Multifunctional Intelligent Autonomous Parking Controller for Carlike Mobile Robots

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Outline

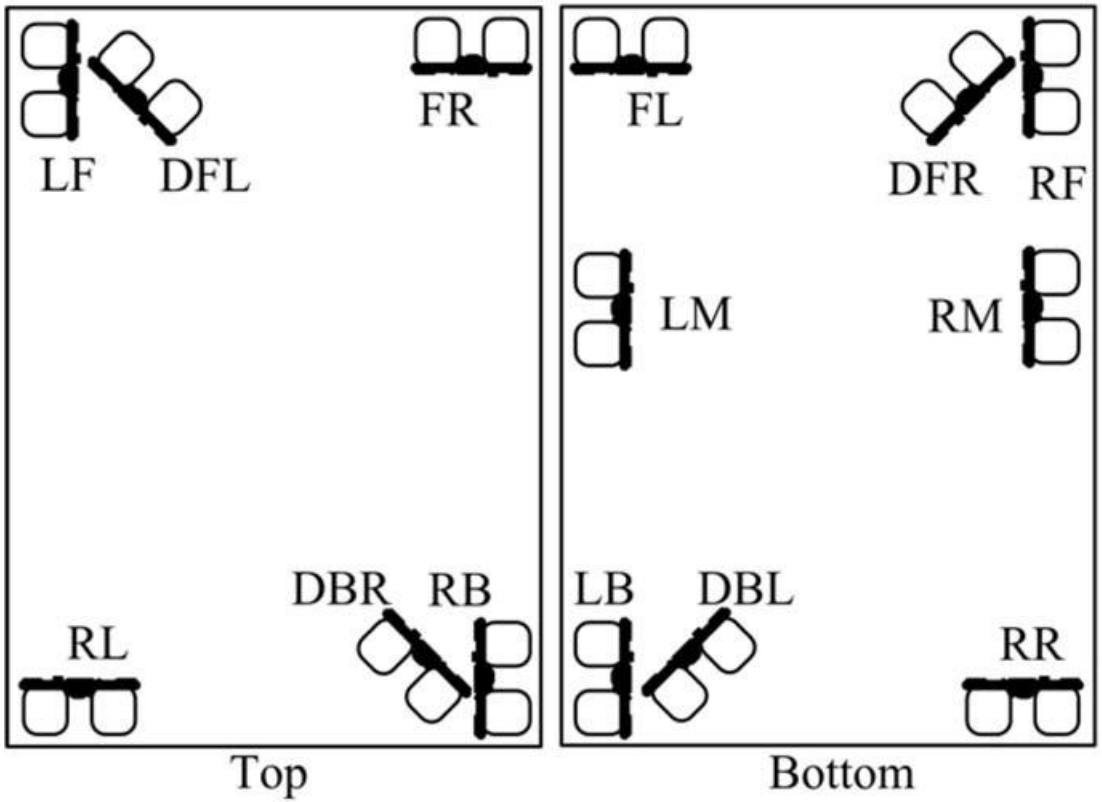
- Introduction
- Ultrasonic Sensors
- Behavior Modes
  - Fuzzy Parallel-Parking Mode
  - Fuzzy Garage-Parking Mode
- Architecture
- Experimental Results
- Conclusion
- References

Introduction

- Designed for Carlike Mobile Robot (CLMR)
- Autonomous Parking and Obstacle Avoidance
- Array of ultrasonic sensors

