

100

Fig. 1a

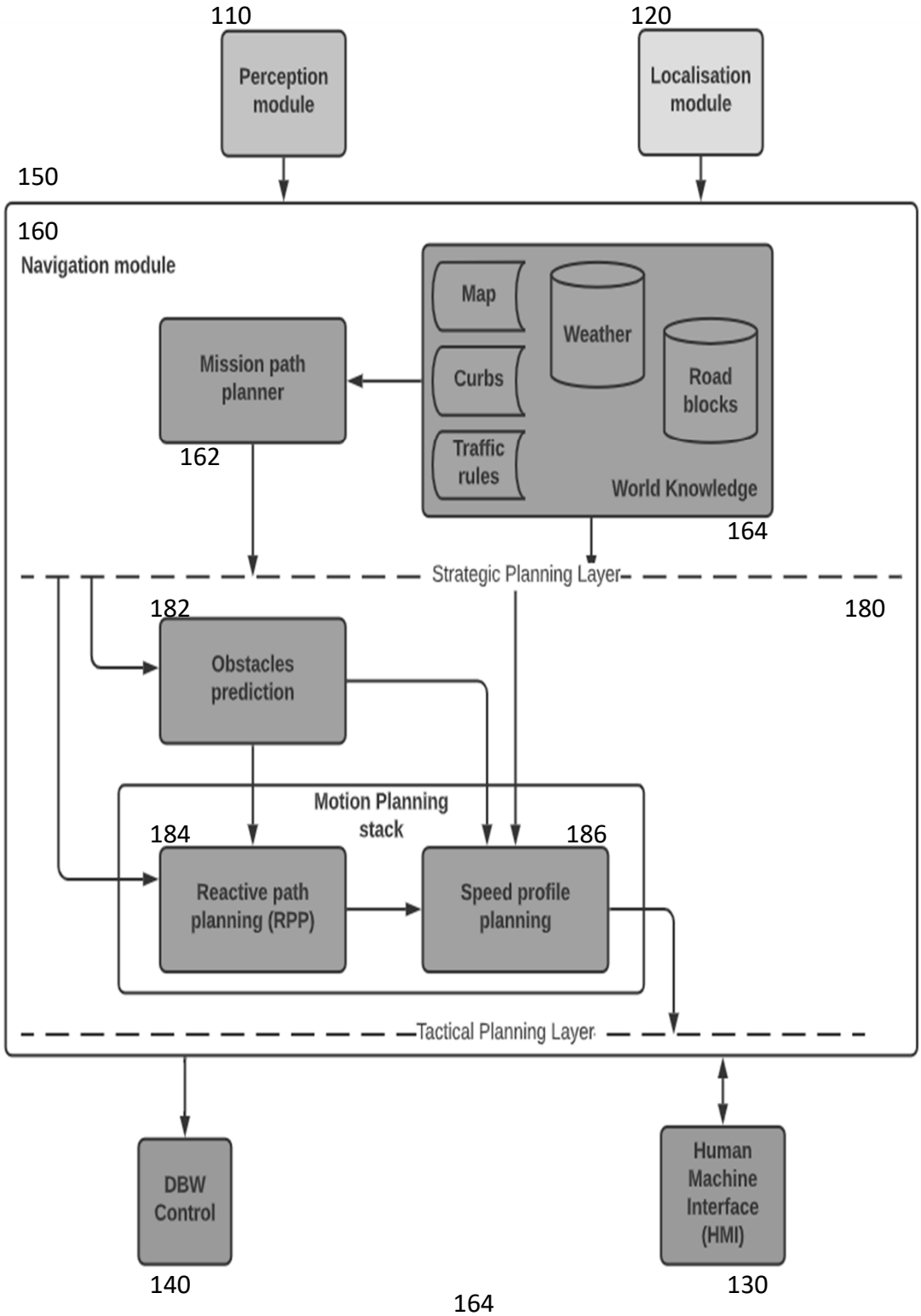

110
Perception module
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Localisation module
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Navigation module
Map
Weather
Road blocks
Curbs
Traffic rules
World Knowledge
Mission path planner
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Strategic Planning Layer
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Motion Planning stack
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Reactive path planning (RPP)
Speed profile planning
Tactical Planning Layer
DBW Control
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Human Machine Interface (HMI)
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101

