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Simulation on Vehicle Collision Accidents and Vehicle Safe Evaluation based on Nais Platform

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Abstract: Application of computer simulation techniques in traffic reconstruction will contribute to the sustainable development of protection of pedestrians and driver. In this paper, introducing National Automobile Accident In-Depth Investigation System，Nais. The proposed database establishment could handle data while cases accumulate to a certain degree. Based on its strict workflow and thought process, take a collision accident as an example, collecting accident information, using PC-CRASH to reconstruct this accident. Evaluating consistency of simulation results and accident. Finally, in the light of this vehicle, making safe evaluation and analyzing the reason of airbag unexploded. The proposed database provides a powerful and extensible framework that is particularly well suited to analyzing big variety data in traffic accident.

Keywords: Nais platform, Traffic Accident Reconstruction, PC-Crash, Safe Evaluation, Airbag

1 Introduction

National Automobile Accident In-Depth Investigation System, NAIS, which is established by Traffic accident research institution, Motor vehicle judicial identification center and universities, to find out safe defect in vehicle product and carry out the car recall.

Some problem has been found in In-Depth Investigation Database.

(1) Most rear protective device in truck does not conform to National standard.

(2) Air bag does not work, so it can not have the best protective effect on the member.

(3) Tire come loose or blow-out from a speeding car make the vehicle out of control.

(4) High speed shock on vehicle lead to auto body frame break, causing serious injury to the occupants of the vehicle.

To carry out Automobile Accident In-Depth Investi-gation and vehicle safety defect management in China have been obtained some results. But compared with foreign countries, automobile accident in-depth Investigation, data analysis and vehicle safety defect management in domestic development is not perfect, the study of the system still need to strengthen to improve the analysis of the defects of the accident vehicle, accuracy and safety defect management level. Although the system has a great contribution to improve the safety performance and vehicle safety defect management of vehicles, it's still inadequate. Because the limited way of data collection, cases in database is not enough to launch overall assessment and analysis in given vehicle segment.

In this paper, the difficult is analyzed in traffic accident analysis. In order to enrich the database of the system, collecting and analyzing accident cases in Southern China District. then input these cases to database, expect to find common points from accidents database, put forward measures to reduce the traffic accident，to redesign the component where impact safety, can better protect pedestrians and passengers when a traffic accident occurs.

2 Basic process and thinking of Nais platform

Nais platform similar to Germany's GIDAS project, Its basic processes include: accident scene investigation, information collection, using the software such as Auto-CAD、PC-Crash to simulate the occurrence of the accident through the acquisition of information before. Analysis of the root cause of the accident according to the professional knowledge. Finally, organize the report and put all the information into the database. The database records the information such as people, vehicles, road, collision description and other aspects. The traffic accident is described in common by dozens of sheets, makes the data information as detailed as possible.

2.1 Accident information collection

Nais platform accident information acquisition is as follows

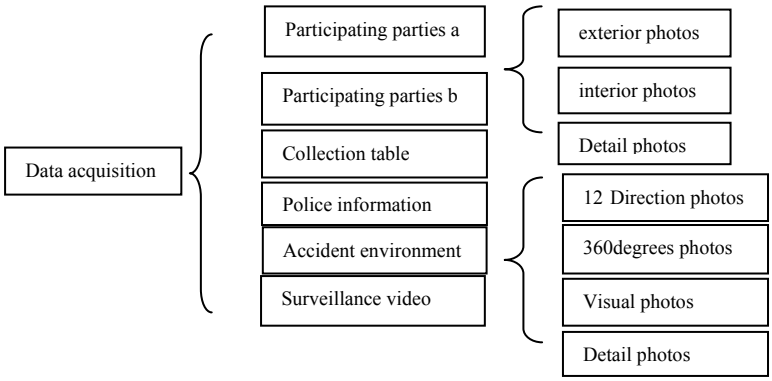


Figure 1. Accident information collection of Nais platform

To get police surveillance video information and police information such as accident scene photos, accident scene graph, participant record, hospital report, police responsibility confirmation, judicial identification and vehicle damage will be better.