Ultrasonic Sensors

- Arrangement



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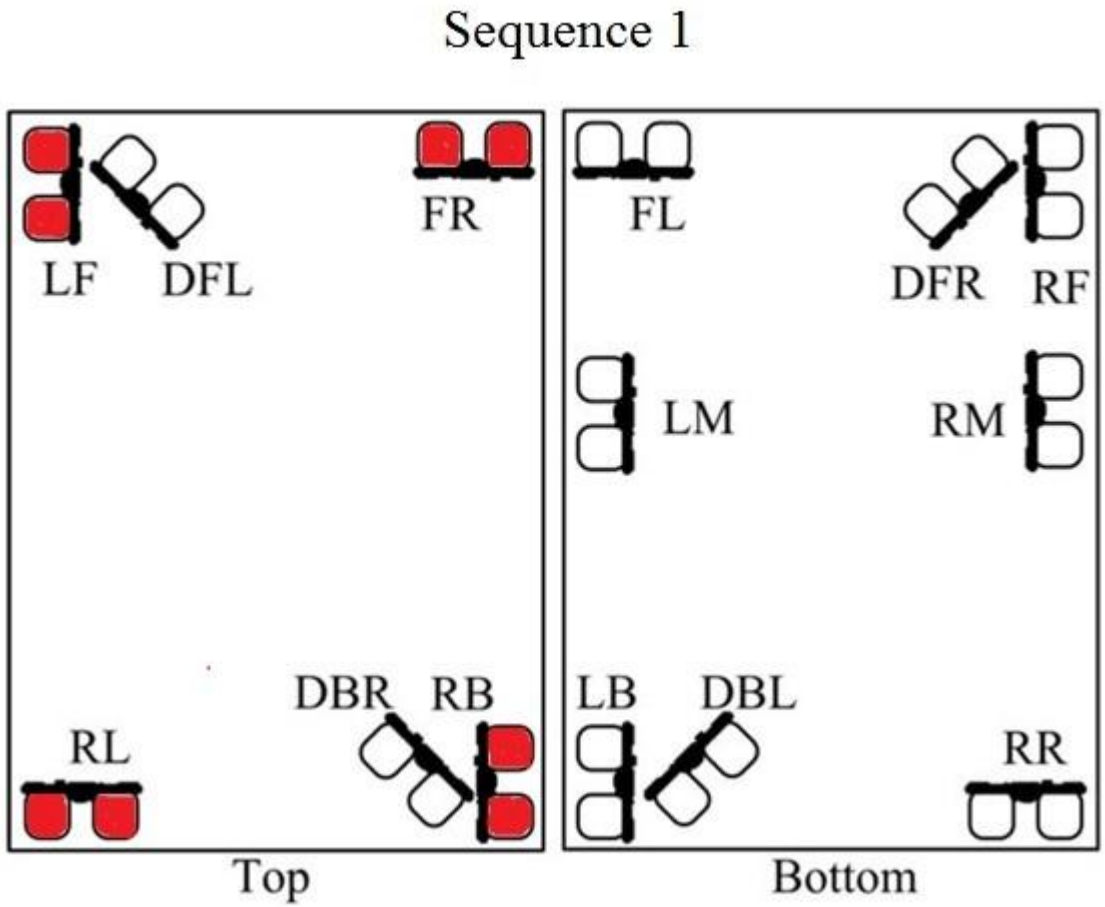
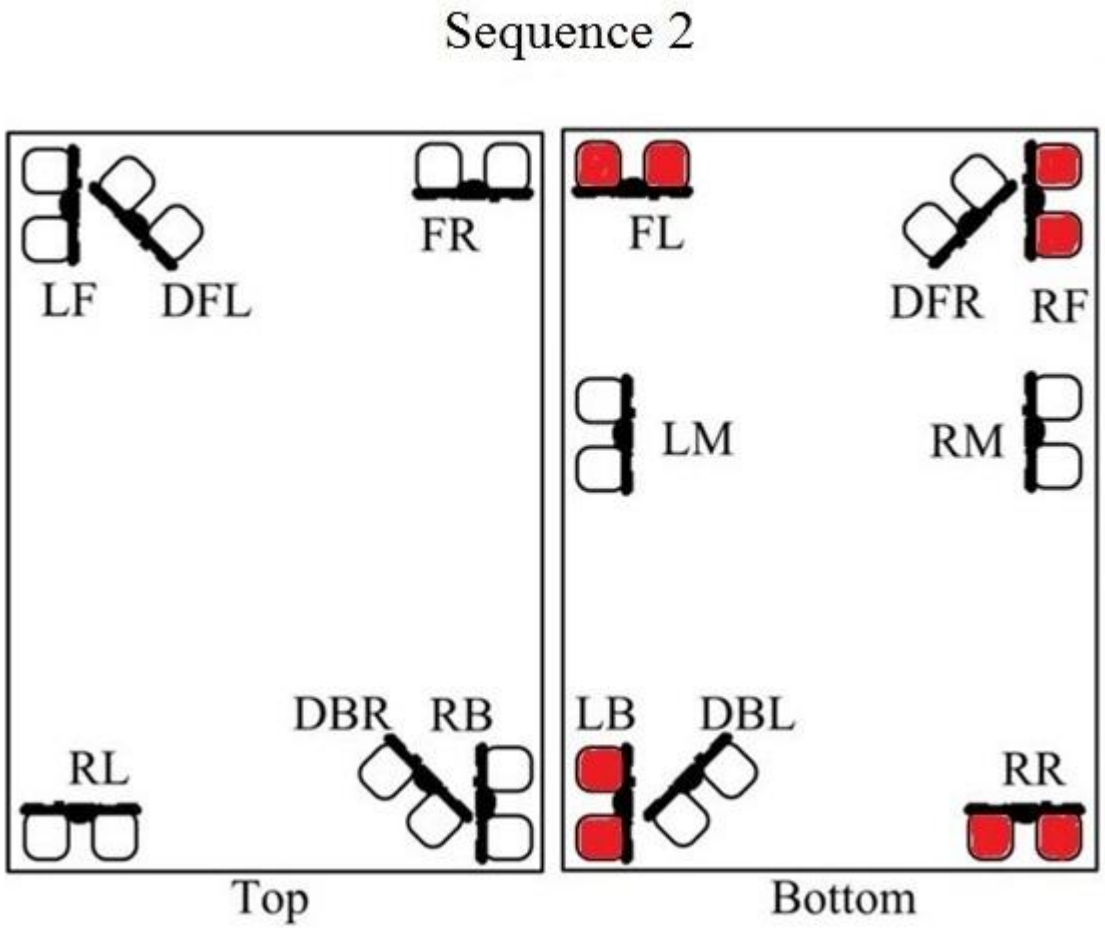
Ultrasonic Sensors

