LabVIEW Based Adaptive Cruise Control Model with Improved Efficiency

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***Abstract*---Semi automation of a vehicle can be achieved by reducing driver's intervention on the CBA (Clutch Brake Accelerator), above a threshold limit of speed. The threshold is limited under the intra-city traffic parameter. Above this threshold, ACC (Adaptive Cruise Control) automatically maintains the speed of the vehicle by sensing speed and inter-distance without making crashes. But while high speed cornering, because of fluctuations between yaw and steering of the vehicle, possibility of skidding or roll over increases. These fluctuations can be reduced by reducing speed with accounting of additional parameters- position of steering and yaw of vehicle. Thence ease of handling and stability of the vehicle can be improved besides to semi automation. All these predefined parameters are modeled using controls and functions in the case of LabVIEW.**

Key terms: **Adaptive Cruise Control, Yaw, Position, Speed**

I. INTRODUCTION

In this paper, the progress of automotive features from manual to semiautomatic is demonstrated and improved in the case of safety using efficiency improvement. Initially, avoidance of intruders' (drivers) fatigue on accelerator pedal on long ways is dealt with using the cruise control system. The system took parameter of current speed alone to maintain it to desired speed. The modeling of the defined system results in safety less due to crash between vehicles when the inter-distance gets zero. To overcome this, the inter-distance besides with current speed parameter is added for controlling the speed. This evolution results in adaptive of the cruise controlling named 'Adaptive Cruise Control'. The latter defined gets inefficient while high speed cornering. To make it more efficient in concern on safety, the advancement in the ACC is evolved by including yaw and steering parameters. This proposed model is achieving the semi automation greatly with improved safety and stability of the vehicle. The hierarchical evolution of automation in automotive is modeled on LabVIEW using controls and indicators in front panel. Their combined functionality and dependency is illustrated in the block diagram panel, which defines the working script of front panel.

II. CONVENTIONAL CRUISE CONTROL

In case of cruise control mode which is the conventional mechanism for semi automation, maintaining the speed of the vehicle is the only criteria. Cruise control allows the driver to set the vehicle speed and when this control is activated the speed of the vehicle is maintained automatically without touching the accelerator pedal. Cruise control systems were first introduced during the mid 1960′s as a means of reducing driver's fatigue on long motorway journeys. This Conventional Cruise Control system is realized using a closed loop control system which is shown in the form of a block diagram as below in Figure 1.

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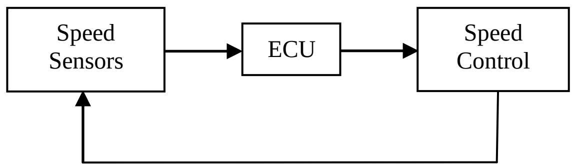

Figure 1. Block diagram of Conventional Cruise Control system

For maintaining the vehicle with the predefined speed set by intruder three conditions are checked. The conditions are

- Set Speed < Current Speed,
- Set Speed > Current Speed,
- Set Speed = Current Speed.

The sensor which can measure current speed can be modeled as control and indicator on the front panel of LabVIEW. The control fetches the input and the indicator reveals the output accordingly.

i. When Set Speed<Current Speed

-The speed of the vehicle is increased until it attains the set speed and then maintained.

ii. When Set Speed>Current Speed

-The speed of the vehicle is decreased until it attains the set speed and then maintained.

iii. When Set Speed=Current Speed

-The speed of vehicle is neither increased nor decreased but it is merely maintained.

By responding as defining for the conditions, the cruise control can be greatly achieved.While cruise control is active; the equipped vehicle which may move at high speed may crash into other slow moving vehicles when they come into the path of the equipped vehicle. For avoiding such scenarios the inter-distance (distance between leading vehicle and equipped vehicle) parameter is included for controlling the speed.

