Possibilities and Benefits of Event Data Recorders (EDR) for Motorcycles

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EUDARTS: The EUDARTS Group (European Data Analysis Research Training & Service) is an association of experts and trainers in more than 30 countries and cooperates with 23 European police forces and 500+ private enterprises.
Within EUDARTS the MODARTS division focuses at EDR for PTW's. MODARTS aims to facilitate and encourage the development and usage of EDR in PTW's and will offer services in the field of diagnosis and analyses, training & service in respect to EDR for PTW's. This is our contribution to safety of motorcycles and other PTW's.

Introduction:

Implementation of advanced electronics in road vehicles, has given the possibility to record events like accidents, defaults or anomalies. An EDR records a set of parameters, such as speed, acceleration/ deceleration, position of throttle and brakes etc. after an event occurs that meet predefined criteria.
EDR became mandatory in the US for new passenger car models in 2006; in the EU from 2022.
Motorcycle accidents are complicated incidents to analyse in comparison to car accidents: the trajectory of the motorcycle is usually not just longitudinal, impacts zones are not easily visible and the rider often has a separated trajectory.

Research question:

Three questions will be answered:

1. What's the state of art, what has been published.
2. Can a motorcycle EDR provide useful data to analyse an accident.
3. What are the benefits of motorcycles equipped with EDRs for traffic safety.

Method:

Desk study was conducted to obtain insight in the state of art.
A sample of registered motorcycle accidents was evaluated on the benefit of using eventual additional data from an EDR systems.

Results:

The results show that EDR data can deliver accident and vehicle dynamics information that lead to a better understanding of motorcycle accidents or near accidents.
It is recommended that further extensive research on this topic will be conducted for validation reasons and to point out areas of further improvement. Technical solutions for EDR in motorcycles are within reach or available, and a matter of making agreements with the PTW industry.

Impact:

Similarly to EDR in cars, motorcycle EDR is an objective data recording method to analyse motorcycle accidents. The deeper knowledge in motorcycle accidents will lead to countermeasures and contribute to safety of motorcycling.

Contents

1. General

Event Data Recorder (EDR)

EDR is a device or function that records the measurements, in chronological order before, during, and after an event happens, such as significant reduction in speed. For passenger cars the EDR is triggered at a delta-V of 8 km/h within a 150 ms interval. To have the EDR ready at the moment the trigger level is reached, a “wake-up call” is given at a cumulative delta-V of over 0,8 km/h within a 20 ms time period [1].
Event Data Recorders are essentially different from a Flight Recorder in an Airplane A Flight recorder registers data and cockpit voice during the whole flight whereas an Event Data Recorder registers data only in case a pre-determined event occurs.
Information obtained from EDR can contribute to understand the causation of an accident. This will allow researchers to better assess the effectiveness of countermeasures, manufacturers to improve future vehicle design and it will allow to determine the liability for the accident more accurately and objectively determined, therefore reducing time and legal costs and providing road users and society with access to justice.

Powered Two-Wheelers (PTW)

The term ‘Powered Two-Wheeler’ (PTW) covers a wide diversity of vehicles. The products are divided into different segments such as moped, scooter, street, classic, super-sport, touring, custom, supermoto and off-road motorcycles.
PTW’s are one of the most affordable forms of personal transport in many parts of the world. In various regions, PTW’s are also the most common type of motor vehicle.
In the international regulatory environment, in particular UNECE, PTW’s are referred to with the term: ‘vehicles of category L’. At first, in this initiative we focus at the category L3, motorcycles: a two-wheeled vehicle with an engine cylinder capacity in the case of a thermic engine exceeding 50 cm3 or whatever the means of propulsion a maximum design speed exceeding 50 km/h. See the UNECE Consolidated Resolution on the Construction of Vehicles [2] for further information.