Fig. 1b

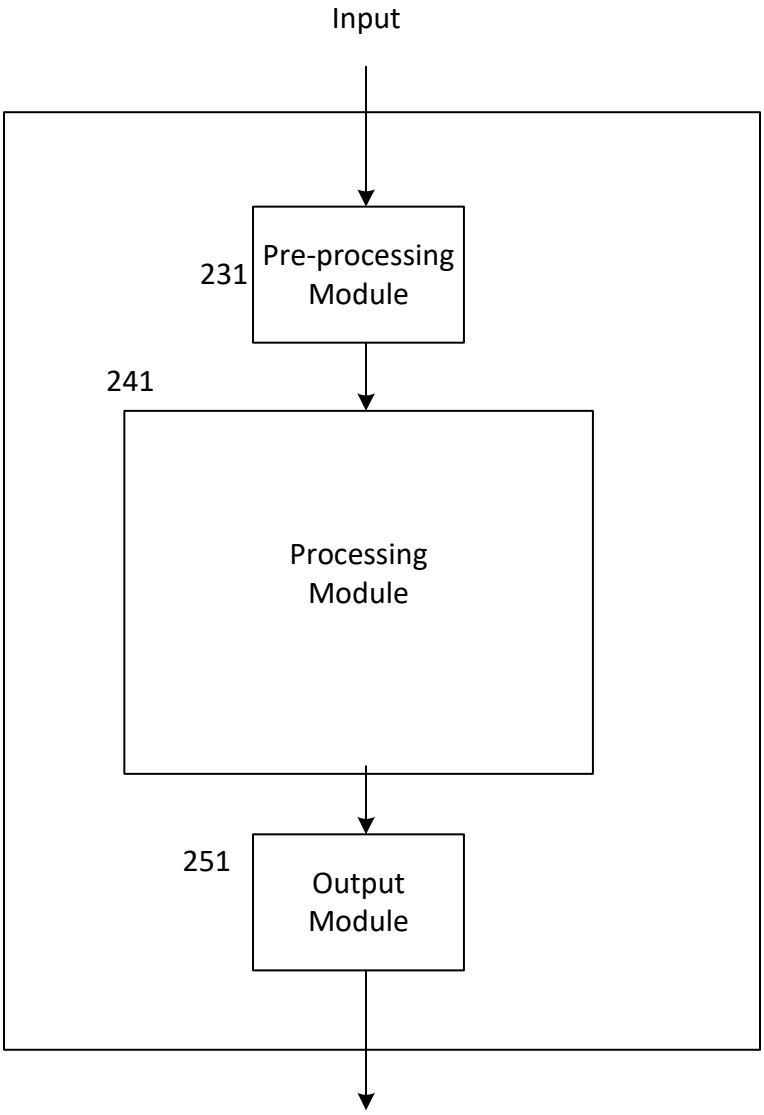
