Advanced Driving Assistance System Validation for Brazilian Market

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ABSTRACT

Safety is one of Honda's pillars and one of the priorities in the product line up strategy.

Honda innovated by offering a technology, usually applied in Premium vehicles, for its entire line up produced at Brazil Manufacturing Plant.

Honda Sensing® is a package of safety and driver assistance technologies that is based on images captured by a long-range, wide-angle camera and a high-capacity image microprocessor, with several functions that help the driver's handling, making the vehicle safer in different conditions.

Brazilian Market has many unique road conditions which may impact on system function, causing a discomfort to customer and not assuring Honda pillar of safety, therefore we developed a strategy to define a validation method for this system validation on Brazilian Market.

The study will describe Honda Safety goals, Honda Sensing® features for Brazil and the strategy to define the validation method and results obtained from testing the system.

INTRODUCTION

As exemplified by the words of the Company's founder Soichiro Honda that "as long as we are handling a mode of transportation, we are entrusted with human lives," Honda is, on the basis of the concept of "Safety for Everyone," aiming at a collision-free mobile society, where not only drivers and riders, but indeed everyone sharing the road, can safely and confidently enjoy the freedom of mobility. Honda has a long history of safety dating back to the 1960s when it started traffic safety promotion initiatives, the first of their kind for motorcycle/ automobile manufacturers. Honda has been proactively undertaking safety awareness activities in many countries and regions while extending the scope from drivers and riders to all people involved in the traffic society, from children to senior citizens. Honda has also developed and released several new technologies before anyone else in the world, setting higher targets exceeding regulatory requirements and in a spirit that "if it does not exist, we will make it." Now, the advancement of the Internet and other technologies has enabled people to gather information from across the world, meet many people and obtain things without having to move around. However, Honda believes that feeling a new world with one's five senses based on curiosity is one of people's invaluable joys. As such, the Company will continue to value "real" experiences and expand the freedom of mobility and its potential across the world. A collision-free mobile society envisioned by Honda is a society where all people can follow their curiosity and go anywhere freely with a total sense of security. In April 2021, Honda announced that it "will strive for zero traffic collision fatalities involving Honda motorcycles and automobiles globally by 2050." Not only to fulfill one of its social responsibilities but also to fabricate a joyous future, Honda will work toward a collision-free mobile society and continue to proactively evolve its traffic safety initiatives based on the actual accident situations unique to each region. So, the reference of Global Safety Slogan, as below [1]:

Figure 1 – Honda Global Safety Slogan.

To achieve it, ADAS (Advanced Driving Assistance System) are being developed and implemented on Honda models globally. Honda Sensing® is the brand's exclusive ADAS.

Before explaining how it was validated for Brazil market, let´s describe each function.

HONDA SENSING®

Based on Honda's long standing "Safety for Everyone" approach which focuses on advancing safety for everyone sharing the road, Honda Sensing® helps to improve the driver's situational awareness and, in certain circumstances, intervenes to help avoid a collision or mitigate its severity [2].

The full suite of Honda Sensing® systems to Brazil debuted on the Accord 10th Gen and CR-V 5th Gen, and Honda Sensing® has since continued to improve and expand, representing a technological bridge to the automated driving technology of the future. Currently, for Honda Brazil production, New City, New City Hatchback and New HR-V, Honda Sensing® suite of technologies includes Collision Mitigation Braking System (CMBS) with Forward Collision Warning (FCW); Road Departure Mitigation (RDM) with Lane Departure Warning (LDW); Lane Keeping Assist System (LKAS); and Adaptive Cruise Control (ACC). New HR-V also include Low-Speed Follow (LSF).

CMBS™ (COLLISION MITIGATION BRAKING SYSTEM™) - alerts the driver when it determines there is the potential for a collision, and then automatically applies emergency braking to help avoid or reduce the severity of a collision if drivers don't take corrective action on their own. On some Honda models, CMBS™ includes pedestrian sensing and automatic emergency braking (Pedestrian AEB).