Urge

Progress in reducing EU-wide road fatality rates has stagnated in recent years. It appears highly unlikely that the EU's current medium-term target, to halve the number of road deaths between 2010 and 2020, will be reached. Even less progress has been made in preventing serious injuries. A prerequisite for reducing the number of road accidents is to have a good understanding how accidents happen.
The introduction of various Advanced Driver Assistance Systems (ADAS) has improved road-safety but made it often even more complicated to determine the causation an accident.
The EU will require for new type of cars, together with the mandatory fitment of a number of ADAS systems an Event Data Recorder from 2022 onwards (EU Regulation 2019/2144 of 27 November 2019). The expected large-scale implementation of EDR in cars together with the on-going miniaturization of electronic components will make the easier to implement EDR on motorcycles too.
Compared to car-car accidents, motorcycle accidents are more complicated to analyse due to the lack of clear impact zones and the movement in three dimensions by the motorcycle.
A large-scale fitment of EDR on motorcycles would help to analyse the causation of motorcycle accidents and at the end to take the appropriate measures to improve road-safety.

2. State of the art

Scientific papers

In 2015 Murugesh Gorajanal eo [3] mounted an embedded system on two wheelers which records the events like brake, gear, speed, stand and congestion. The results of analysis showed that the recorders can report real world crash data and therefore be a powerful tool by providing useful information to crash reconstruction experts.
In 2016 A.H. Alasiry eo [4] presented a preliminary design of a simple low cost EDR prototype which utilize only external sensors, i.e. IMU, GPS and Compass information, therefore, this EDR can be banded easily and cheap to be used even on a motorcycle. This research was to be continued in the near future by researching new features such as data compression, security, low energy, signal behaviour and also advance testing of this EDR performance and reliability.
Co-writer E.S. Ningrum [5] presented 3D reconstruction tools to accessing real-time data in the Event Data Recorder (EDR) loaded in a motorcycle. The aim is to facilitate investigators for analysing the chronology of motorcycles accident as well as being one of authentic forensic evidence.

The US-researcher and collision-analyst Edward Fatzinger and Landerville [6] [7] published in 2017 and 2018 about the testing of Electronic control units (ECU) from Kawasaki Ninja motorcycles in order to examine the capabilities and behaviour of the event data recorders (EDR).

According to Montalbano eo [8] a number of methods have been presented previously in the literature for determination of the impact speed of a motorcycle or scooter at its point of contact with another, typically larger and heavier, vehicle or object. However, all introduced methods to date have known limitations, especially as there are often significant challenges in gathering the needed data after a collision. Unlike passenger vehicles and commercial vehicles, most motorcycles and scooters carry no on-board electronic data recorders to provide insight into the impact phase of the collision. Recent research into automobile speedometers has shown that certain types of modern stepper motor-based speedometers and tachometers can provide useful data for a collision reconstruction analysis if the instrument cluster loses electrical power during the impact, resulting in a “frozen” needle indication.
Filliger ea [9] already in 2013 computed information from measurements of a commercially available, low-cost 6-axes MEMS-IMU (3 specific force and 3 angular rates sensors), in order to avoid privacy issues related to GPS-based EDR-functionality.

Patents

Scanning Google patents* shows not much of research has been protected by patents so far. Whether this is also a sign of comprehensive R&D on this subject or not, is still unknown.
*https://patents.google.com/patent/EP2026287B1/en?q=event&q=data&q=recording&q=motorcycles&oq=event+data+recording+motorcycles EDR is in classification G07C5/085.

Current application in motorcycles

About Kawasaki it is known from the user manual that EDR functionality is present in at least a number of Ninja- and recent models. The same is for Honda’s US Gold Wing model. About cars in general there is a relation between airbags and EDR. Kawasaki shows it doesn’t have to be the case, because the Kawasaki patent is about triggering events without an airbag sensor.
BMW through its E-Call functionality [10] shows to have the technical solutions to trigger the major events: ‘The consequences of the collision and the state of the motorcycle are transmitted via sensors on the motorcycle so that accidents can be reliably recognised and differentiated from typical motorcycle driving situations.’
No official statements about EDR for motorcycles have been published so far. A survey along European Head Quarters of major OEMs showed EDR is not top of mind yet, although the subject attracts attention. Most OEM's have it or will have it 'under investigation'. A common remark is about the costs issue. It is relatively and absolutely more expensive in motorcycles than in cars because of the different production numbers.