- Firing Sequence



Ultrasonic Sensors

- Firing Sequence



Ultrasonic Sensors

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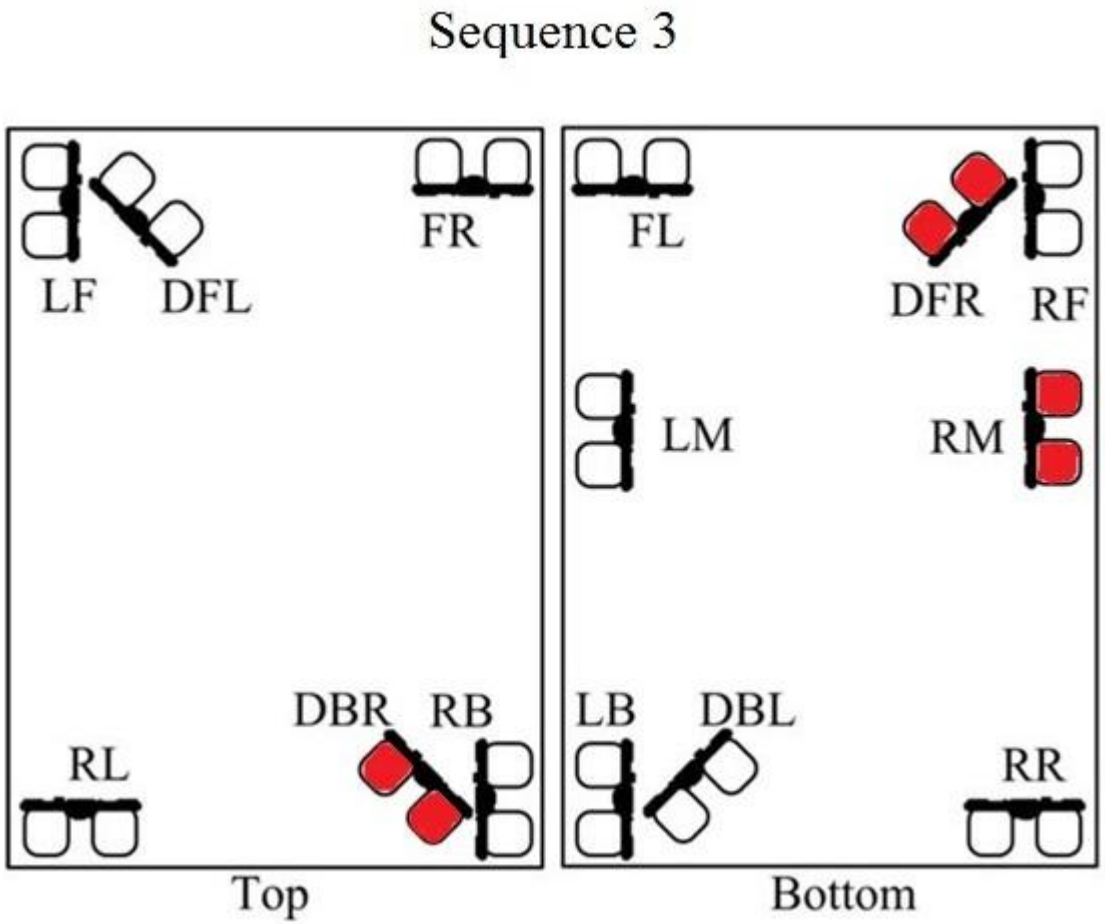
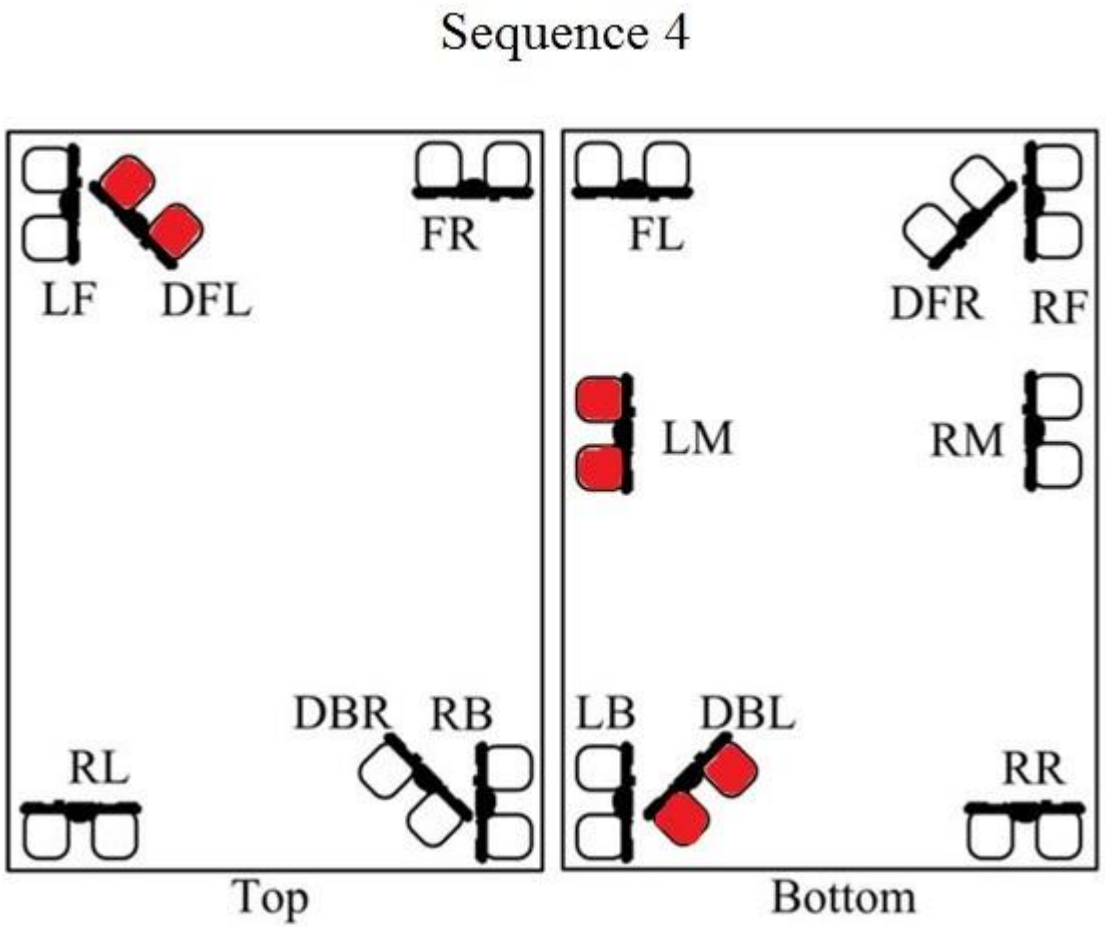