III. ADAPTIVE CRUISE CONTROL

Adaptive Cruise Control (ACC) is cruise control mode that allows a vehicle's cruise control system to adapt the vehicle's speed to the traffic environment. If a slower moving vehicle is detected, the ACC system will slow the vehicle down and control the clearance, or time gap, between the ACC vehicle and the forward vehicle. If the system detects that the forward vehicle is no longer in the ACC vehicle's path, the ACC system will accelerate the vehicle back to its set cruise control speed. This operation allows the ACC vehicle to autonomously slow down and speed up with traffic without intervention from the driver.

To achieve ACC, operation is performed under two modes. One is a traditional cruise control mode while the other is the time gap mode.

i. Cruise Control Mode

-Speed is merely maintained without consideration of other parameters.

ii. Time Gap Mode

-Clearance is maintained with appropriate speed.

Relationship between speed and clearance is derived as

Time Gap = Clearance / ACC Vehicle Speed

For sensing of traffic parameter, the inter-distance is used which is acquired through the distance measuring sensor. It is also modelled as the same way of speed sensor. The actual inter-distance is because of traffic environment which is modelled in this paper to vary under user constraints. The time gap or clearance parameter is predefined by intruder which is compared with inter-distance. On the outcome of a comparison, decisions are made to control the vehicle's speed. Three possible outcomes are

- Clearance (Set Distance) < Inter-Distance,
- Clearance (Set Distance) > Inter-Distance,
- Clearance (Set Distance) = Inter-Distance.

i. When Clearance (Set Distance) < Inter-Distance

-The very traditional cruise control system is followed which is called as velocity mode.

ii. When Clearance (Set Distance) > Inter-Distance

-The time gap mode in which the difference between inter-distance and set distance has to be nullified and the vehicle is maintained with the speed at which nullification is done.

iii. When Clearance (Set Distance) =Inter-Distance

-Vehicle's speed is merely maintained and exclusive of set speed and current speed which may/may not be equal.

The transition between the two modes in either way is possible, which is done automatically under the conflict between inter-distance and set distance.

- If a conflict exists: cruise control mode → time gap mode (or) remain in time gap mode
- If a conflict does not exist: time gap mode → cruise control mode (or) remain in cruise control mode.

This automotive feature gets inefficient while high speed cornering, because the confliction between yaw of the vehicle and intended direction of the vehicle results in slip angle variations and thence skidding or rollover of vehicle possible to happen. In concern with avoiding such instabilities, proposed model can improve adaptive cruise control efficiency by accounting additional parameters-yaw of vehicle and position of steering.

IV. EFFICIENT ADAPTIVE CRUISE CONTROL

From the defined drawback, the efficiency of the ACC can be improved while high speed cornering and this leads to 'Efficient Adaptive Cruise Control' system.

A.Modes Of Skidding

- Understeer-Vehicle id pushed toward the outside of the road curve.
- Oversteer-Vehicle pulls going into the curve

Under these modes, the instability by means of skidding or rollover can happen. This is because of the nonzero difference between yaw of the vehicle and steering position.

B. Estimating Yaw Of The Vehicle

For calculating yaw, current speed and steering position are used. Since in this paper generic modelling is handled, factor of current speed denoted by the parameter 'a' and factor of the modulus of steering position denoted by 'b' are used. Two possible outcome for yaw value are zero and nonzero. Yaw can be zero if the sum of 'a' and 'b' is lesser than or equal to factor of maximum speed by which a vehicle can move on. If it is greater, then the yaw is a nonzero value.

C. Detection Of Skidding Or Rollover

From the yaw value and the defined steering position value, parameter called 'diff' is calculated as follows.

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Diff=|yaw-steering position|

Nonzero value of diff indicates the occurrence of skidding or rollover.

D. Decisions Based On 'Diff' Parameter

If diff is nonzero, the speed gets reduced until diff is nullified. If diff is zero, ACC mode plays its vital role. If first case exists, the remedy will be taken as defined and then shift to second case automatically.

The effect of decision for two modes- oversteer and understeer, is shown in figure 2 and figure 3 respectively in the graphical format.