3. Accident Analyses

Case A

The following has been anonymised for this publication. It is an intersection accident, between a motorcycle and a car.

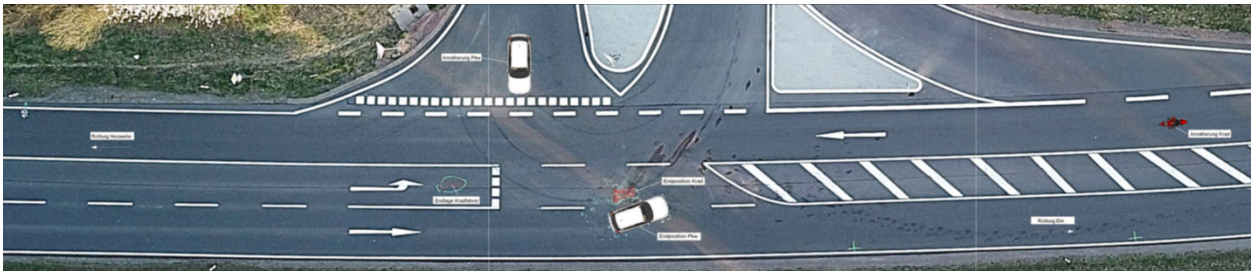

Image 2: Overview of the collision scene case A

The investigation report of the scene describes: 'Intersection accident: The *car* came from the *road number 1* (vertical on the picture above) and intended to turn left onto the *road number 2* (horizontal) in the direction of *city name 1* (to the right side from this picture). The cyclist drove on the *road number 2* in the direction of *city name 2* (to the left side). When the *car* turned left onto the *road number 2*, it overlooked the motorcyclist who had the right of way. According to the car driver, the cyclist drove too fast. The *road number 2* has a speed limit of 100 km/h, and 70 km/h at the crossing.'

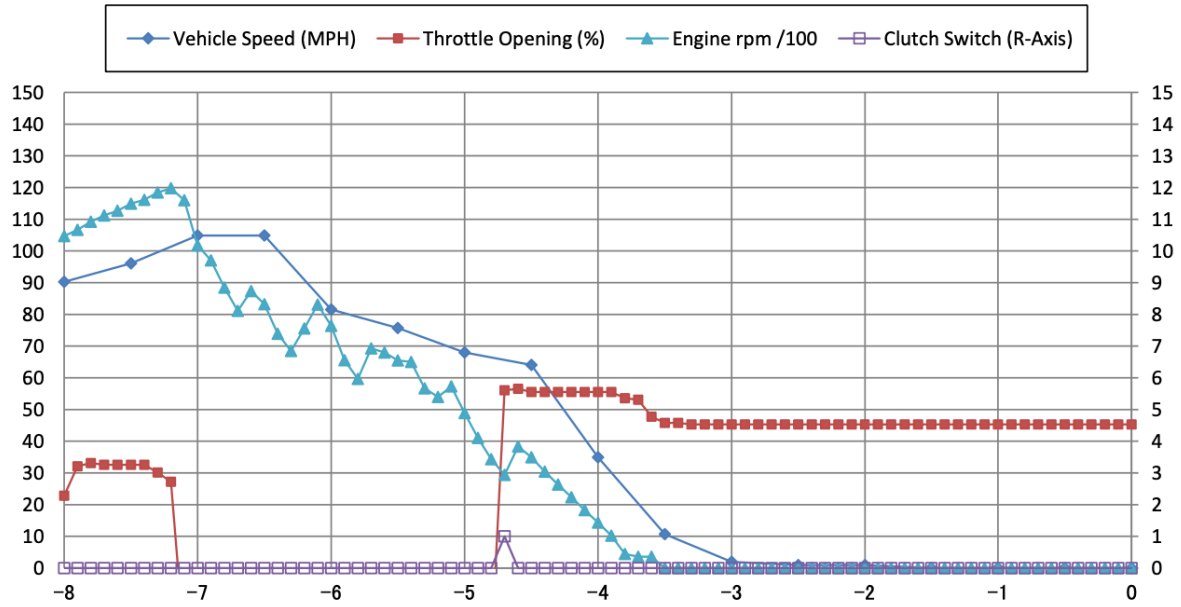

Diagram 2: Event data recordings (correction in legenda: MPH = km/h)