Detecting vehicles and pedestrians falls to the millimeter wave radar unit and monocular camera. This fusion of radar and camera sensors allows the system to effectively detect the nature, distance and speed of obstacles to determine whether there's a potential for a collision. On the 11th-generation Civic, the monocular camera and powerful software achieve a similar result.

When CMBS ™ determines there is potential for a collision, visual and audible alerts prompt the driver to take corrective actions. The visual alerts appear on the digital screen on the instrument panel, and Head-Up Display (if equipped). If the system determines that a collision is imminent, it applies the brakes to help reduce vehicle speed and eventual collision forces.

Although in many cases CMBS ™ will stop the car, it is not intended to apply enough braking force to prevent all collisions. Based on the conditions, the system also may not perform all visual- and audible-alert stages, and may instead automatically engage the brakes if the system deems it necessary.

Figure 2 - CMBS™ - Activate Brake to avoid/reduce severity potential collision.

FORWARD COLLISION WARNING (FCW) – Integrated with CMBS, FCW uses the monocular camera to detect vehicles and pedestrians ahead and to determine whether a collision is imminent. If the FCW system detects a vehicle or pedestrian in front of the vehicle and the speed differential between the vehicle and object indicates a collision may occur, it will sound an audible alert and trigger a visual warning on the instrument panel. If CMBS is also activated and the driver fails to respond, the vehicle's brakes will be automatically applied if the system determines a collision is imminent.

Drivers may adjust the distance at which FCW alerts occur and may choose between "Long," "Normal," or "Short." FCW cannot detect all objects ahead; accuracy will vary based on weather, speed and other factors.

ROAD DEPARTURE MITIGATION (RDM) WITH LANE DEPARTURE WARNING (LDW) - uses the monocular camera to identify solid or dashed painted lane lines, Botts' dots and cat's eye markers. Depending on the model, RDM uses steering force, braking or both to help the vehicle stay in its lane.

The monocular camera recognizes lane features and identifies the lane. If the RDM system detects that the vehicle is about to leave the detected lane, it displays a visual LDW on the instrument panel. If the driver does not respond, the system will produce a warning and take corrective action by providing steering assist and/or braking to help the driver stay on the road.

Figure 3 - RDM – Help the vehicle stay in its lane by steering force or/and with brake in case of leave the lane.

LANE KEEPING ASSIST SYSTEM (LKAS) - provides a less stressful driving experience by reducing steering correction movements and driving effort on the

highway, from approximately 45 to 90 mph. LKAS uses a camera to read lane markings and uses the electric power steering (EPS) to assist the driver in keeping in the middle of the lane.

Designed for the general road structure, the system uses the monocular camera to identify solid or dashed painted lines, and cat's-eye markers. When LKAS senses that the driver is drifting from the middle of a detected lane, the system generates corrective steering torque to assist the driver in maintaining lane position.

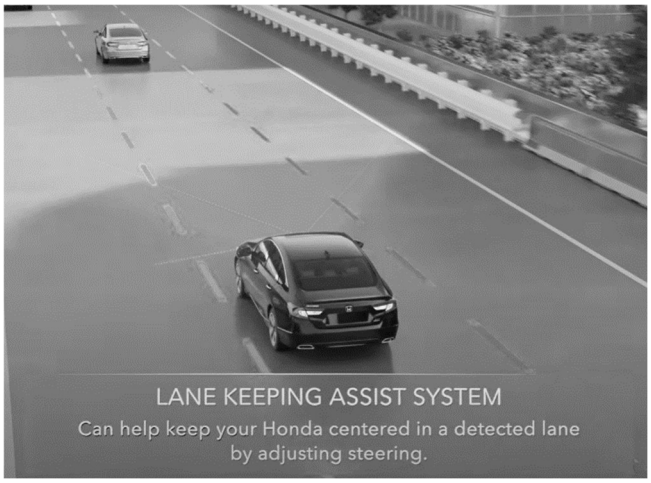


Figure 4 – LKAS – Steering force to maintain lane position.