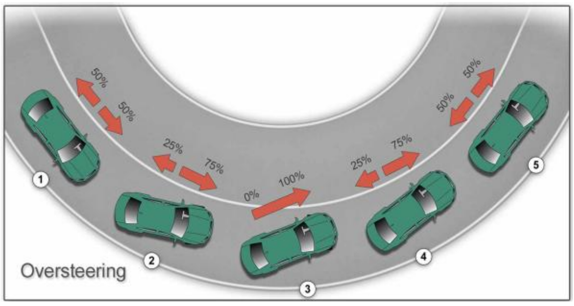

Figure 2. Effect of decision for oversteer

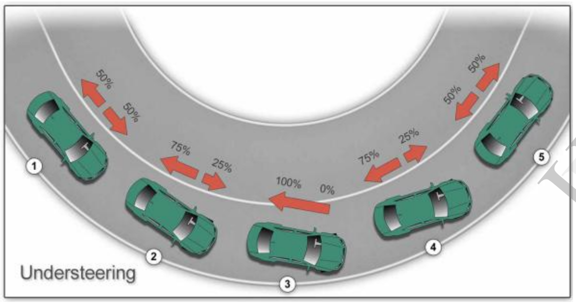

Figure 3. Effect of decision for understeer

The decisions show that the efficiency of ACC gets improved while high speed cornering by reducing speed.

V. MODELLING IN LabVIEW

A. Front Panel Design

The Front Panel is designed as follows. In the three hierarchical developments of the system from cruise control to efficient adaptive cruise control are through the controlling modes. Prerequisite control is defined as the Vehicle ON/OFF switch. The speedometer which resembles the actual dashboard of the vehicle in the same analog way indicates the current speed of the vehicle. Its digital format is shown below to that. The speed is set by entering the values in the 'Speed Set' box which ranges between (20kmph - 200kmph). The distance measuring sensor is modelled as control and indicator. The actual control part is taken from the actual distance (m) control unit. The indicator part is like the digital speedometer which is explained above. The intruder defined inter-distance parameter is modelled in the name of 'distance set'. The steering is modelled as a knob. The diff which indicates the skidding intensity is also modelled as level indicator. The fully modelled Front Panel is shown as below in figure 4.

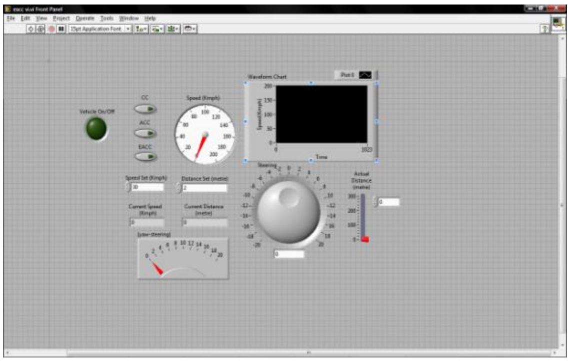

Figure 4. Front Panel Design

B. Scripted Block Diagram Window

The modelled module is embedded inside the while loop function so that the operation is continuously working under any of the three modules. All the front panel controls and indicators have their own unique functional blocks in the block diagram window. The blocks are connected using wires and the wires get differed based on the data type of the block. Certain logic functions like Boolean for integer, comparator and greater than operator are used. The main functional unit used here is the formula node which has accommodated C coding and executes with the compiler rules. This block diagram is the background executing scripted part of the front panel which is shown in figure 5.