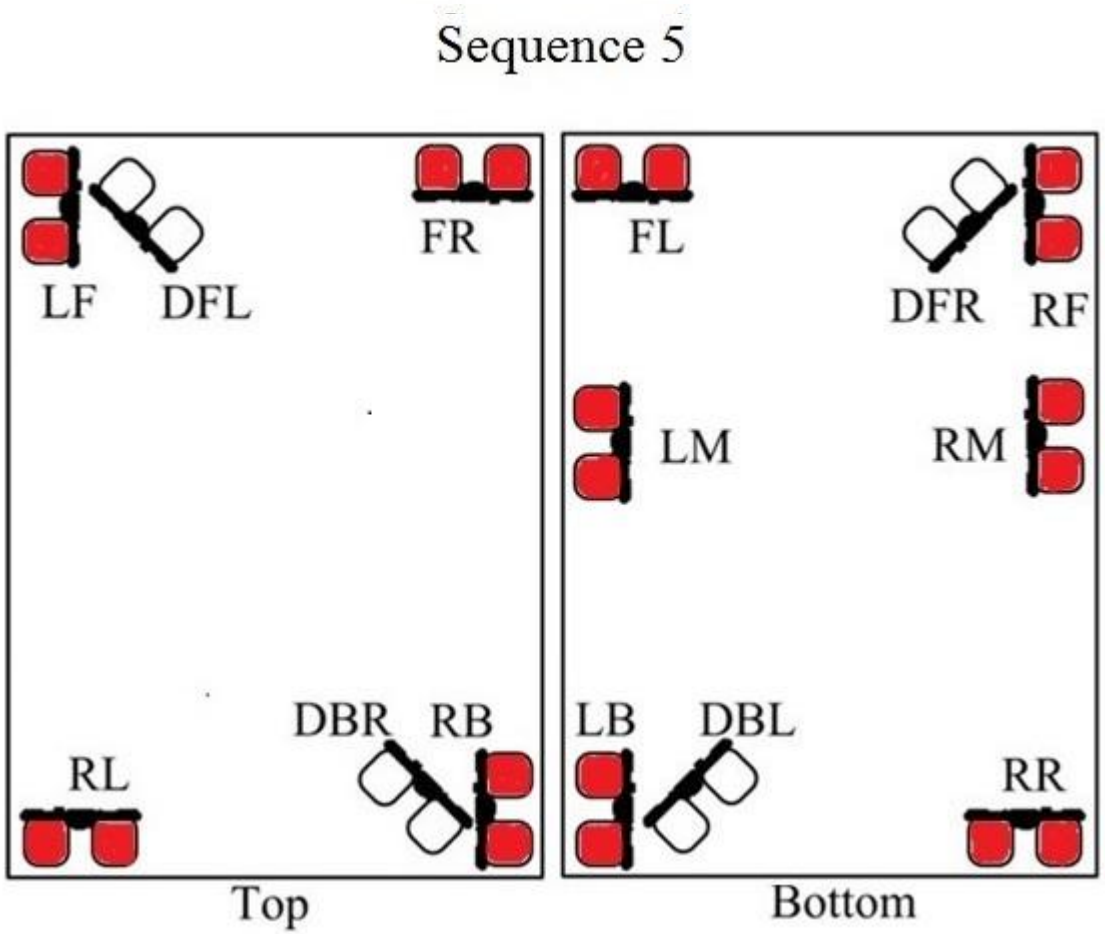
Ultrasonic Sensors

- Firing Sequence



Ultrasonic Sensors

- Firing Sequence



Determination of Reflector Position

$x = A\cos(\alpha)\cos(\phi) - B\sin(\alpha)\sin(\phi) + x_{tr}$

$y = A\cos(\alpha)\sin(\phi) + B\sin(\alpha)\cos(\phi) + y_{tr}.$

Where,

$\phi = \arctan((y_r - y_t)/(x_r - xt_)),$

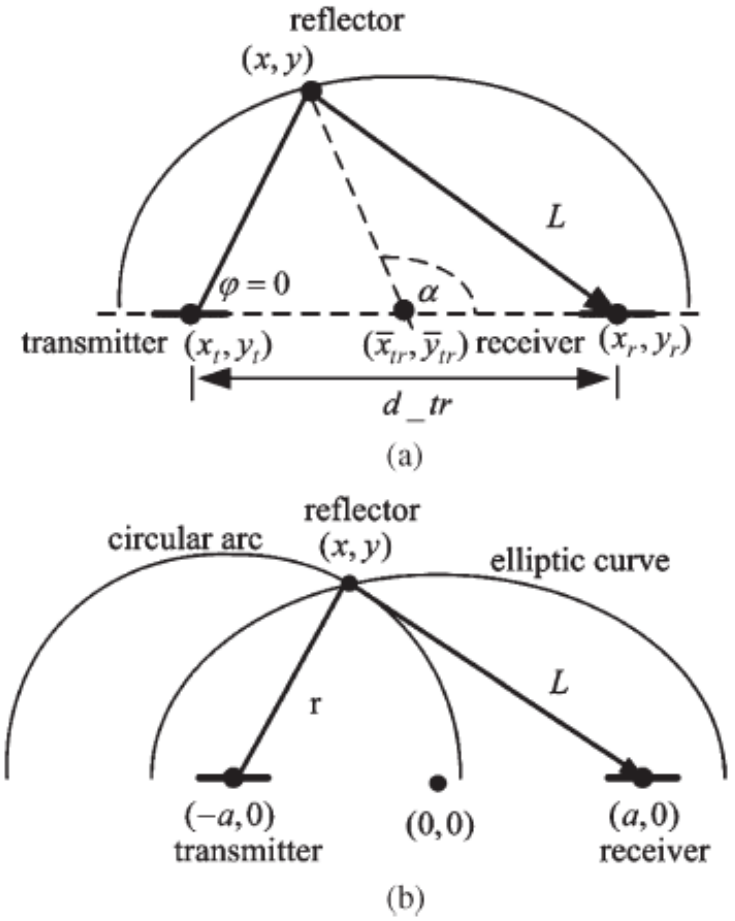
$A = L/2,$

$B = ((L^2 - d^2{}_{tr})/2)^{1/2},$

$d\_tr = ((x_r - x_t)2 + (y_r - y_t)2)^{1/2}$

$x_{tr} = (x_r + xt_)/2$

$y_{tr.} = (y_r - y_t)/2$



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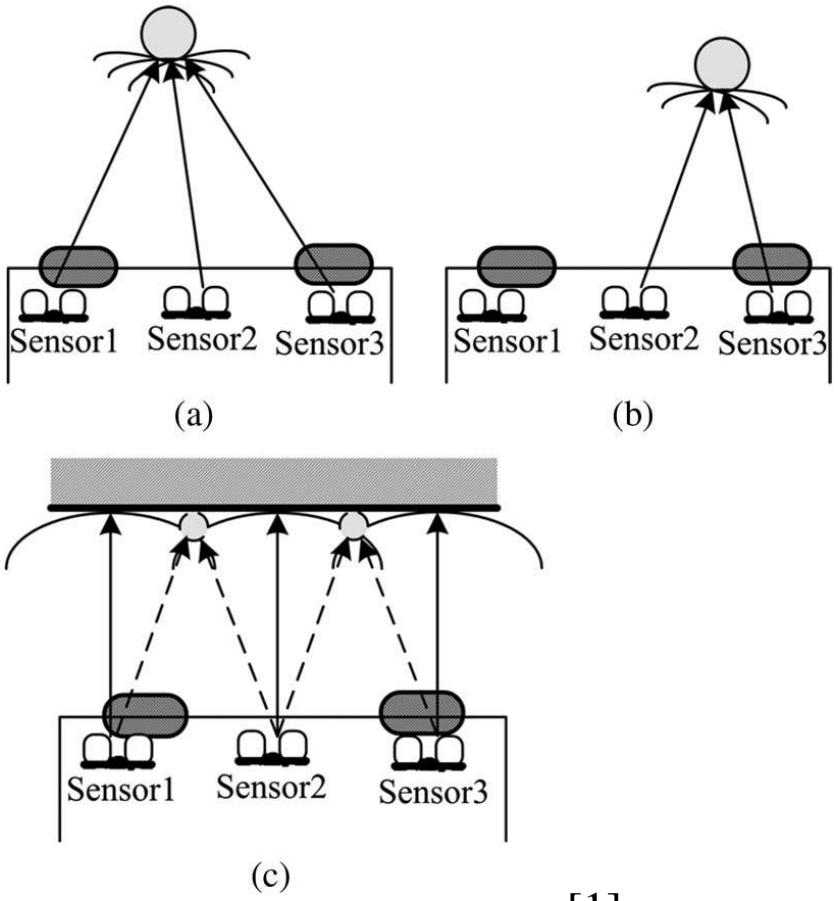
Determination of Types of Reflectors