Data analysis: telephone return call, injury assessment, CAD drawing, speed calculation, After Analysising and judging the above information writing report then input the information into databases.

2.2 Work idea

After receiving the accident phone call, quickly rushed to the scene to carry out information collection. In order to reconstruct the accident, need to master the following important information：final position of vehicles, pedestrians and other accidents involved, crash site and site trace, movement direction of the collision, pavement condition, driver operation and so on. After mastering the above information, calculate speed by the following ways: kinetic and kinematic formula, video recording data, empirical chart, energy method and stiffness coefficient method, use Pc-Crash for accident reconstruction calculation, technical identification of vehicle speed in typical traffic accident [1].

3 Reconstruction and simulation of the collision accident example

3.1 Case outline

A collision accident of motorcycle and car occur one night in Baoan District, Shenzhen. The car traveling from east to west, have the first collision with motorcycle traveling from north to south. The car did not stop after the crash, continue to move forward, and have the second collision with tree then stop. Severe deformation of the front right side of the car, motorcycle driver injured. Collecting information of this accident [2], vehicle collision scene graph as shown below. In the accident above, this vehicle occurred collision twice. After judging by the injury of the motorcycle driver and the motorcycle, could conclude that the serious distortion in the car front is due to the second time collision with tree. Thus, should construct accident with tree in detail. After data collection for the accident, Some basic parameters can be obtained for simulation， the accident could be reconstructed by using PC-Crash.

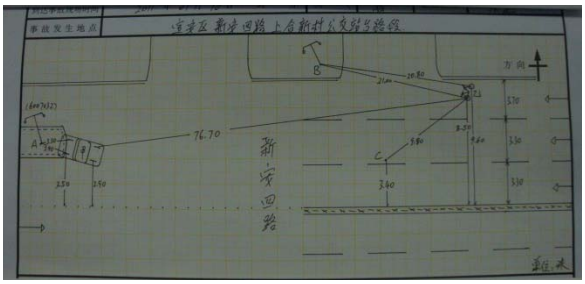


Figure 2. Sketch map: vehicle collision scene

Figure 3. Picture: accident vehicle

3.2 Model establishment

Vehicle: PC-Crash is based on the momentum theorem for accident reconstruction[3]. This example directly invoke mathematical model of the vehicle, then set up the parameters of the model such as Vehicle Shape、Impact parameters, Stability control, Braking and so on[4].

Exporting driver model from the software, then set up driver's parameters such as weight, action, initial orientation and so on. The car is equipped with safety belts, airbags, side air curtain and other passive safety device, all of these parameters need to be set up in the software.

Exporting mathematical model of motorcycle from the software, and then set the parameters for the motorcycle and motorcycle drivers. The setting of the parameters is derived from the experience and some relevant literature[5].

Road and environment model establishment: Based on the information collected in the field, draw a spot picture with Autocad, and import the picture into Pc-Crash, then establish A model of road based on CAD picture.

Derived tree model which its radius is 10cm According to the results of the field survey from PC-CRASH database. Finally, derived the model of the road from the software according to the situation[6][7].

3.3 Parameter setting

Speed setting: Set the initial speed of the PC-CRASH model. The initial speed of the car is 69km/h and the motor is 39km/h, tree is zero.

Accident parameter setting: Vehicle order parameter including vehicle deceleration, vehicle steering, friction coefficient, and collision speed and so on. The driver of the vehicle in the escape process operate the steering system. With the road tire mark and the second collision position, the wheel steering angle can be determined[8].

Setting the position of the impact point, the coefficient of resilience, and the amount of energy change：In this example, the position of the impact point is determined according to the car, the motorcycle driving trajectory and the tree position. Then set the car's energy change (EES). According to the deformation of the body， PC-CRASH can accuratly estimate energy changes in different parts of the vehicle collision. According to the measurement of body deformation after the car accident, estimate the EES of the car accident car is76km/h. The rebound coefficient of vehicle deformation is 0.2 according some reference[9].