ADAPTIVE CRUISE CONTROL (ACC) - allows the driver to set a desired speed and following interval behind a vehicle detected ahead, allowing the use of cruise control in light highway traffic conditions. This significantly reduces the stress of driving in traffic. The system uses millimeter wave radar and a monocular camera to continually track the distance to the vehicle ahead, and then adjusts the vehicle's speed to maintain the driver-selected following interval. On the 11th-generation Civic, the monocular camera combined with its powerful software work together to achieve the same functionality.

A short, medium, long, or extra-long interval can be selected. When required, the vehicle automatically brakes to maintain the set interval.

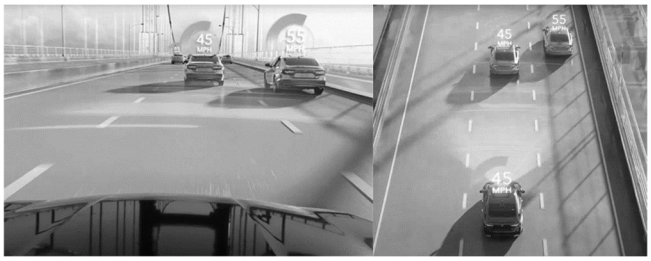


Figure 5 - ACC - Adjusts the vehicle's speed to maintain the driver-selected following interval.

ACC WITH LOW-SPEED FOLLOW (LSF) - extends the automatic following capability of ACC to stop-and-go traffic situations (down to 0 mph). ACC with Low-Speed Follow functions include the following:

- A preceding vehicle is detected in the lane ahead: decelerates automatically, if required, and then controls the following interval.

- The preceding vehicle slows to stop: stops automatically and remains stationary.

- The preceding vehicle accelerates from a stop: resumes following accelerator pedal is operated or using steering wheel SET/RES buttons.

- Another vehicle is detected merging in between the Honda and the preceding vehicle: automatically switches "targets" to the nearest detected vehicle.

- The preceding vehicle exits the lane: ACC with low-speed follow system continues at cruise-control speed previously selected by driver.

VALIDATION METHOD DEVELOPMENT STRATEGY

The Honda Sensing® system has been used in Japan and other countries for a long time, and there are no reports of malfunctions or customer complaints. With that in mind, we seek to identify critical points facing public highways in Brazil due to unique road and traffic conditions. This is a challenge since we must assure the system functions for our customer comfort and safety in Brazilian Market from customer point of view.

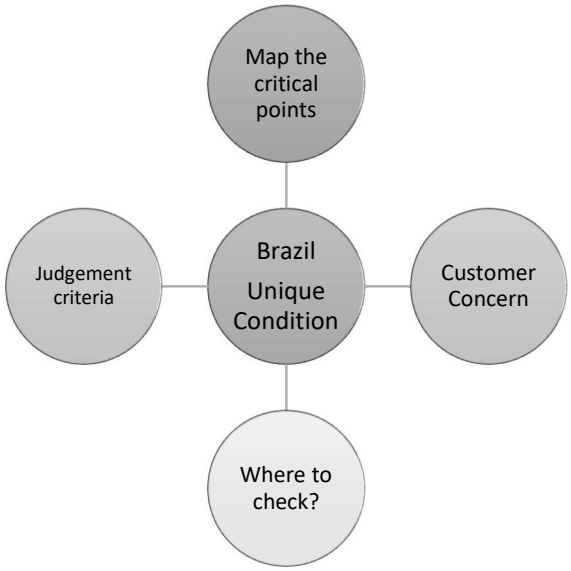


Figure 6: Methodology strategy development

MAP CRITICAL POINTS - Mapping was carried out on Brazilian highways, where some points considered critical for the use of the Sensing system were raised. Brazilian market has unique conditions that is the challenge to assure a comfortable and safety usage of the system.