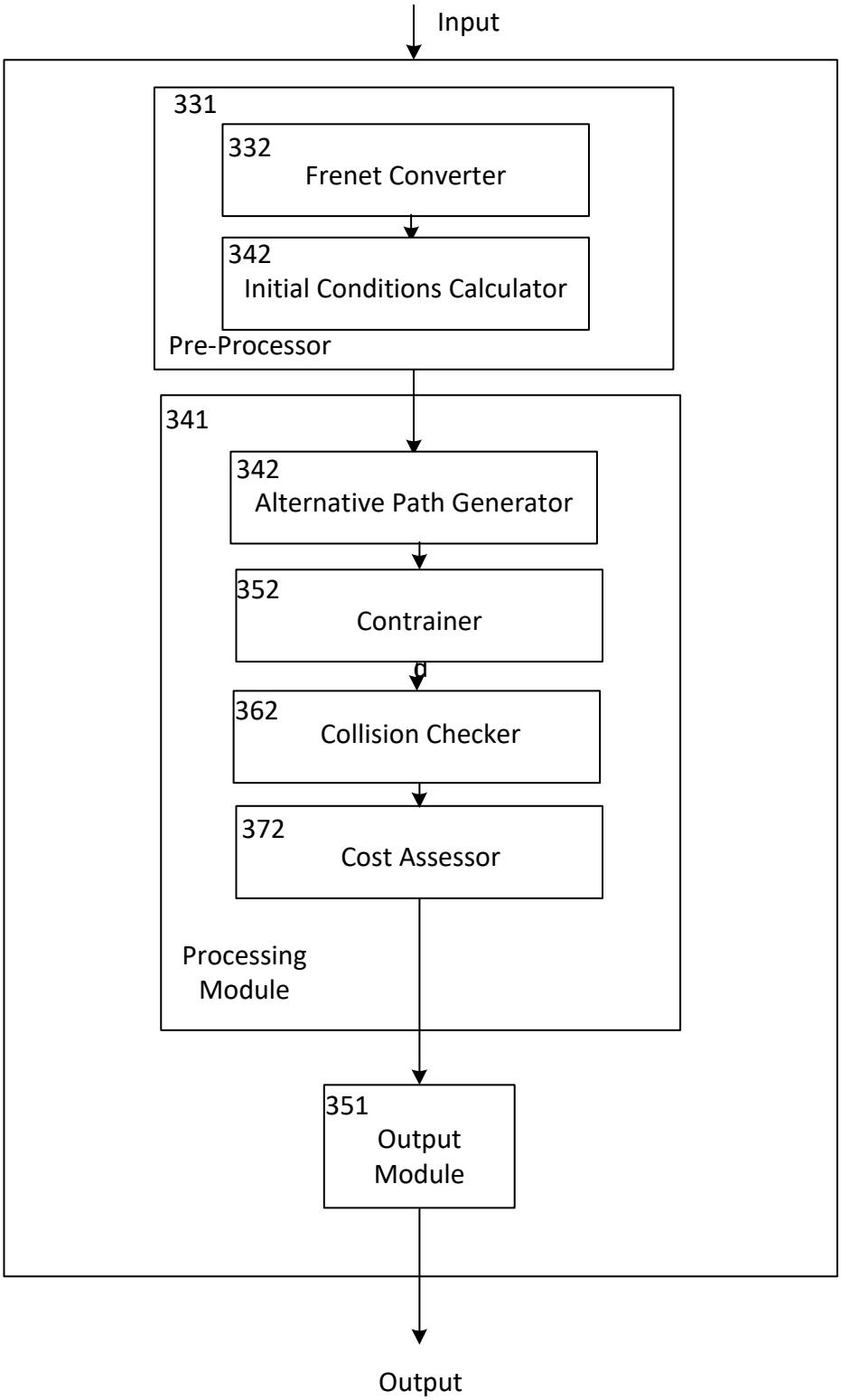

