Mediator Scenario Setting

# Main Observations

driver\_seg = np.hstack((distraction\_level, fatigue\_level))

auto\_seg = np.hstack((auto\_level,level\_max))

tt\_seg = np.hstack((TTDF,TTDU,TTDD,TTA2F,TTA3F,TTA4F,TTA2U,TTA3U,TTA4U))

context\_seg = np.hstack((ndrt\_type, event\_type, sensor\_failure))

hmi\_seg = np.hstack((driver\_request, driver\_response,last\_action))

# Simulation Assumptions

* TTDF is determined by NDRT and fatigue level
* TTDU is determined by distraction and fatigue level
* NDRT is detected for L3/L4 and distraction is detected for L0/L2
* Critical scenario is controlled by AEB, and decision logic can ignore this

# Driver unfit due to distraction

Important states

* Distraction
* TTDU: TTDU<10
* TTAF: TTAF<TTDU
* TTAU: TTAU>300

Issues

* How to simulate the distraction and related TTDU along a route?
* How to simulate level\_max

|  |  |
| --- | --- |
| **Signals** | **Simulation** |
| route | Distance: 1km + 2km = 3km  Distraction occurs at 1km  Decision Logic (DL) guides take over for the remaining 2km |
| vehicle\_speed | 100km/h (27.8m/s)  Constant Speed |
| total\_time | 108s |
| distraction\_level | len(distraction\_file) + 80 |
| fatigue\_level | None |
| auto\_level | L0 |
| level\_max | random.randint(L0, L4) |
| TTDF/TTDU/TTDD | TTDD = 9999  TTDF is undefined  TTDU is determined by distraction\_level |
| TTAF/TTAU | 0~1km: TTAF = 0, TTAU = 9999  1~3km: TTAF is undefined, TTAU = 0 |
| **leave\_odd** | **0,1** |
| ndrt\_type | None |
| uc\_event | None |
| sensor\_failure | False |
| driver\_request | False |
| driver\_response | 0,1,2-determined by action |
| last\_action | Default value “Doing Nothing”, determined by DL action |

## Transitions

L\_opt = level\_max

# Driver unfit due to fatigue in L0

Mediator determines to correct fatigue, shift to L4 or emergency stop when the driver becomes

unfit because of fatigue.

Important states

* Fatigue
* TTDU
* TTAF
* TTAU

Issues

* How to simulate the fatigue and related TTDU along a route?

|  |  |
| --- | --- |
| **Signals** | **Simulation** |
| route | Distance: 1km + 2km = 3km  Fatigue randomly occurs at 0~1km  Decision Logic (DL) guides take over for the remaining trips |
| vehicle\_speed | 100km/h (27.8m/s)  Constant Speed |
| total\_time | 108s |
| distraction\_level | None |
| fatigue\_level |  |
| auto\_level | L0 |
| level\_max |  |
| TTDF/TTDU/TTDD | TTDD = 9999  TTDF is undefined  TTDU is determined by distraction\_level |
| TTAF/TTAU | 0~1km: TTAF = 0, TTAU = 9999  1~3km: TTAF is undefined, TTAU = 0 |
| ndrt\_type | None |
| event\_type | None |
| sensor\_failure | None |
| driver\_request | None |
| driver\_response | Default value -1, determined by DL action |
| last\_action | Default value “Doing Nothing”, determined by DL action |

# Automation unfit

Automation becomes unfit due to **sensor failures or leaving ODD**. The scenario setting for sensor failures and leaving ODD are shown below.

## Unpredictable Automation Unfit-Sensor Failure

The scenario setting for automation unfit due to sensor failures is shown in the table below.

|  |  |
| --- | --- |
| **Signals** | **Simulation** |
| route | Distance: 1km + 2km = 3km  Sensor failure occurs at 1km  Decision Logic (DL) guides take over for the remaining 2km |
| vehicle\_speed | 100km/h (27.8m/s)  vehicle motion model: constant speed |
| total\_time | 108s |
| distraction\_level | distraction\_level = 0 (Not distracted) |
| fatigue\_level | This variable has an impact on takeover time  **If Fatigue= True:**  0~1km: fatigue\_level = random(0,4)  1~2km: fatigue\_level is determined by DL action (i.e., prepare driver)  2~3km: fatigue\_level = ‘alert’ (driver is ready)  **Else:**  0~3km: fatigue\_level = ‘alert’ |
| auto\_level | 0~1km: auto\_level = random (L3, L4)  1~2km: DL guides take over  2~3km: L0 |
| level\_max | 0~1km: level\_max = L4  1~3km: level\_max = L0 (due to sensor failures) |
| TTDF/TTDU/TTDD | TTDD = 9999  TTDF is determined by ndrt\_type and fatigue\_level  TTDU is undefined |
| TTAF/TTAU | 0~1km: TTAF = 0, TTAU = 9999  1~3km: TTAF is undefined, TTAU = 0 |
| ndrt\_type | This variable has an impact on takeover time  **If ndrt= True:**  0~1km: ndrt\_type = message/Watching video, etc.  1~2km: ndrt\_type is determined by DL action (e.g., prepare driver)  2~3km: ndrt\_type = 0 (driver is ready)  **Else:**  0~3km: ndrt\_type = 0 |
| event\_type | None |
| sensor\_failure | 0~1km: sensor\_failure = 0  1~3km: sensor\_failure = 1 |
| driver\_request | None |
| driver\_response | Default value -1, determined by DL action |
| last\_action | Default value “Doing Nothing”, determined by DL action |

## Predictable Automation Unfit-Leave ODD

The scenario setting for automation unfit due to out of ODD is shown in the table below.