1. Multichannel Method



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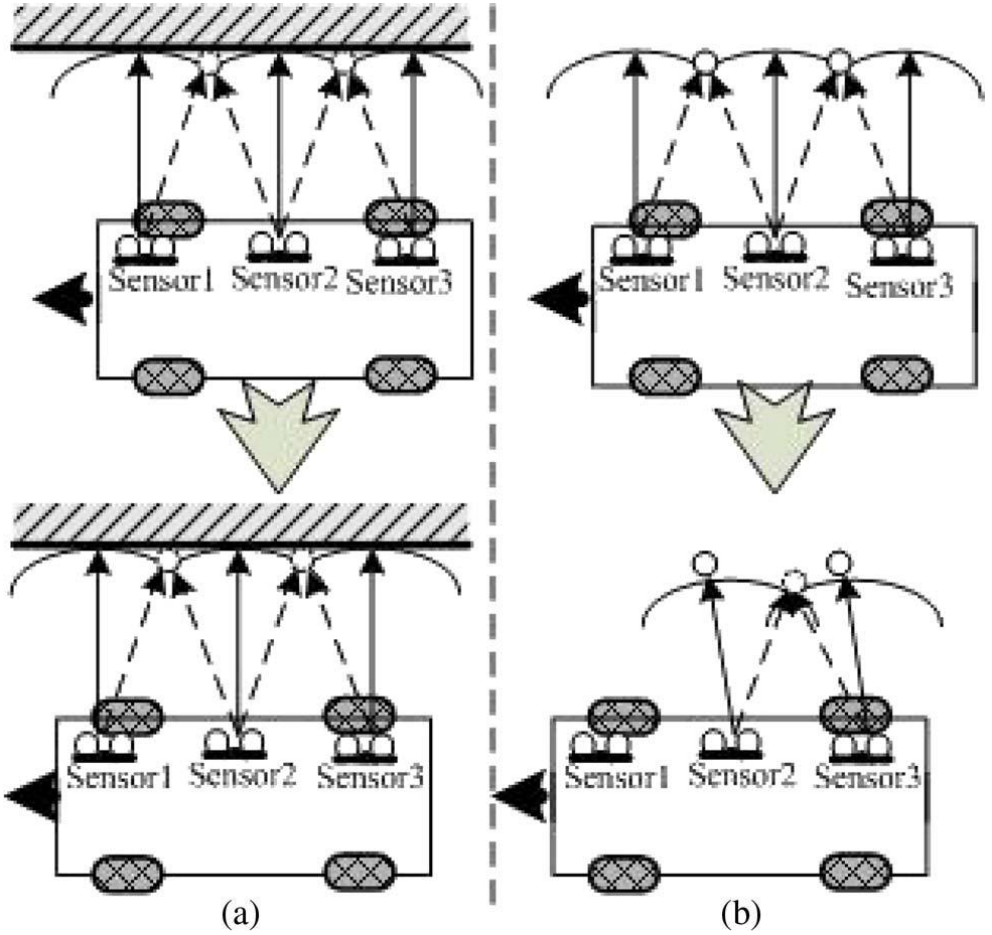
Determination of Types of Reflectors

2. Displacing Position Method



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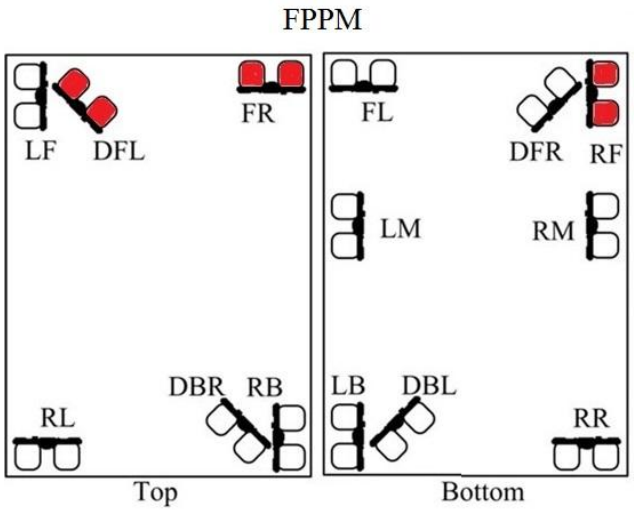
Behavior Modes of CMLR

- Fuzzy Parallel Parking Mode

  - Basic Constraints:
    $(1.2W < d\_rf < 1.5W)$
    $(1.35L < d\_f < 1.75L)$
    $(1.6L < d\_df\ l < 2.2L)$



