Simulation of real pre crash accident scenarios using German In-Depth Accident Study (GIDAS)

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Abstract - The focus of the technical innovation in the automobile industry is currently changing to sensor based safety systems, which are operating in the pre-crash phase of an accident. To get more information about this pre-crash phase for real accidents a simulation of this phase using the GIDAS database is done.
The basics for this simulation are geometrical information about the accident location and the exact accident data out of the GIDAS database. This aggregated information gives the possibility to simulate an exact motion for every accident participant, using MATLAB / SIMULINK, in the pre-crash phase. After the simulation the information about the geometrical positions, the velocities and maneuvers of the drivers to an individual TTC (time to collision) are available. With those results it is possible to develop new useful sensor geometries using pre-crash scatter plots or estimate the efficiency of implemented active safety systems in combination with sensor characteristics.
This simulation can be done for every reconstructed accident included in the GIDAS database, so these results can represent a wide spread basis for the further development of active safety systems and sensor geometries and characteristics.

BASE

As basis for the simulation of the pre-crash accident scene there are mainly three groups of information.

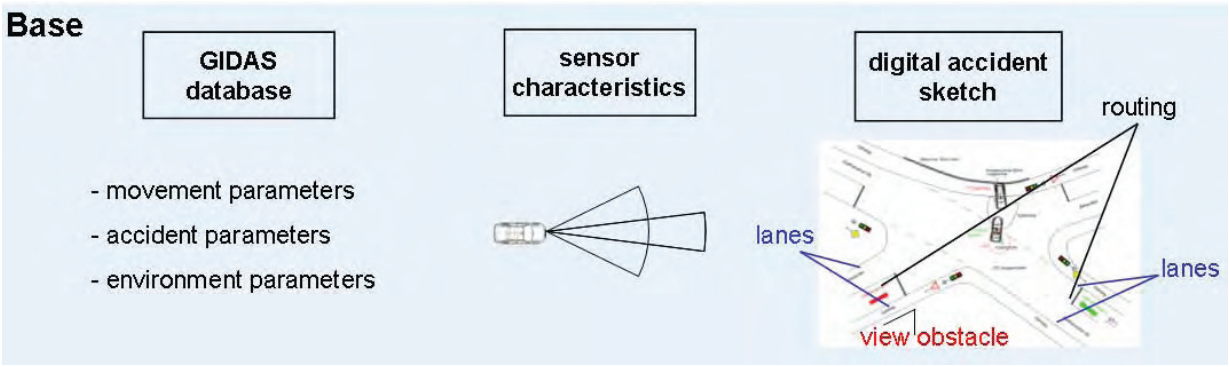

Figure 1. Base

GIDAS database

The first group is the GIDAS database, out of this database movement-, accident- and environment parameters can be extracted. Such parameters are for example the car deceleration or acceleration, speeds, weather, road conditions or the collision angle.

Sensor characteristics

Second group of information are the sensor characteristic features like angle, range and detection latency. These characteristic features are used later in the simulation to calculate if an object is in the geometrical field of the sensor and if it is detected.

Digital accident sketch

The digital accident sketch is build out of the real accident sketch which exists for every accident in the GIDAS database. The main information about the routing of the occupants, the lanes of the occupants and of course about the position of the view obstacles is elevated, put into a digital format and exported to a MATLAB readable file.

SIMULATION

After the base is elevated an automatic simulation done by SIMULINK starts. During this simulation the following main steps are calculated.

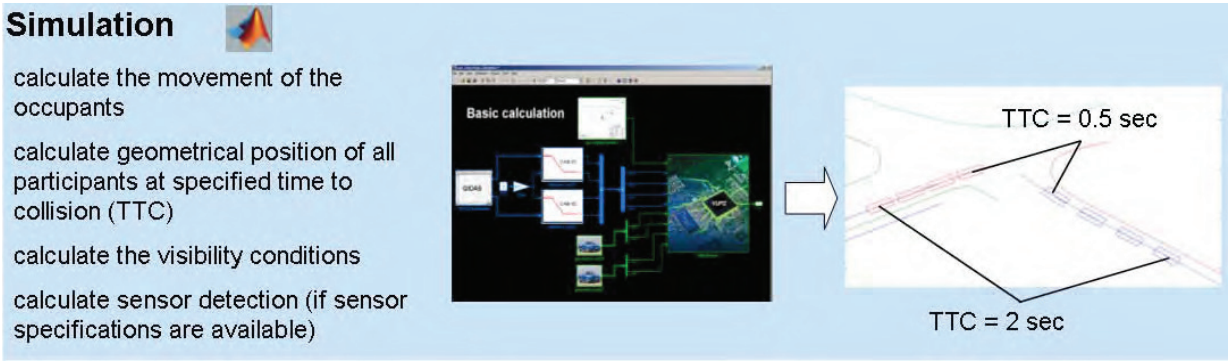

Figure 2. Simulation progress

Movement

The movement calculation uses the parameters out of the GIDAS database to describe an exact movement of each participant. Using this movement calculation the distance to the collision point can be calculated for every given time to collision (TTC) starting two seconds before the crash.