Explanation to the recorded variables: time of impact is between -4.5 and -4 seconds. At -7.5 seconds the motorcyclist releases the throttle and reduces speed to 80 km/h in 1 second, a deceleration of 6 m/s^2. The next second speed is reduced to 70 km/h (speedlimit at the crossing), at before the moment of impact speed further to 65.
The car came from the right and turned left, but the driver overlooked the motorcycle. The motorcycle approaching reflexively dodged to the left. The collision analysis confirmed exactly the value from the EDR.

Case B
The accident has been anonymised, all information that can lead to time, place, people has been omitted.

In this case, the vehicles initially drove in a column, the combination of car and trailer turned left at the very same moment as the motorcycle overtook the white van behind car and trailer. The motorcycle is thrown to the left after the impact, the motorcyclist is thrown straight ahead over the turning car and lands further down the street.

The job for the expert involved was to determine whether the driver of the car-trailer combination could have seen the motorcycle or determine how long the motorcycle had been driving in the left lane. It turned out that the driver of the car-trailer combination could not see the motorcycle at the moment of the turn because it was obscured by the following white van. The motorcycle did not go too fast (speedlimit 100 km/h).

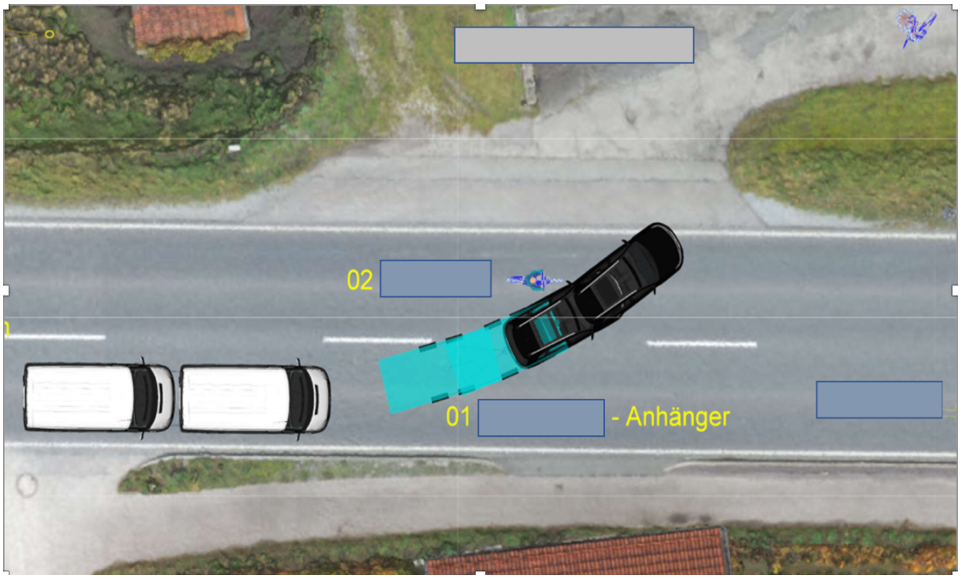

Image 3: collision situation case B

Reconstruction using skidmarks etc. shows the displacement of the motorcycle as a function of time. For this case we focus at only one quantity, speed. Among other items, speeds and deceleration at different moments in time were calculated. This analysis does not point at extraordinary speed directly right before impact, from 21 m/s (75 km/h) to 3.6 m/s less (63 km/h), after one second.

