength is under threshold



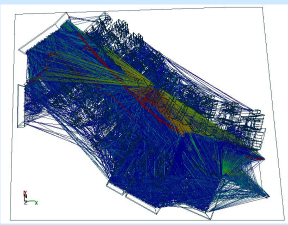


Fig. 9. Munich, multi-paths at LOS receiver

TABLE II
COMPARISONS FOR BOTH RUNS

	With	Without
Total Reflections	121, 170	89, 902
Total Diffractions	157, 201	101, 356
Total Multi-paths	122, 722	93, 521
Avg STD for 3 routes	7.11	7.81
Avg RMSE for 3 routes	7.02	7.69
Avg running time (s)	49	22

References

[1] Z. Lai, N. Bessis, G. de la Roche, H. Song, J. Zhang and G. Clapworthy, An intelligent ray launching for urban coverage prediction, 3rd European Conference on Antennas and Propagation EUCAP 2009, Berlin, Germany, 23-27 March 2009, pp. 2867-2871.

[2] G. de la Roche, J. Gorce and J. Zhang, Optimized implementation of the 3-D MR-FDPF method for Indoor radio propagation predictions, 3rd European Conference on Antennas and Propagation EUCAP 2009, Berlin, Germany, 23-27 March 2009, pp. 2241-2245.

[3] Z. Lai, N. Bessis, P. Kunoen, G. de la Roche, J. Zhang and G. Glapworthy, A performance evaluation of a grid-enabled object-oriented parallel outdoor ray launching for wireless network coverage prediction, The Fifth International Conference On Wireless and Mobile Communications ICWMC 2009, Cannes/La Bocca, France, 23-28 August 2009, pp. 38-43

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