# THE USAGE OF SMARTPHONES FOR RECORDING ACCIDENTS AND INCIDENTS FROM THE CRITICAL SITUATION UP TO THE POST-CRASH PHASE

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## ABSTRACT

Smartphones are becoming more and more popular not only for younger people. Contrary to traditional mobile phones they are mostly equipped with sensors for acceleration and yaw rates, GPS modules as well as cameras in high definition resolution. Additionally they have high-performance processors that enable the execution of CPU-intensive tools directly on the phone. The wide distribution of these smartphones enables researchers to get high numbers of users for such studies.

The paper shows and demonstrates a software app for smartphones that is able to record different driving situations up to crashes. Therefore all relevant parameters from the sensors, camera and GPS device are saved for a given duration if the event was triggered. The complete configuration is independently adjustable to the relevant driver and all events were sent automatically to the research institute for a further process. Direct after the event, interviews with the driver can be done and important data regarding the event itself are documented.

The presentation shows the methodology and gives a demonstration of the working progress as well as first results and examples of the current study. In the discussion the advantages of this method will be discussed and compared with the disadvantages.

## INTRODUCTION

Changes of technologies from passive/secondary to active/primary safety become more and more important. Due to that, also the used data will change from conventional impact und injury data to all information prior to the collision. In figure 1 the real accident database GIDAS is compared to naturalistic driving data of VUFO.

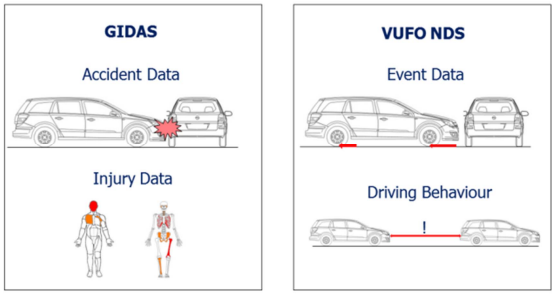


**Figure 1. Comparison of accident and incident data.**

If an accident occurs, the accident investigation team will be informed by the police or rescue services, so that they can investigate the real data on the spot immediately.

If an incident occurs, it will be much more difficult to get informed. A complete new method of investigation of this data is necessary to realize an interview with the participant as fast as possible. A normal event data recorder can detect crashes and strong near misses, but a video-based analysis of the situation is not applicable.

## INVESTIGATION OF INCIDENTS

For that reasons VUFO began to develop a new tool for the investigation of incident data with the following boundary conditions.

- minimum installation effort at the vehicle
- (preferably) no influence to the driver
- Tool should record video-, speed-, acceleration-, gyro- and global position-data
- events should be triggered automatically

- triggering should be possible depending on position, by exceeding of physical thresholds or manually
- tool should be centrally configurable

To realize a high number of participants in a representative manner the tool should be easy to handle for consumers as well as the study operators. For an easier analysis of the data, the coding of the parameters should be analog to the GIDAS database. This also implements the simulation process analog to GIDAS with a Pre-Incident-Matrix (PIM). This allows the use of the same tools and simulation framework that already exist for real accident database like GIDAS.

In figure 2 the setup of this method is shown.

**Figure 2. Setup for investigation of naturalistic driving data using smartphones.**

Modern smartphones are equipped with

- camera
- acceleration sensor
- gyro-sensor
- GPS sensor
- transceiver
- CPU and memory

The described method based on an application for these smartphones which will record all the necessary parameters in a circular buffer.

For the central configuration of the application, especially for the individual triggering parameters, the method bases on a server environment as shown in figure 3.

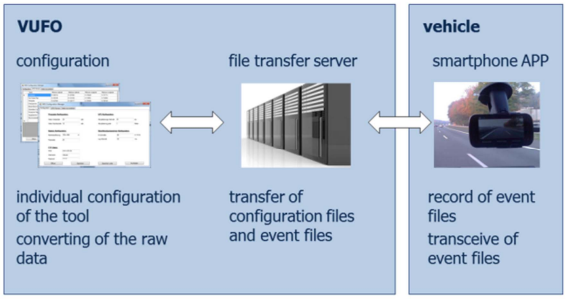


**Figure 3. Server environment.**

To realize a complete and independent investigation of all parameters, the tool can be configured via file transfer server. The complete data exchange is also managed via file transfer server. This guarantees that the triggered events will be as fast as possible available for the subsequent investigation of the other relevant data in relation to the event. The study participant can be interviewed concerning the event by our experts soon.