Input
231
Pre-processing Module
241
Processing Module
251
Output Module
220

Fig. 2


Input
331
332
Frenet Converter
342
Initial Conditions Calculator
Pre-Processor
341
342
Alternative Path Generator
352
Contrainer
362
Collision Checker
372
Cost Assessor
Processing Module
351
Output Module
Output

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Fig. 3

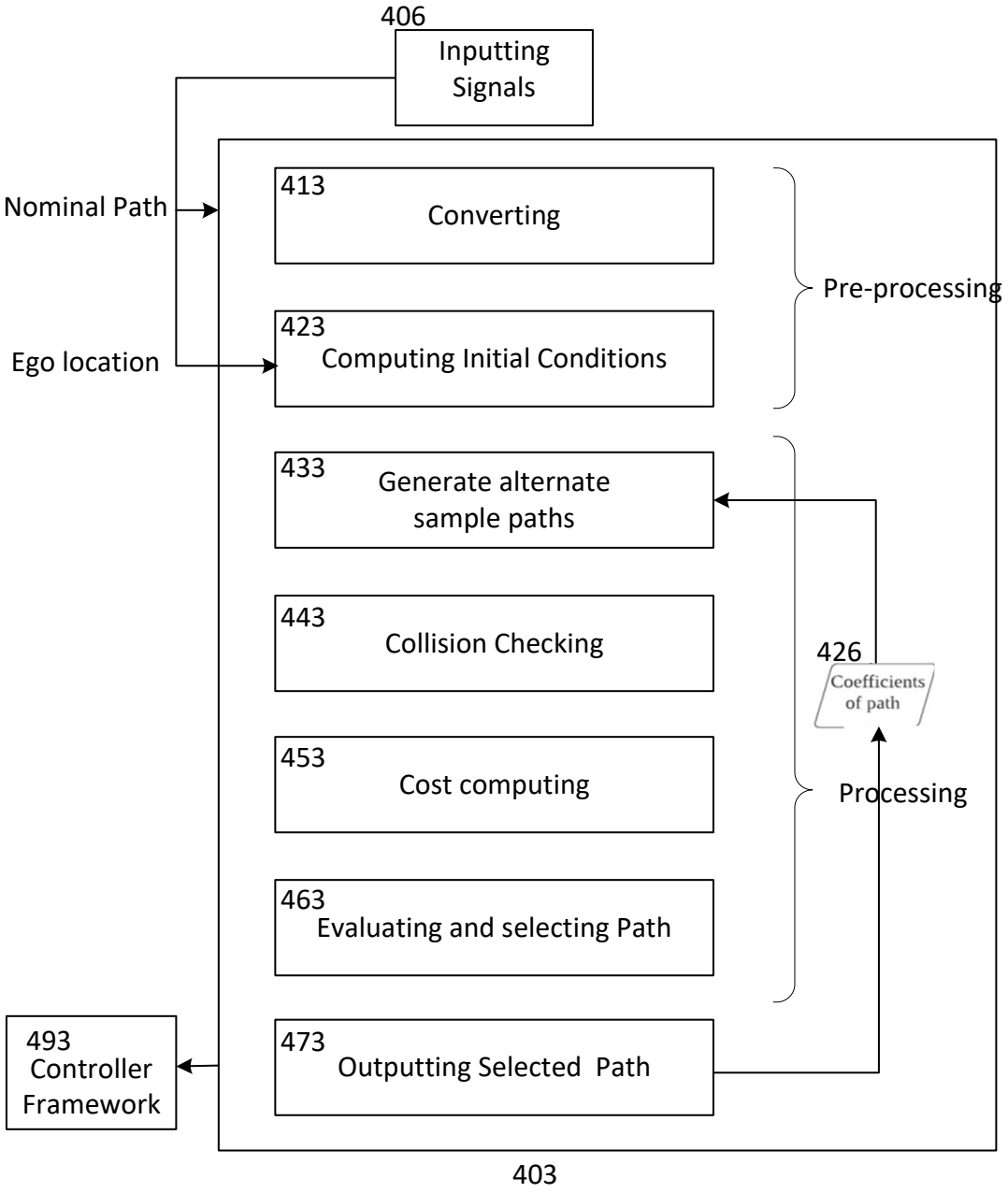

406
Inputting Signals
Nominal Path
Ego location
413
Converting
423
Computing Initial Conditions
Pre-processing
433
Generate alternate sample paths
443
Collision Checking
426
Coefficients of path
453
Cost computing
Processing
463
Evaluating and selecting Path
493
Controller Framework
473
Outputting Selected Path
403

Fig. 4

Input
$\mathrm{P}(s, d_f = 0)$ Nominal path
v_{ego} Velocity of ego vehicle
} 510

Output
$\mathrm{P}_{\mathrm{opt}}$ Optimal path
} 520

Compute initial conditions $s = s_0$
for $d_{lat} = (-N, \ldots, -1, 0, 1, \ldots, N)$ **do**
  Generate frenet sub path $\mathrm{P}(s, d_f = d_{lat})$
  Compute longitudinal goal $\mathrm{P}(s = s_{min}, d_f = d_{lat})$
  Find coefficients $a_0, a_1, a_2, a_3, a_4, a_5$
  for $s_i = s_0, \ldots, s_f$ **do**
    Find (x, y) for $\mathrm{P}(s = s_i, d_f = d_{lat})$
    Check for collision at (x, y)
    if collision **then**
      break
    end if
  end for
  Compute $C(\mathrm{P}(s, d_f = d_{lat})) = \lambda_1 C_1 + \ldots$
  if $C_{th} < C_{min}$ **then**
    $\mathrm{P}_{\mathrm{opt}} = \mathrm{P}(s = s_i, d_f = d_{lat})$
    $C_{min} = C$
  end if
end for
return $\mathrm{P}_{\mathrm{opt}}$
} 530