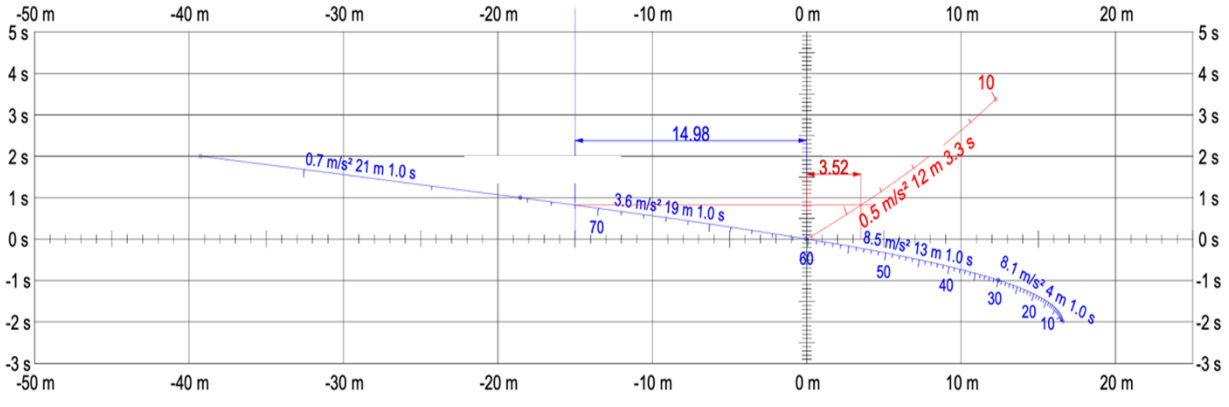

Diagram 3: displacement-time diagram case B

Also in this case, EDR data was available from the motorcycle. An extract of a number of sensors is shown here in diagram 4. This provides insight into the actual speeds and actions of the rider and thus provides valuable information.

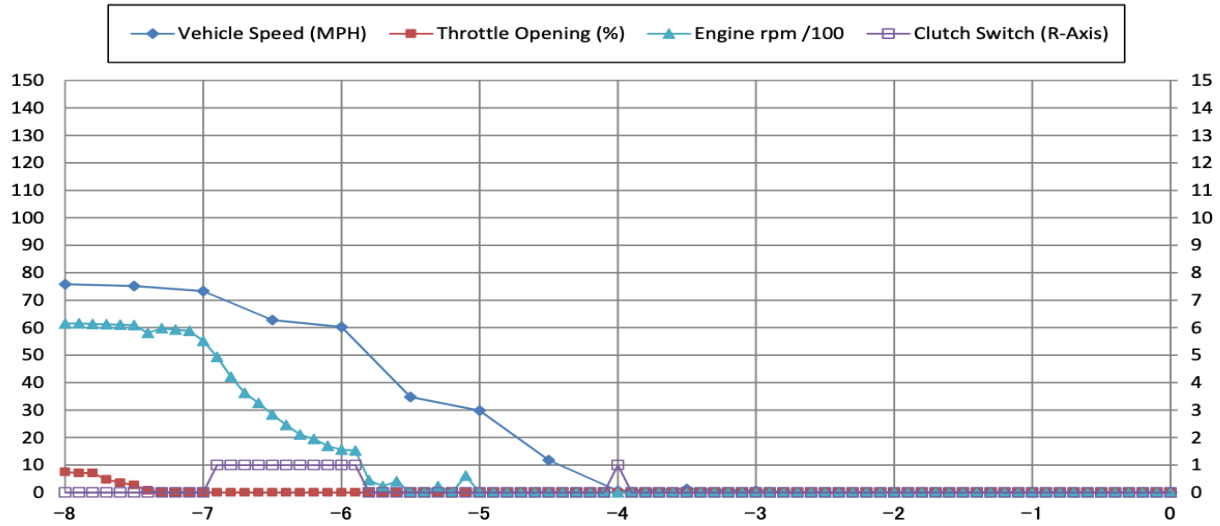

Diagram 4: Event data recordings (correction in legenda: MPH = km/h)

As we can see in diagram 4, approximately 2 seconds (t = - 8) before impact (between t = - 6 and t = - 5,5) the speed of the motorcycle as stored by the EDR was 75 km/hour. This is a plausible speed: at that moment there still wasn't any slip of the rear wheel.

4. Conclusions and recommendations

Motorcycles are considered as vulnerable road users. The fatalities per million driven kilometers are relatively high. It is likely assumed that new technologies can contribute to enhanced safety, for example directly with ADA-systems.
Our experience in legislation issues, the desk study and survey along European Head Quarters of motorcycle OEM's show EDR on motorcycles is not on the agenda's yet, although technical solutions for EDR in motorcycles are within reach or available and ready for large scale implementation.