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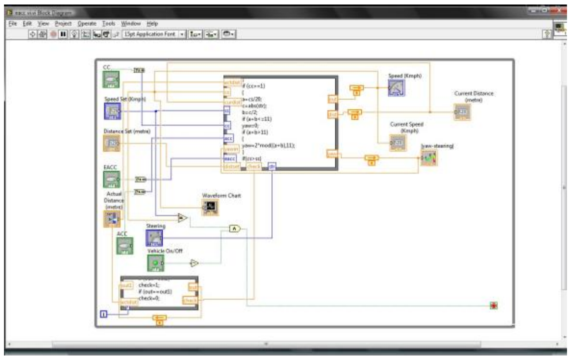

Figure 5. Scripted Block Diagram Window

VI. RESULT AND DISCUSSION

The designed front panel which is having the modelled controls and indicators, functions based on the functionally scripted in the block diagram panel. When the designed model is simulated using LabVIEW 8.5 in ACC mode, the skidding or roll over intensity which is experienced while high speed cornering is indicated by an indicator labelled '|yaw-steering|' in front panel by means of nonzero values. The increment in the indicator shows the intensity increment of skidding or rollover. This inefficiency gets reduced by nullifying (diff=zero) intensity which is accomplished in case of EACC mode. Intensity nullify is actually done by reducing speed accordingly while high speed cornering. This ascends the efficiency of ACC in EACC mode. Besides that, stability and handling of vehicle by intruder gets ascended. These are observed while simulation.

VII. CONCLUSIONS

The automotive feature, cruise control from conventional to adaptive which has been modelled has its own pros and con (Inefficient). The efficiency with stability and safety of semi automation which is acquired through ACC is improved by the additional parameters accounted. The efficiency can be improved by another way through which the modes of skidding are handled uniquely rather than common handling technique (speed reduction).

REFERENCES

[1] Worrawut Pananurak, Somphong Thanok, Manukid Parnichkun, "Adaptive Cruise Control for an Intelligent Vehicle" Proceedings of the 2008 IEEE International Conference on Robotics and Biomimetics Bangkok, Thailand, February 21 - 26, 2009 pp.1794-1799

[2] Bageshwar, V. L. Garrard, W. L. and Rajamani, R. "Model Predictive Control of Transitional Maneuvers for Adaptive Cruise Control Vehicles" IEEE Trans.Tech. vol 53., Sep 2004, pp.1573-1585

[3] K. Santhanakrishnan and R. Rajamani, "On spacing policies for highway vehicle automation," IEEE Trans. Intell. Transport. Syst., vol. 4, pp. 198–204, Dec. 2003.

[4] W. D. Jones. "Keeping cars from crashing" IEEE Spectrum. Sep 2001, pp.40-45

[5] D. Q. Mayne et al., "Constrained model predictive control: stability and optimality," Automatica, vol. 36, pp. 789–814, 2000.

[6] D. Swaroop and J. K. Hedrick, "Constant spacing strategies for platooning in automated highway systems," J. Dyn. Syst., Meas., Control, vol. 121, pp. 462–470, 1999.

[7] D. G. Hull, "Conversion of optimal control problems into parameter optimization problems," J. Guid., Control, Dyn., vol. 20, no. 1, pp. 57–60, 1997.

[8] J. Frankel, L. Alvarez, R. Horowitz, and P. Li, "Safety oriented maneuvers for IVHS," Veh. Syst. Dyn., vol. 26, pp. 271–299, 1996.

[9] P. Fancher and Z. Bareket, "Evaluating headway control using range versus range-rate relationships," Veh. Syst. Dyn., vol. 23, pp. 575–596, 1994.

[10] V. K. Narendran, J. K. Hedrick, and K. S. Chang, "Merge control of vehicles in an automated highway system," in Proc. 3rd ASME Symp. Transportation Systems, vol. DSC-44, pp. 269–279, 1992.

[11] R. J. Caudill and W. L. Garrard, "Vehicle-follower longitudinal control for automated transit vehicles," J. Dyn. Syst., Meas., Control, vol. 99, pp. 241–248, 1977.

[12] G. C. Goodwin, S. F. Graebe, and M. E. Salgado, Control System Design. Englewood Cliffs, NJ: Prentice-Hall, 2001, pp. 739–765.

[13] www.ni.com/pdf/manuals/320998a.pdf

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