In figure 4 the basic functionality of the VUFO NDS-APP is shown.

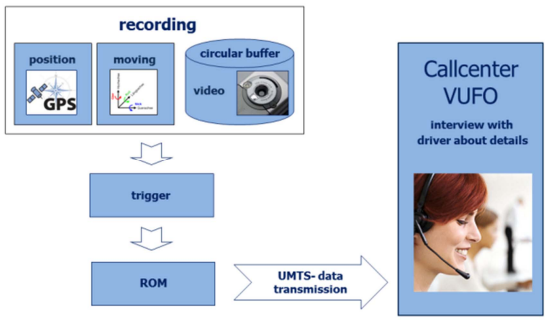


**Figure 4. Basic functionality of VUFO NDS-APP.**

The software records the GPS positions, all the moving parameters and the video stream in a circular buffer. If an event is triggered, a sequence of maximum 60 seconds backwards will be saved to the RAM of the smartphone. This event file will be sent via UMTS or WLAN connection to the file transfer server immediately.

In the next step VUFO will analyze this event and call back the participant to get further information, if the event is of interest for VUFO NDS.

In figure 5 the further tasks are shown.

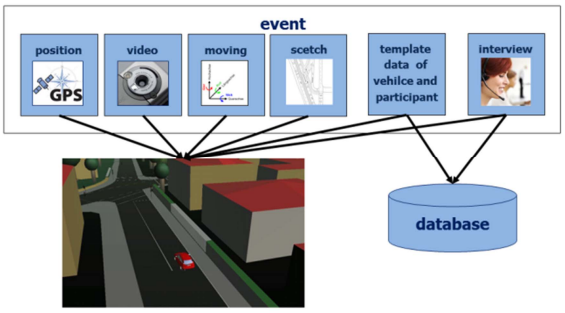


**Figure 5. Further tasks for events in VUFO NDS.**

The event data will be combined with a scaled sketch, all available template data of the vehicle and the participant and the interview data to a simulation of the event. This file is called Pre Incident Matrix (PIM). All parameters will be coded into the VUFO NDS database additionally.

## DATA OF VUFO NDS

With the described process VUFO NDS is able to collect data in the following manner:

- driving behavior
- incidents
- accidents
- manually triggered records
- position-based records

Especially the driving behavior of the participants is important to know. VUFO NDS is using this data for an individual triggering threshold for incidents of this participant as well.

### Driving Behavior

Figure 6 shows a recording of a participant with his individual comfort zone regarding longitudinal and lateral acceleration. This comfort zone is based on a record of all moving parameters for several days.

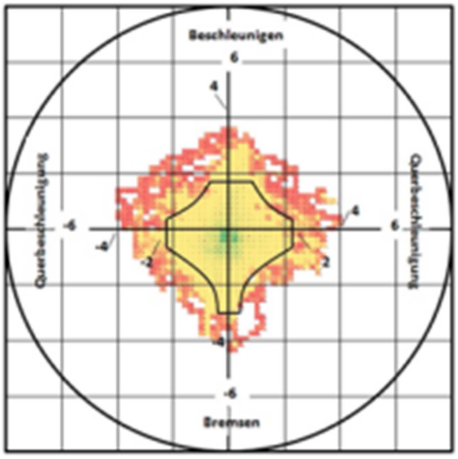


**Figure 6. Recorded individual comfort zone for acceleration in x- and y-direction for the individual participant.**

### Incidents

Especially incidents and more or less critical situations are of interest in this project. As rare as they happen, they are very important to analyze the pre incident phase.

All warning strategies of ADAS are only appropriate when they are accepted. If acceptance could be assumed in high critical situations, it will become more and more difficult for less and uncritical situations.

### Accidents

Accidents are very rare events. Only every 500.000 km an accident will occur. Nevertheless if an accident happens, the VUFO APP will record all the relevant parameters prior to the crash. These data could be used by experts to proof the innocence of the participant or at least provide data similar to an EDR.

### Manually triggered records

Not all situations of interest can be triggered by exceeding of a moving parameter or by passing of GPS positions. In that case the participant can trigger an event manually.

### Position based records

Especially for accident hotspots it will be of high interest to record individual sequences by passing the spot. These records can be analyzed via video and moving parameters. In figure 7 a special

analysis regarding loss of control accidents on an accident hotspot is depicted.