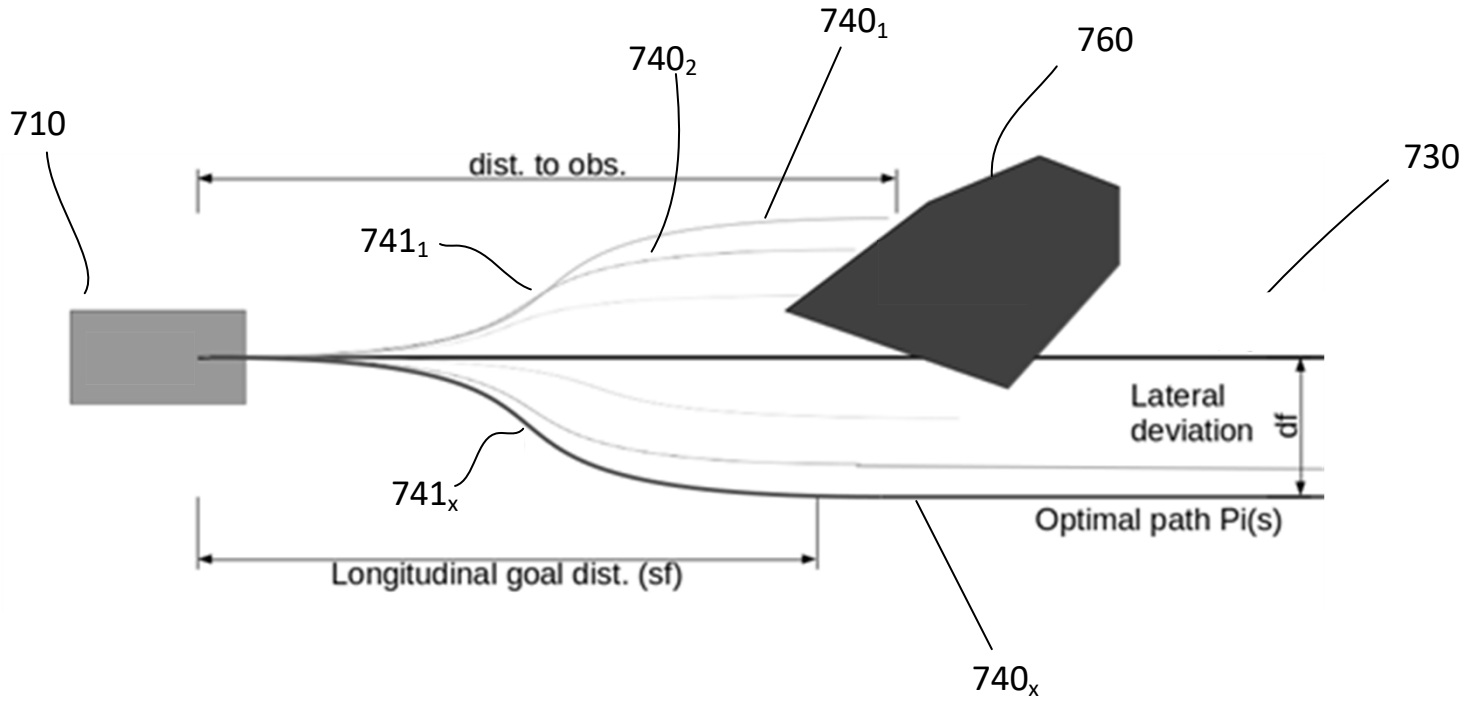
500

Fig. 5

Method	Samples Generated	Time (ms)	Time Per Sample (ms)
RPP	80	20	0.25
SAA	165	5870	35
OPA	100	66	0.66

600

Fig. 6


740_1
740_2
760
710
730
dist. to obs.
741_1
Lateral
deviation
df
741_x
Optimal path Pi(s)
Longitudinal goal dist. (sf)
740_x

700

Fig. 7a

Weight	Description	Value
W1	Mean curvature	35.5
W2	Maximum curvature	15
W3	Sigmoid (distance to obstacle)	1750
W4	Lateral distance to previous optimum path	15
W5	Time travelling along the path	50
W6	Lateral acceleration, ego speed	50
W7	Lateral distance to nominal path	50

700

Fig. 7b