Result output; From PC-CRASH's, output simulation results which reflects the movement track of the car and motorcycle.

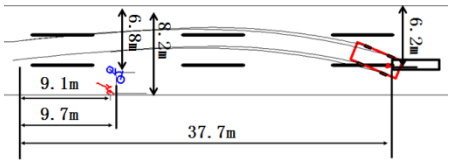


Figure 6. Simulation chart: collision process

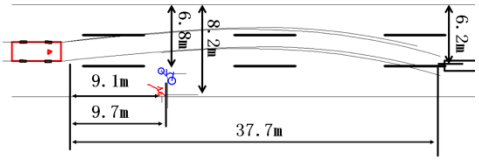


Figure 7. Simulation chart: collision process（t=0s）

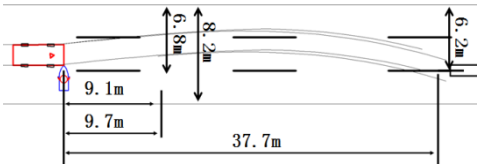


Figure 8. Simulation chart: collision process（t=0.18s)

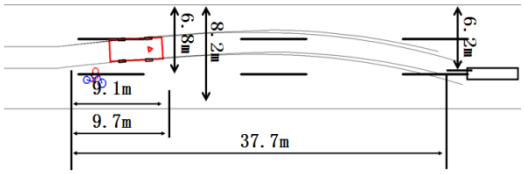


Figure 9. Simulation chart: collision process（t=0.705s)

When t equals zero, The vehicle drive from east to west, while motorcycle drive from north to south in front of the road fork, suddenly appeared in front of the car.

When t equals 0.18, The car has collided with the motorcycle, its pilot flew out and his head hit the car's hood. Record the impact strength at this moment, the impact of the head can be estimated and evaluated which influence driver's life safety.

When t equals 0.705, the motorcycle driver's head hit the floor. Record the impact strength at this moment, can also estimate and evaluate the impact of the head. Estimate the distance of the driver's throwing distance according the track of the motorcycle driver.

Some cars are equipped with a collision data recorder, which will record the information of the vehicle collision time such as signals of air bag, ECU data, engine speed, torque, speed, acceleration pedal position, brake pedal position and vehicle deceleration and so on.

Data processing methods are as follows: using a data reader to read data directly connected to the vehicle when the battery wire is not damaged. Otherwise, remove airbag ECU so that use a specific connector to read effective information.

3.4 Evaluation of simulation results

The accuracy of simulation results is evaluated by the following aspects[10]:

(1) The actual collision point between vehicle and motorcycle is similar to the simulation point. The final position of vehicle and motorcycle is also similar to the simulation one.

(2)There is no footprint left on the road because the driver of vehicle didn't brake before collision. The moving track of motorcycle in simulation is similar to the mark left on the road. Vehicle escape after the first collision without brake, so there is no footprint left on the road. However, as the driver brake before the second collision, the moving track of vehicle is very close to simulation.

(3)The strength of the first collision is not strong while the second collision is the major reason of vehicle body deformation. The deformation of vehicle body in simulation is very close to the deformation that collect on the spot.

(4) The pre-velocity of collision in simulation is close to the data displayed in the collision data recorder.

Based on the above points, it can be considered that the simulation results are in close to the simulation results.

4 Collision safety assessment

Distance and velocity: In this example, the velocity of vehicle is 76km/h, which velocity has decreased to 71km/h. Then, vehicle escape and stop after the second collision. The relationship between distance and speed in the whole process is shown in figure.

Brake force: The brake force data can be export from the simulation results. To evaluate the power of each wheel, can judge whether the car brake system is working correctly.Found that its braking system braking system is insufficient, but there is no leakage in braking line, which means that the reasons for the anomaly may be collision.