Geometrical position

If the distance at the chosen TTC is calculated for each participant, it is placed onto the digital accident sketch. After placement of both participants distance to the collision the exact point of each participant referring to each other can be calculated.

Visibility check

After calculation of the geometrical positions the visibility to each other can be checked using connection lines between the participants. The visibility is given, if the connection lines between the occupants do not intersect a view obstacle. Possible results of the visibility check are visible or not visible.

Sensor detection

If sensor specifications are available for the actual accident, the simulation is able to check if the occupant is detected by the sensor in time. This calculation is done, by using the sensor characteristics, the actual position of the occupant and the information about the actual visibility. Three results are possible for sensor detection first detected, second not considered, third not in range.

Plotting the results

After simulating the accident and calculating position, visibility and detection the results can be plotted in pre-crash scatter plots shown for example in the results.

RESULT

After the simulation three kinds of results can be differentiated.

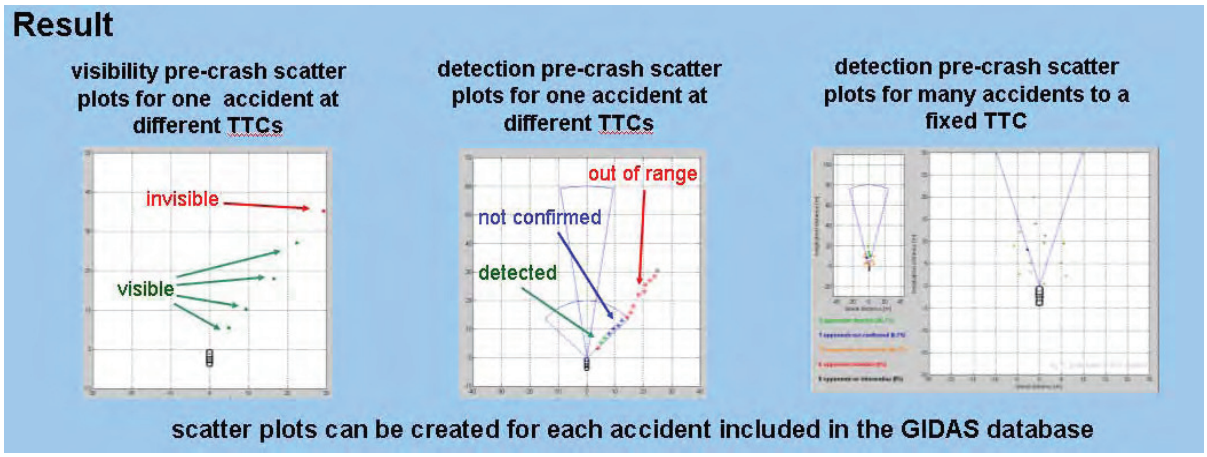

Figure 3. pre-crash scatter plots

Visibility pre-crash scatter plots

A visibility pre-crash scatter plot is drawn in a "fixed to car" coordinate system. It unites the information about the position of the occupant at different TTCs and the information about the visibility of the occupant. Such a scatter plot gives the information of the first visibility to the fixed car.

Detection pre-crash scatter plots (single accident)

Detection pre-crash scatter plots are drawn in a "fixed to car" coordinate system, similar to the visibility pre-crash scatter plots. Different to the visibility pre-crash scatter plots the sensor geometry is included. Using this implemented sensor geometry additional information can be given. The additional information in this plot is the first detection of the occupant. The geometrical points are divided into three groups the out of range, which are not inside of the sensor geometry, the not confirmed, which are in the geometrical field of the sensor but not yet detected and the detected group, which are in the geometrical field of the sensor and confirmed.

Detection pre-crash scatter plots (many accidents)

Different to the other pre-crash scatter plots are these plots only at one fixed TTC, but for more than one accident. Meaning the position of all considered accidents to a fixed TTC is drawn. This geometrical information is added with the detection information drawn by color. Similar to the pre-crash scatter plot for a single accident the information can be detected, not confirmed, and out of range.

Usage of pre-crash scatter plots

Pre-crash scatter plots can be drawn for every accident coded in the GIDAS database. Due to this fact new and existing sensor systems and configurations can be estimated using the representative GIDAS database. It is a beneficent possibility to check the necessity characteristics of a sensor system before placing it into a car.