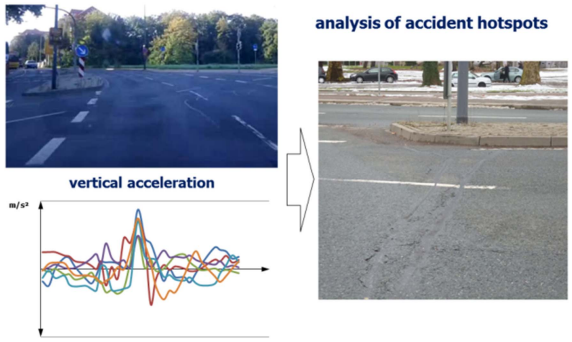


**Figure 7. GPS position based accident hotspot recording.**

## VALIDATION OF VUFO NDS

To validate the measurement results of the VUFO NDS APP different test drives were initiated. Figure 8 shows the scenario on the test track.

**Figure 8. Scenario of the test drive.**

The test car was equipped with a KIENZLE event data recorder and the VUFO NDS APP. Both measuring devices recorded the longitudinal and lateral acceleration as well as the speed.

Figures 9 and 10 show the validation results of longitudinal and lateral acceleration.

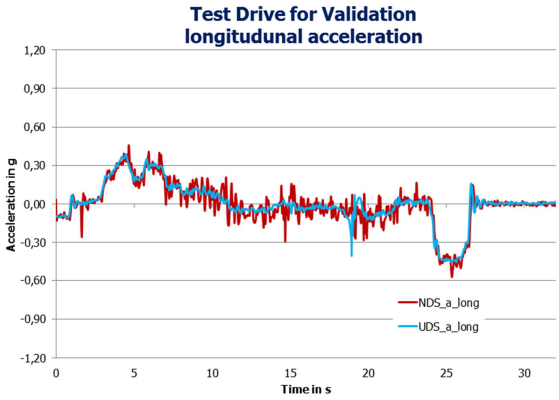


**Figure 9. Validation of the longitudinal acceleration.**

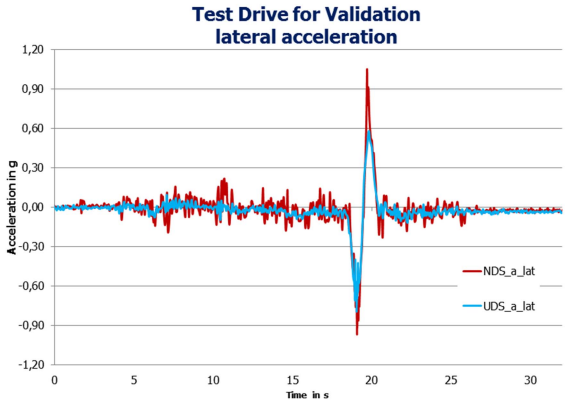


**Figure 10. Validation of the lateral acceleration.**

Both measurement results of VUFO NDS APP correlate with the accredited and calibrated results from the event data recorder.

## CONSUMER BENEFIT OF VUFO NDS

### Event Data Recorder

For the consumer and study participants of this project the VUFO NDS APP will work as a normal event data recorder with additional video information. (see figure 11) This data could be used by experts to proof the innocence of the participant.

**Figure 11 VUFO APP as event data recorder**

A normal upgraded event data recorder costs around 1000€ while the VUFO NDS APP is free of charge.

### Hazard Warning

The VUFO NDS APP could also be used as a hazard warning due to different daily driven situations. Figure 12 shows show some of these possibilities.


**Figure 12. Hazard warning functionality.**

The warning threshold could be easily adjusted be using the driver behavior results as described before.

**Economic Driving**

Economic driving is becoming more and more important. VUFO NDS APP could help to drive as economically as possible by measuring the real situation and comparing it to the average or most effective one in the same situation. This will help to reduce unnecessary expense. Figure 13 shows the principle setup.


**Figure 13. Economic driving functionality.**

**CONCLUSIONS**

Detailed information about the pre-crash or pre-incidence phase needs to be investigated with new methods. The paper shows an application for smartphones which is able to detect critical scenarios as well as recording moving parameters of the participant.

At the Accident Research Unit VUFO, this app is used to build up a naturalistic driving database near to existing real world accident databases (e.g. GIDAS).

The comparability to this database guarantees the use of the same methods and simulation tools for all future users.

The VUFO NDS APP could also be used for the consumer in terms of event data recorder for crashes and warnings and information about hazard and economic driving.