Where,

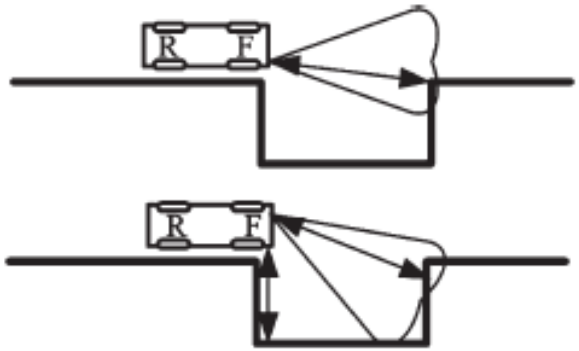
W → Width of CLMR

L → Length of CLMR

d_rf → Distance detected by RF

d_f → Distance detected by FR

d_dfl → Distance detected by DFL



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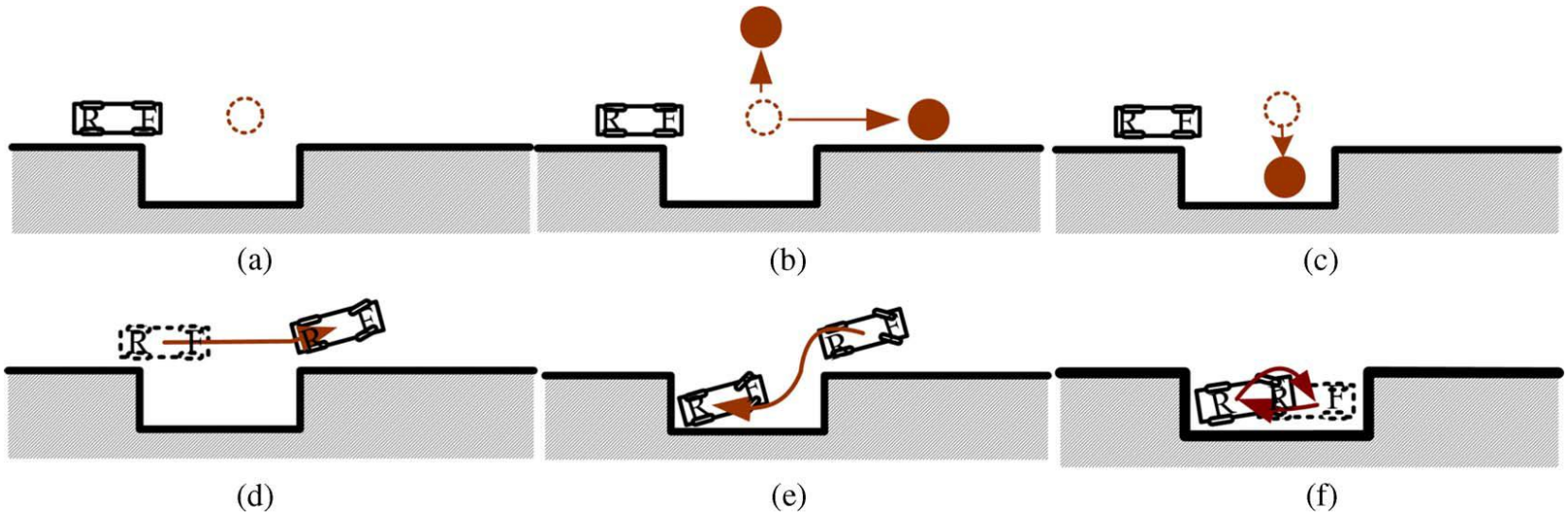
Fuzzy Parallel Parking Mode



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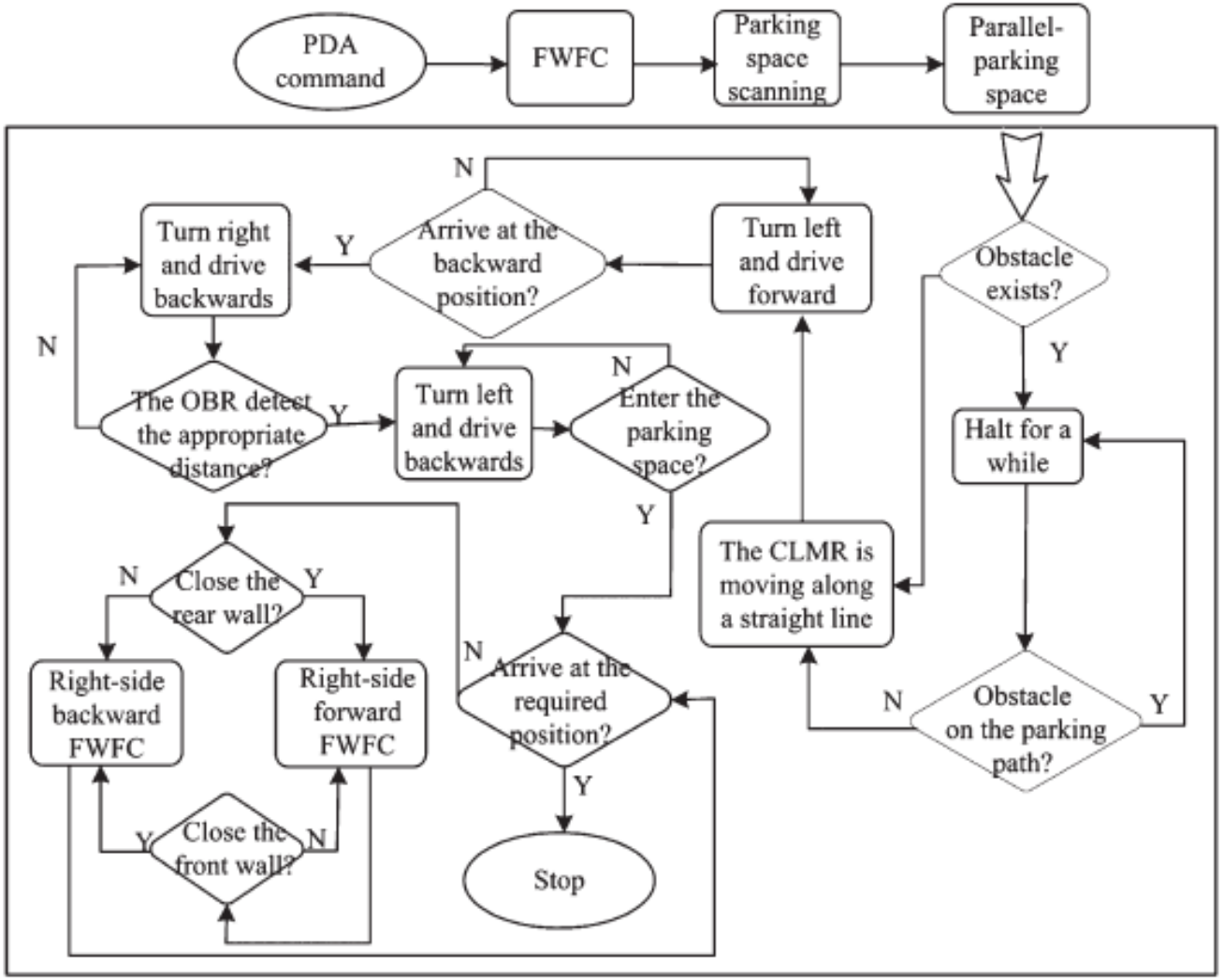
Fuzzy Parallel Parking Mode



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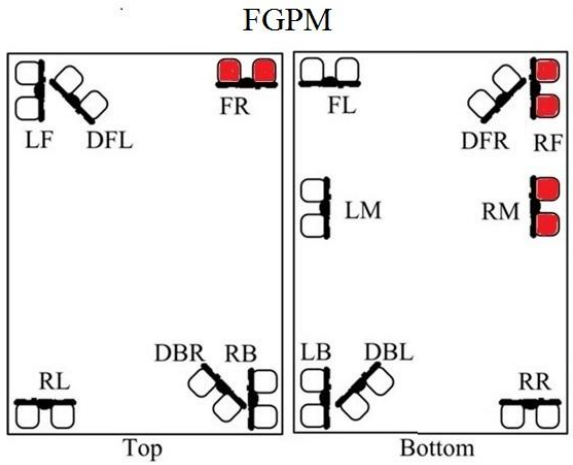
Behavior Modes of CMLR