|  |  |
| --- | --- |
| **Signals** | **Simulation** |
| route | Distance: 5km + 1km = 6km  Leave ODD occurs at 5km  Decision logic guides the take over to L0 before leaving ODD |
| vehicle\_speed | 100km/h (27.8m/s)  vehicle motion model: constant speed |
| total\_time | 216s |
| distraction\_level | distraction\_level = 0 (Not distracted) |
| fatigue\_level | **If Fatigue= True:**  This variable has an impact on takeover time  0~4km: fatigue\_level = ‘sleepy’  4~5km: fatigue\_level is determined by DL action (Prepare driver)  5~6km: fatigue\_level = ‘alert’ (driver takes over)  **Else:**  0~6km: fatigue\_level = ‘alert’ |
| auto\_level | 0~4km: auto\_level = **random (L3, L4)**  4~5km: DL guides take over to L0  5~6km: L0 |
| level\_max | 0~5km: level\_max = L4  5~6km: level\_max = L0 (leave ODD) |
| TTDF/TTDU/TTDD | TTDF is determined by ndrt\_type and fatigue\_level  TTDU is undefined  TTDD = 9999 |
| TTAF/TTAU | 0~5km: TTAF = 0, TTAU is determined by ODD  5~6km: TTAF=9999, TTAU is undefined |
| ndrt\_type | This variable has an impact on takeover time  **If ndrt= True:**  0~4km: ndrt\_type = message/Watching video, etc.  4~5km: ndrt\_type is determined by DL action (e.g., prepare driver)  5~6km: ndrt\_type = 0 (driver takes over)  **Else:**  0~6km: ndrt\_type = 0 |
| event\_type | None |
| sensor\_failure | 0~6km: sensor\_failure = 0 |
| driver\_request | None |
| driver\_response | Default value -1, determined by DL action |
| last\_action | Default value “Doing Nothing”, determined by DL action |

# Driver-initiated Shift

Time step: 1s

* Prefer Automation Mode

|  |  |
| --- | --- |
| auto\_level | random.choice((L0, L2, L3, L4)) |
| level\_max | random.randint(auto\_level, L4) |
| driver\_request | random.choice({ L2, L3, L4}\{ auto\_level }) |

* Prefer Manual Mode

|  |  |
| --- | --- |
| auto\_level | random.choice((L2, L3, L4)) |
| level\_max | random.randint(auto\_level, L4) |
| driver\_request | L0 |

NDRT is defined when L3 or L4 on

## Prefer Automation: L2/L3/L4

|  |  |
| --- | --- |
| **Signals** | **Simulation** |
| route | Distance: 1km + 2km = 3km  Driver request occurs randomly in the first 1km of the route  Decision Logic (DL) guides take over for the remaining 2km |
| vehicle\_speed | 100km/h (27.8m/s)  Constant velocity |
| total\_time | 108s |
| distraction\_level | 0 |
| fatigue\_level | random.choice(0,1)  Determine initial fatigue. With probability 0.75, no fatigue (0), and with probability 0.25, fatigued (1). If fatigue is 0, with probability 0.1, pick a random time step where fatigue becomes 1. |
| auto\_level | random.choice((L0, L2, L3, L4)) |
| level\_max | random.randint(auto\_level, L4) |
| TTDF/TTDU/TTDD |  |
| TTAF/TTAU |  |
| ndrt\_type |  |
| event\_type |  |
| sensor\_failure | None |
| driver\_request | random.randint(auto\_level+1, L4)  \* Pick a random time step `t` in the first 1000 meters (first 36 time steps) on which a `DriverRequest` should activate  \* Sample `DriverRequest` to values according to the prefer auto vs prefer manual scenario |
| driver\_response |  |
| last\_action |  |

## Prefer Manual Driving: L0

|  |  |
| --- | --- |
| **Signals** | **Simulation** |
| route | Distance: 1km + 2km = 3km  Driver request occurs at 1km  Decision Logic (DL) guides take over for the remaining 2km |
| vehicle\_speed | 100km/h (27.8m/s)  Constant velocity |
| total\_time | 108s |
| distraction\_level | 0 |
| fatigue\_level | 0 |
| auto\_level | random.choice((L2, L3, L4)) |
| level\_max | random.randint(auto\_level, L4) |
| TTDF/TTDU/TTDD |  |
| TTAF/TTAU |  |
| ndrt\_type |  |
| event\_type |  |
| sensor\_failure | None |
| driver\_request | L0 |
| driver\_response |  |
| last\_action |  |

# Mediator-initiated Shift

Assumptions

Important states

* event\_type
* TTDD
* TTAF
* TTAU

Issues

* How comfort, uncomfortable events and related TTDD changes along one route?

Actions:

* DN

|  |  |
| --- | --- |
| **Signals** | **Simulation** |
| route | Distance: 1km + 2km = 3km  Uncomfortable event occurs at 0~1km  Decision Logic (DL) guides take over for the remaining 2km |
| vehicle\_speed | 100km/h (27.8m/s)  Constant Speed |
| total\_time | 108s |
| distraction\_level | None |
| fatigue\_level | None |
| auto\_level | L0 |
| level\_max |  |
| TTDF/TTDU/TTDD | TTDD = 9999  TTDF is undefined  TTDU is determined by distraction\_level |
| TTAF/TTAU | 0~1km: TTAF = 0, TTAU = 9999  1~3km: TTAF is undefined, TTAU = 0 |
| ndrt\_type | None |
| event\_type |  |
| sensor\_failure | None |
| driver\_request | None |
| driver\_response | Default value -1, determined by DL action |
| last\_action | Default value “Doing Nothing”, determined by DL action |