Fuzzy Logic Control For Lane Change Maneuver's In Lateral Vehicle Guidance

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Problem statement:

The objective of the lane change maneuver is to laterally transfer the vehicle from one lane to the adjacent lane. Use the fuzzy logic control (FLC) algorithm to automatic steering control of the vehicle for a lane change maneuver.

SOLUTION:

INPUT: 1) lateral lane displacement

2) lateral acceleration

3) lateral acceleration error

OUTPUT: Change in steering angle (in degree) Updated every 0.01 sec

The lane maneuver is divided into three modes:

1) Lane following mode on the first lane
2) Lane changing between two adjacent lanes
3) Lane following mode on the adjacent lane

Lateral acceleration error = Desired lateral acceleration – lateral acceleration

Desired lateral acceleration can be calculated for every instant of time:

Desired lateral acceleration = maximum lateral acceleration * (current time – initial time)

Lateral Lane displacement is described in four fuzzy subsets {first, second ,third , final}

Each region form two stages -total 8 stages

First region

1) Increase the lateral acceleration until it reaches max lateral acceleration
2) Maintain the max lateral acceleration when it reaches max

Second region

1) decrease the acceleration until it reaches zero

2) maintain zero acceleration when lateral acceleration reaches zero

Third region

1) Decrease the acceleration to - max lateral acceleration (increase acceleration in the opposite direction of the movement)
2) Maintain – max lateral acceleration

Final region

1) Increase the lateral acceleration until it reaches zero
2) Maintain the zero acceleration.

The rules are based on each stage: there are 3 rules for each stage- total 24 rules

1)

i) if first region and lateral acceleration is less than maximum lateral acceleration and lateral acceleration error is negative then consequent singleton is b3

ii) if first region and lateral acceleration is less than maximum lateral acceleration and lateral acceleration error is zero then consequent singleton is b2

iii) if first region and lateral acceleration is less than maximum lateral acceleration and lateral acceleration error is positive then consequent singleton is b1

2)

i) if first region and lateral acceleration is greater than or equal to maximum lateral acceleration and lateral acceleration error is negative then consequent singleton is s1

ii) if first region and lateral acceleration is greater than or equal to maximum lateral acceleration and lateral acceleration error is zero then consequent singleton is 0

iii) if first region and lateral acceleration is greater than or equal to maximum lateral acceleration and lateral acceleration error is positive then consequent singleton is -s1

3)

i) if second region and lateral acceleration is greater than zero lateral acceleration and lateral acceleration error is negative then consequent singleton is -b1

ii) if second region and lateral acceleration is greater than zero lateral acceleration and lateral acceleration error is zero then consequent singleton is -b2

iii) if second region and lateral acceleration is greater than zero lateral acceleration and lateral acceleration error is positive then consequent singleton is -b3

4)

i) if second region and lateral acceleration is less than or equal to zero lateral acceleration and lateral acceleration error is negative then consequent singleton is s1

ii) if second region and lateral acceleration is less than or equal to zero lateral acceleration and lateral acceleration error is zero then consequent singleton is 0

iii) if second region and lateral acceleration is less than or equal to zero lateral acceleration and lateral acceleration error is positive then consequent singleton is -s1

5)

i) if third region and lateral acceleration is greater than -max lateral acceleration and lateral acceleration error is negative then consequent singleton is -b1

ii) if third region and lateral acceleration is greater than -max lateral acceleration and lateral acceleration error is zero then consequent singleton is -b2

iii) if third region and lateral acceleration is greater than -max lateral acceleration and lateral acceleration error is positive then consequent singleton is -b3

6)

i) if third region and lateral acceleration is less than or equal to -max lateral acceleration and lateral acceleration error is negative then consequent singleton is s1

ii) if third region and lateral acceleration is less than or equal to -max lateral acceleration and lateral acceleration error is zero then consequent singleton is 0

iii) if third region and lateral acceleration is less than or equal to -max lateral acceleration and lateral acceleration error is positive then consequent singleton is -s1

7)

i) if final region and lateral acceleration is less than zero lateral acceleration and lateral acceleration error is negative then consequent singleton is -b1

ii) if final region and lateral acceleration is less than zero lateral acceleration and lateral acceleration error is zero then consequent singleton is -b2

iii) if final region and lateral acceleration is less than zero lateral acceleration and lateral acceleration error is positive then consequent singleton is -b3