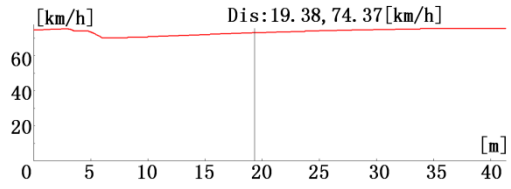


Figure 12. Curve: distance and velocity

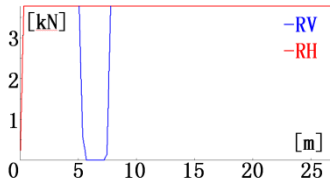


Figure 13. Curve: wheel braking force

Wheel yaw angle: In this instance, the car steering system has work. The curve of the steering angle of the wheel is derived from the simulation results, as shown below.

After hit the motorcycle, the car deviation to left. The driver turns the steering wheel to the right in his first thoughts so that the vehicle can maintain its original trajectory. Although the steering system can't be detected because of the impact, its mechanical connection parts of steering system works normal and there is no leakage in power steering line, which means that steering system works normal.

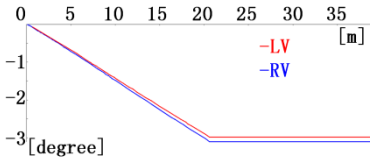


Figure 14. Curve: wheel braking force

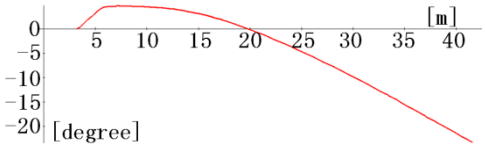


Figure 15. Curve: yaw angle

Analysis of airbag unexploded: This car is equipped with a driver's airbag. Derived deceleration data from the simulation results could know that deceleration of the car is 1.50m/s2,which don't meet the requirements of air bag explode. In the second collision, velocity of the car drop to 0, which means that its deceleration match condition of airbag explode while airbag haven't work. It is necessary to analyze the reasons.[11]

According to data of collision data recorder[12], left front sensor signal interrupt, which fault code is 14. Through the detection of the vehicle after the accident, the sensor harness has been broken. It is likely that the impact of the car and motorcycle caused the front bumper off, which cause sensor wire broken.

Write the accident analysis report after completing the accident simulation analysis, and the input information such as photos, vehicle information and so on to database.

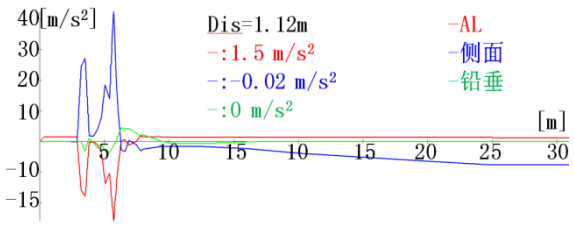
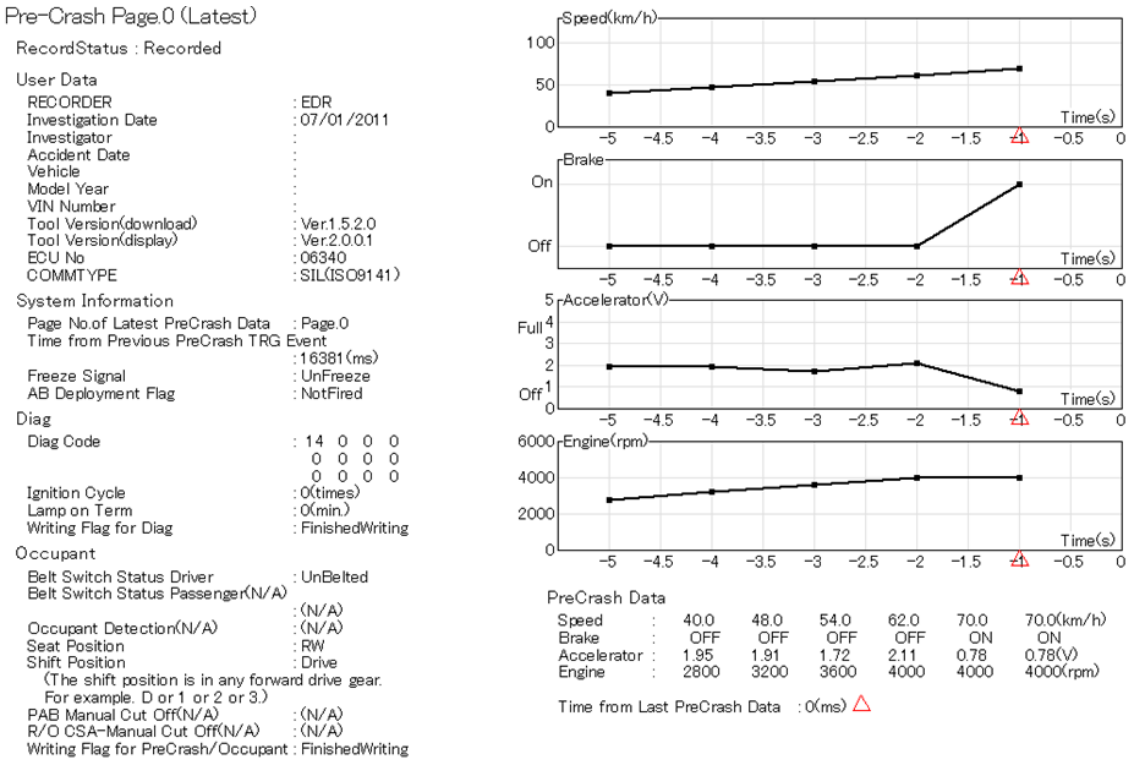