- Fuzzy Garage Parking Mode
  - Basic Constraints

$(1.4L < d\_rf < 1.8L)$

$(1.8W < d\_f < 2.4W)$

$(1.4L < d\_rm < 1.8L)$



Where,

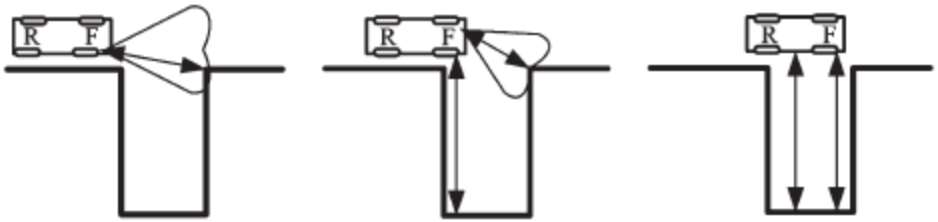
W → Width of CLMR

L → Length of CLMR

d_rf → Distance detected by RF

d_f → Distance detected by FR

d_dfl → Distance detected by DFL



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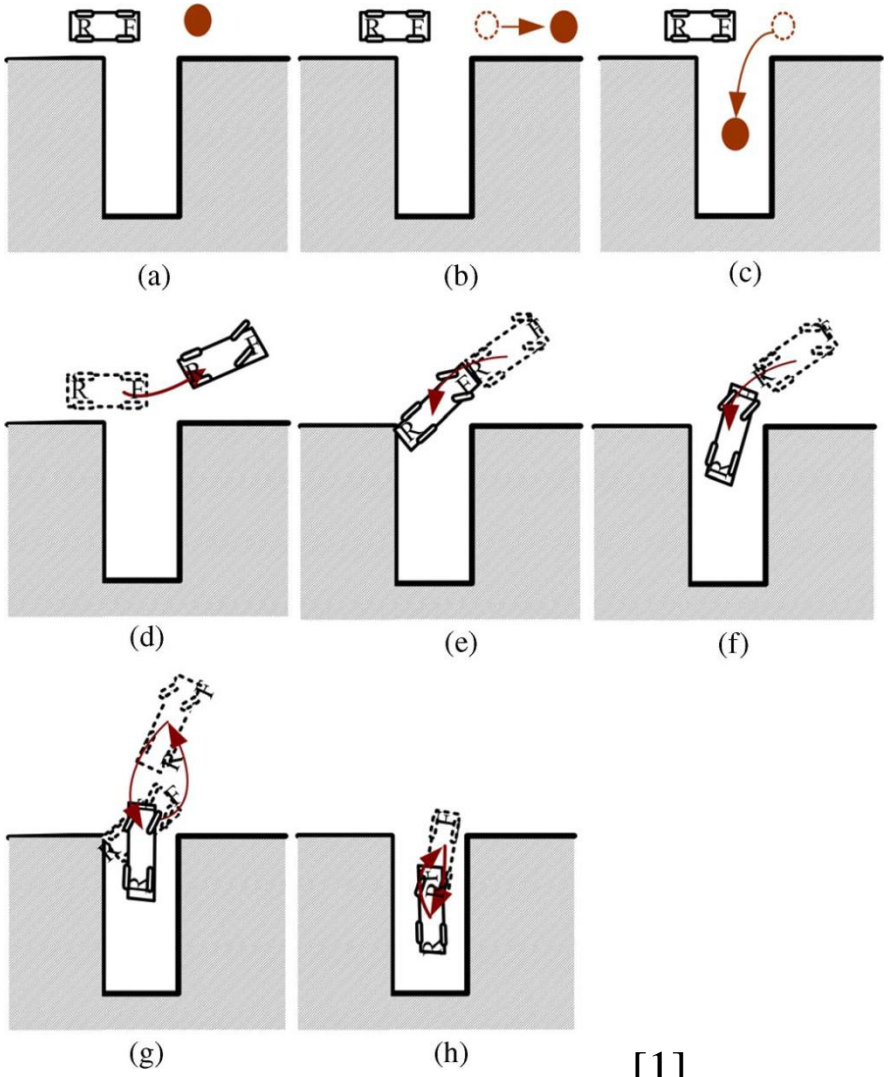
Fuzzy Garage Parking Mode



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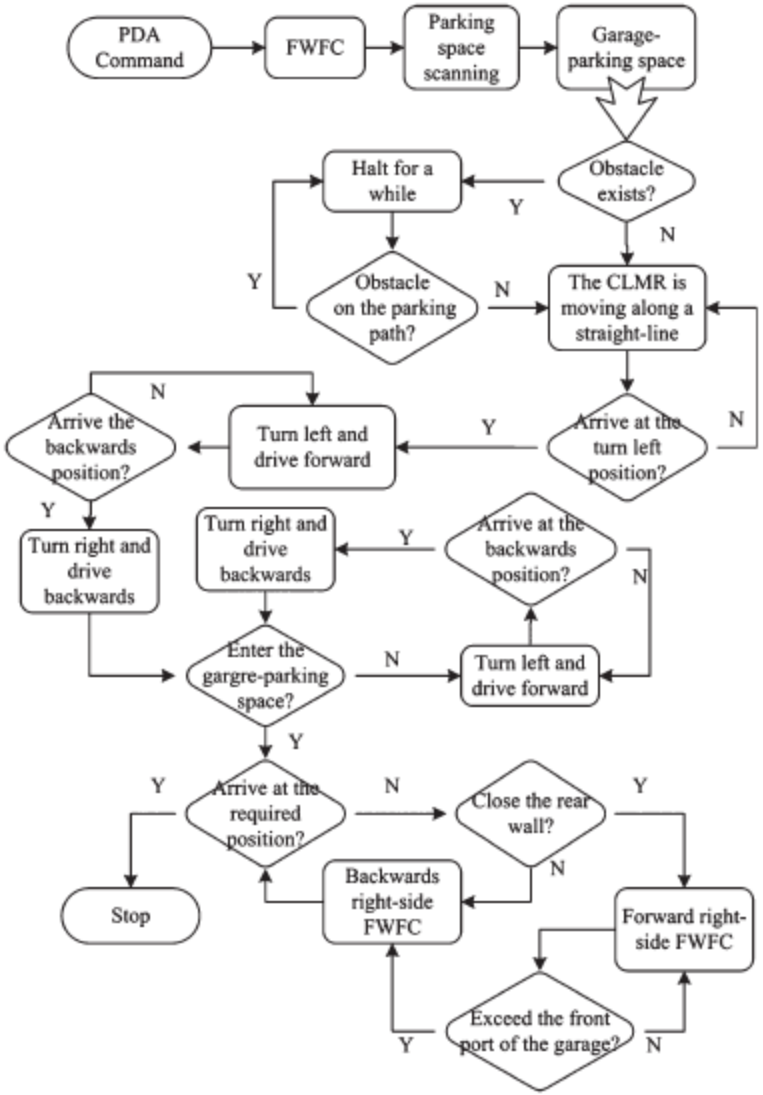
Fuzzy Garage Parking Mode