8)

i) if final region and lateral acceleration is greater than or equal to zero lateral acceleration and lateral acceleration error is negative then consequent singleton is s1

ii) if final region and lateral acceleration is greater than or equal to zero lateral acceleration and lateral acceleration error is zero then consequent singleton is 0

iii) if final region and lateral acceleration is greater than or equal to zero lateral acceleration and lateral acceleration error is positive then consequent singleton is -s1

Increment in steering angle

b3= 0.0046 b1=0.0034

b2= 0.004 s1=0.0006

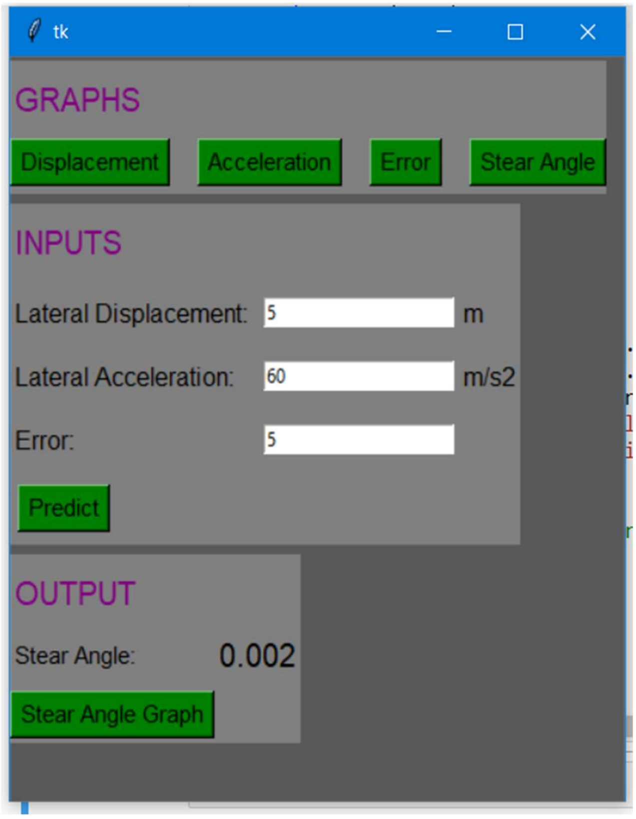
using this rule creating the fuzzy logic control using skfuzzy then using tramf and triangular member function we can classify the inputs and the output.

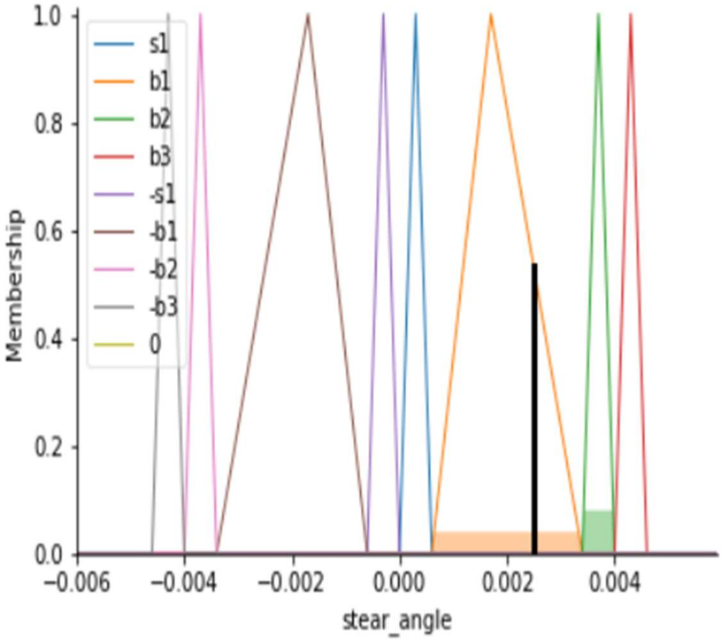
Computing and creating the control system we can get the steering angle per 0.01 second.

Running the process for giving particular time we can get the time required to cross the adjacent lane.

[in the solution of the problem we solved the problem imagining the error that could occur in between desired lateral acceleration and lateral acceleartion]

Working:





Here the ranges of displacement are given[0-1000m]

Acceleration[0-300]

Error[0-100]