Conclusions

1. Our studies show EDR-data can enhance and enrich analyses on accident causation and vehicle behavior in case of impactful events. These experiences with analyses on EDR of motorcycle accidents show promising results, not a priori against the interest of the motorcyclist. The results show that EDR data can deliver accident and vehicle dynamics information that lead to a better understanding of motorcycle accidents or near accidents.
2. Technical solutions for EDR in motorcycles are within available and in reach and ready for large scale implementation.
3. EDR on Motorcycles will help to understand how and why accidents happen and can contribute to the development of a safer motorcycling.

Recommendations

1. We wish all stakeholders to adopt these new technologies to enhance safety of motorcycling. Therefore, it is recommended that further extensive research on this topic will be conducted: the development of a minimum set of parameters that has to be recorded by the EDR in case of an event, a validation program to ensure the reliability and the standardization of the data protocols to allow a single reader for all motorcycle models.
2. We recommend the European Commission together with the industry takes an active role on the development and standardization and validation of EDR.
3. MODARTS is ready to assist manufacturers and regulators with the implementation of EDR in Motorcycles.

5. Appendix: regulations

Drivers for EDR
Regulation is a strong driver for development and implementation of EDR, by regional regulation or anticipation on this. Nevertheless, recent history has shown that OEM's might take the initiative to offer EDR functionality for various reasons, others than regulation. Although the fitment of EDR is not mandatory in the US, all cars need to satisfy a number of requirements if data is recorded. De facto all cars sold in the US are equipped with EDR. How the data is stored is not standardized, but the manufacturer has to make available equipment to read the data.
In Europe some large manufacturers have done the same as in the US (e.g. Volvo, VW) but others have encrypted the software or haven't installed an EDR.

General Safety Regulation
Event Data Recorders (EDR) will become mandatory in the EU for new cars, vans, heavy goods vehicles and buses, as a part of a package of safety measures in the revised General Safety Regulation (GSR), approved by European Parliament on the 16th of April 2019 and published and therefore entered into force in the EU on January 5th 2020. It means that all new vehicle models introduced on the market from July 2022 will have to comply. The new regulation requires new vehicles to be fitted with a large number of Advanced Driver Assistance Systems (ADAS) and Event Data Recorder (EDR).
PTW's haven't been taken in account yet, but is most likely to believe this will come in the future. This will take time. Even if there's a Publication of a Regulation, the entry into force is 20 days after the date of publication. New type approvals have to comply after a certain time after the entry in to force (eg. for cars and vans 30 months, for the latest GSR Juliy 2022) and new registrations have to comply after a longer period of time (cars and vans 54 months).
Powered Two-Wheelers (Category L) are not part of the recent GSR, which means RI. 2002/24/EC ofVo. (EU) Nr. 168/2013 is leading.

Regulations and directives on motorcycles
In Europe there is on-going development of regulation concerning safety and sustainability, especially by application of modern techniques in data sensoring and communication. Regulation (EU) No 168/2013 of the European Parliament and of the Council of 15 January 2013 on the approval and market surveillance of two- or three-wheel vehicles and quadricycles contain the current legislation. Following the Lisbon Treaty in 2007, regulations in this area are determined by regulations that were previously directives. From 2013 up to and including 2018, a number of Implementing and Delegated appeared [3]. Most recent is Regulation (EU) 2019/129 of the European Parliament and of the Council of 16 January 2019 amending Regulation (EU) No 168/2013 as regards the application of the Euro 5 step to the type-approval of two- or three-wheel vehicles and quadricycles. NB: it shows that European Parliament and Council don't delegate the environmental and sustainability issues to the Commission.
Of the Regulations on Powered2Wheelers published since 2013, none is aimed at the application of electronics and data for the direct or indirect improvement of active safety, apart from ABS and monitoring functions via an OBD. This contrasts with the GSR of April 2019, which describes a range of ADAS features for other motor vehicles, and EDR.

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