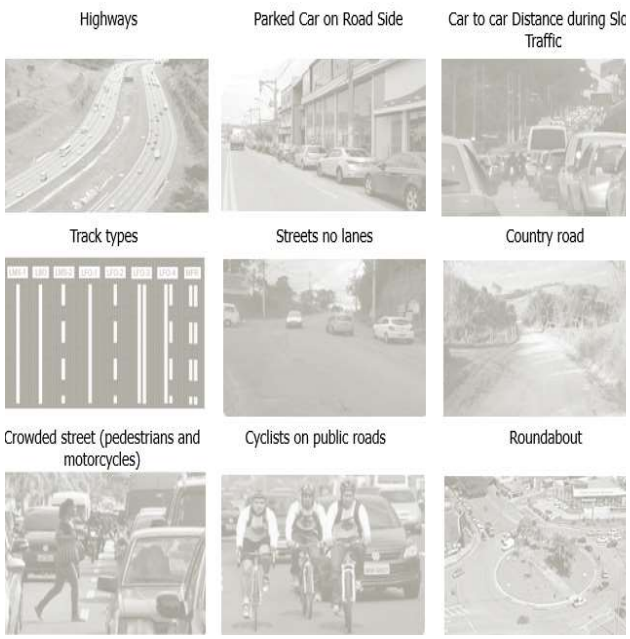


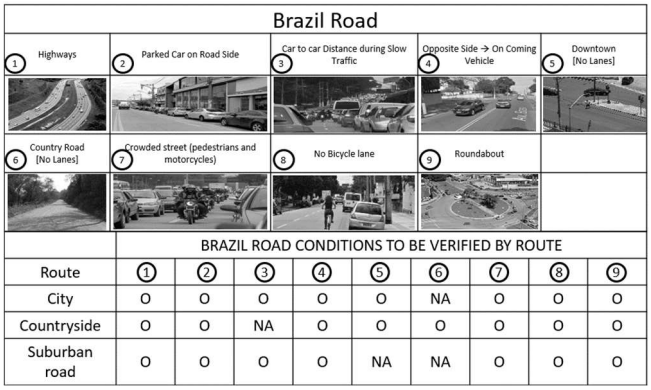
Figure 7: Public Road conditions

CUSTOMER CONCERN ITEMS - Concerns related to customer were listed and described on table 1.

Table 1: Customer Concern Items

Brazil Original Conditions	Concern item
Highways	No concern, same as other countries
Parked Car on Road Side	Miss-Operation/Miss-Judgement by RDM/CMBS Function
Car to Car Distance during Slow Traffic	Need to tune the range of the Camera for preceding Vehicle Stopping From 4 meters → 2 meters
Track types	Miss-Operation/ Miss-Judgement by Camera
Street no lanes	↑
Country Road	↑
Crowded street (pedestrians and motorcycles)	CMBS cannot be canceled manually [Need to confirm on Public Road condition]
No Bicycle Lane	Miss-operation of RDM/ CMBS function
Roundabout	↑

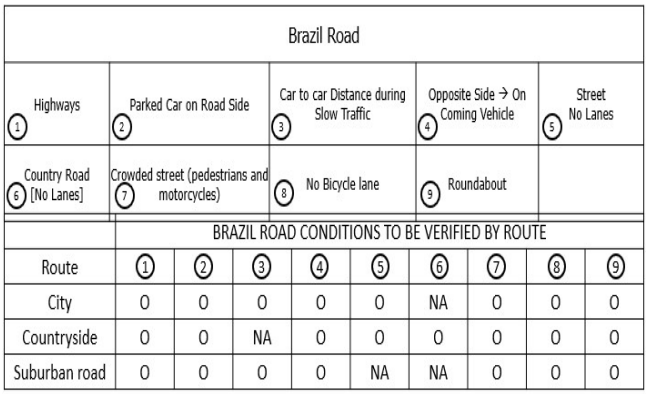
TEST REGION DEFINITION – We identified in the region, routes where it would be possible to verify from the point of view of the customers, the critical points raised.



	BRAZIL ROAD CONDITIONS TO BE VERIFIED BY ROUTE								
Route	①	②	③	④	⑤	⑥	⑦	⑧	⑨
City	O	O	O	O	O	NA	O	O	O
Countryside	O	O	NA	O	O	O	O	O	O
Suburban road	O	O	O	O	NA	NA	O	O	O

Figure 8: Verification route.