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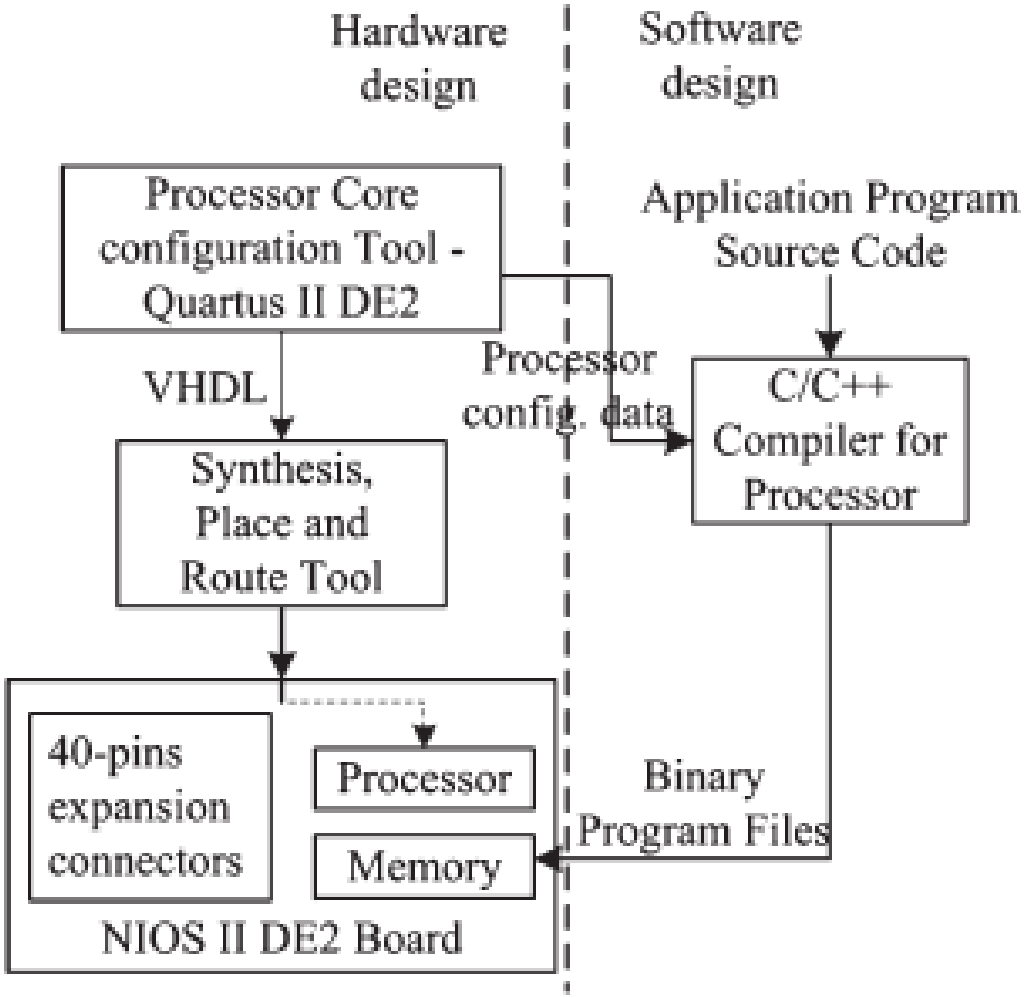
NIOS Embedded System



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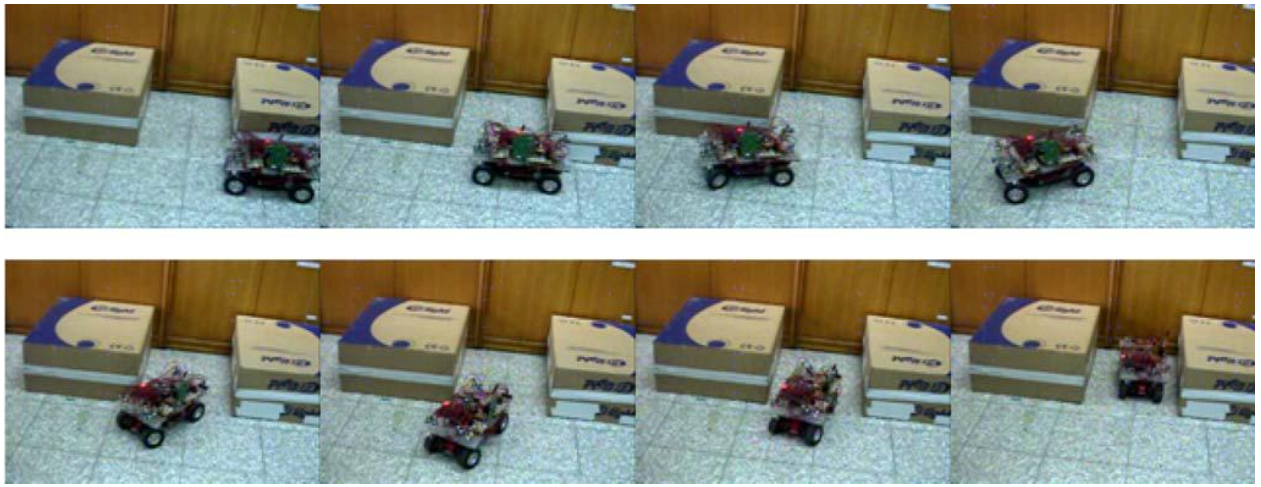
Experimental Results

1. FPPM

2. FGPM



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Conclusion

- Multifunctional intelligent autonomous parking controllers of CLMR implemented using NIOS-embedded systems
- Autonomous parking controller capable of effectively parking CLMR in parking space has been developed
- It can recognize parking space and obstacle's position to ensure safe autonomous parking

References

1. Tzuu-Hseng S. Li, Ying-Chieh Yeh, Jyun-Da Wu, Ming-Ying Hsiao, and Chih-Yang Chen, "Multifunctional Intelligent Autonomous Parking Controllers for Carlike Mobile Robots", Industrial Electronics, IEEE Transactions on Volume: 57 , Issue: 5