Figure 16. Curve: vehicle deceleration



Pre-Crash Page.0 (Latest)

RecordStatus : Recorded

User Data

RECORDER	: EDR
Investigation Date	: 07/01/2011
Investigator	:
Accident Date	:
Vehicle	:
Model Year	:
VIN Number	:
Tool Version(download)	: Ver.1.5.2.0
Tool Version(display)	: Ver.2.0.0.1
ECU No	: 06340
COMMTYPE	: SIL(ISO9141)

System Information

Page No.of Latest PreCrash Data	: Page.0
Time from Previous PreCrash TRG Event	: 16381(ms)
Freeze Signal	: UnFreeze
AB Deployment Flag	: NotFired

Diag

Diag Code	: 14 0 0 0 0 0 0 0 0 0 0 0
Ignition Cycle	: 0(times)
Lamp on Term	: 0(min.)
Writing Flag for Diag	: FinishedWriting

Occupant

Belt Switch Status Driver	: UnBelted
Belt Switch Status Passenger(N/A)	: (N/A)
Occupant Detection(N/A)	: (N/A)
Seat Position	: RW
Shift Position	: Drive
(The shift position is in any forward drive gear. For example. D or 1 or 2 or 3.)	
PAB Manual Cut Off(N/A)	: (N/A)
R/O CSA-Manual Cut Off(N/A)	: (N/A)
Writing Flag for PreCrash/Occupant	: FinishedWriting

PreCrash Data

Speed	:	40.0	48.0	54.0	62.0	70.0	70.0(km/h)
Brake	:	OFF	OFF	OFF	OFF	ON	ON
Accelerator	:	1.95	1.91	1.72	2.11	0.78	0.78(V)
Engine	:	2800	3200	3600	4000	4000	4000(rpm)

Time from Last PreCrash Data : 0(ms) △

Figure11. Data: collision recorder

5 Conclusion

It is necessary to establish a database of traffic accident cases. In this paper, we have described the basic working ideas and processes of the Nais platform and completed a collision accident base on this method. Finally, make safety assessment after simulation and analyze the cause of the air bag unexploded. Through the acquisition of more relevant cases can find more useful information which can optimize vehicle components design, Reduce casualties in traffic accidents and so on. This method has standardized the process of accident acquisition, database store. The database could be a resources to make a depth analysis in large amounts of data, put forward the countermeasures of traffic accident, optimized vehicle design, contribution better protection to the driver and pedestrian.

Acknowledgement

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