JUDGEMENT CRITERIA - Based on the functions and also on the functioning of the system, it was created some verification items and the judgement criteria for each one of them.



	BRAZIL ROAD CONDITIONS TO BE VERIFIED BY ROUTE								
Route	①	②	③	④	⑤	⑥	⑦	⑧	⑨
City	0	0	0	0	0	NA	0	0	0
Countryside	0	0	NA	0	0	0	0	0	0
Suburban road	0	0	0	0	NA	NA	0	0	0

Figure 9: Check items and judgment.

TEST RESULTS

Running tests were carried out during the day and also at night on the City, Countryside and Suburban road routes to verify the functionality of the system from the point of view of the Brazilian Customer.

RDM - Checked all system functions and did not find any operational issues.

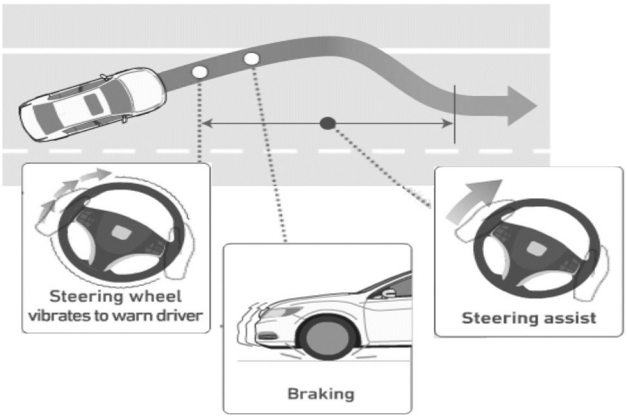


Figure 10: RDM – Function checkpoints, steering and braking response.

ACC - Checked all system functions and did not find any operational issues.

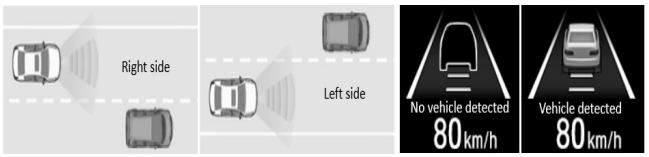


Figure 11: ACC functions checkpoints – vehicle detection.

LKAS - Checked all system functions and did not find any operational issues.

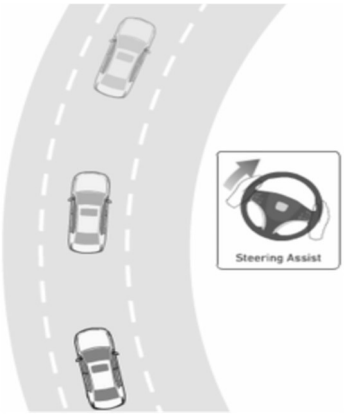


Figure 12: LKAS Checkpoints – Steering correction adjust.

CMBS - Checked all system functions and did not find any operational issues.

Figure 13: CMBS Checkpoints – Brake response.

LSF - Checked all system functions and did not find any operational issues.

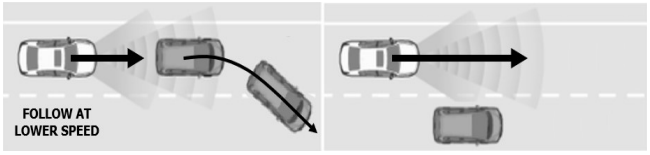


Figure 14: LSF checkpoints – Follow at low speed and recover speed after preceding vehicle change lane.

CONCLUSION

Honda strives for a safer traffic and aims towards zero traffic collision fatalities and in order to achieve it Honda has developed products with technologies to assist drivers for a safer and comfortable driving. Honda Sensing® is a technology for automobile to support Honda vision with many functions regarding safety and comfort.

A method for validation was defined by mapping the unique condition for Brazilian market and considering the system functions and correct response during these conditions. The system response was satisfactory to attend Brazilian market condition and customer usage.

REFERENCES

[1] Honda, “Honda Sustainability Report 2022”, Honda. [Online]. Available : https://global.honda/sustainability [acesso 18/05/2023]

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