ABSTRACT

Man with his intuitive sense for assimilating past experience learns to invoke effective control interventions for various crisis situations encountered in navigation. He learns from exemplars of good interventions used in past trials, which helped him avert a crisis situation as also from exemplars of bad instances, which landed him in difficulties. The behavioral modeling of human driver would reveal that experienced drivers anticipate curve changes, obstacles, lane drifts, motions of adverse vehicles, changes in vehicle states etc and act appropriately to introduce necessary corrections for path adherence, correct instability or to avoid obstacles.

Automation of driving functions without accounting for human factors can lead to undesirable effects counteracting the benefits, as has been proved in ABS fitted vehicles. Further, it would be difficult for these systems aiding and supporting the human driver to function either singly or independent of human collaboration. Ethical considerations favor and rely on human action being carried out in responding to a crisis rather than machine intelligence and intervention.

Further, intelligent navigation models presuppose several factors in proposing solutions to determine, estimate and avert crisis conditions. Hence, such solutions may not work under all conditions.

Under crisis conditions caused by and deviant vehicle conditions, the driver intuitively applies trials and discerns the vehicle response for applying further corrections. In novel situations with unknown dynamics, options for controller action and the manner in which the deviation would be corrected are experimented on a trial and error mode by a human driver who may or may not be successful in averting the crisis. It is also

not possible to pretrain and implement a controller for such situations. Thus online learning need to be investigated for its capabilities and limitations.

In a given navigation context, crisis may continue to evolve and there is a case for continuous online and dynamic learning. Experience with implementations of controller being trained to deal with a specific crisis indicate the need for such intelligent and on line techniques using neuro controls or such other intelligent systems to regulate and discern the nature of the machine intervention or integrate factors such as adaptation in human skills and capabilities.

The work addresses some of the issues related to such online machine learning taking into account the intent of man and deal with complex crisis conditions such as a structural damage, tyre blow outs, lateral hit etc. In order to carry out simulation trials to examine the capability of such online machine learning, a simulator was designed and developed with steering wheel, brake and accelerator pedal which enable recording of human control inputs during simulation trials of crisis conditions. The response of the modeled vehicle was updated and projected visually on to a graphic screen at sampled intervals comparable to real life situations.

The system is developed where the driver gives the input to a simulator (not directly to the real vehicle) and under normal conditions, his actions are passed on to the physical vehicle. But under abnormal conditions sensed, the driver inputs are taken only as intent of the driver under the crisis and actual control is done through an inverse vehicle neuro-model. This inverse neuro model of the vehicle trains itself to reflect the changed dynamics of the vehicle in real time of the order of 0.5 secs. The inverse neuro model is a nominal controller trained through the vehicle mathematical model or real life data, but is designed to retrain itself in online mode, back propagating the responses though the actual vehicle using an online learning rule which has been derived for this purpose.

The Online Learning Rule (OLR) is developed by extending the backpropogation learning to take into account the actual vehicle performance to retrain the inverse neuro model. The online learning algorithm uses the computed instantaneous sensitivities of the plant (real vehicle) *i.e* the ratio of the vehicle responses { r } to the control inputs { c } and uses it in place of the plant differential during back propagation of errors and adaptation of interconnect weights.

It has been shown that by taking the driver's intent indicated by his control inputs just at the onset of crisis, the inverse neuro model retrains in an online mode to correct the crisis condition in the control of yaw rate and lateral velocity of the vehicle within 4 to 5 passes (cycles through the actual vehicle after the onset of crisis) using low learning rates.

Issues relating to man /machine interactions was addressed and it was realized that by keeping man overriding the machine, his intent could be used as a clue for online machine learning.