Deliverable 3.1

Propulsion System Specifications

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Executive Summary

The main objective of Work Package 3 is to provide the specifications that a propulsion system should follow to be appropriate for their use in PTW testing. The propulsion systems must ensure the respect of the acceptable corridors specified in the protocols defined in WP4. (Núñez Miguel, D4.1 Car To PTW AEB Test Protocol, 2019) (Núñez Miguel, D4.2 Car To PTW LSS Test Protocol, 2019).
In the project we have worked with two propulsion system providers: 4activeSystems (4activeSystems Freeboard small) and Antonhy Best Dynamics (Launchpad).
This report summarizes the discussions held during the project as well as the conclusions reached in form of specifications. Finally, it provides some future improvements that will be recommended to apply in further steps.

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1 Introduction

1.1 MUSE project

Despite representing a small part of the road users (e.g. 2% of the traffic in France) the percentage of motorcyclists in the total deaths is the highest of the VRUs (World road deaths in 2010: 23% PTWs, 22% pedestrian and 5% Cyclist). A motorcyclist is between 9 to 30 times more likely to be killed in a traffic crash than a driver (OECD, 2015).

In recent years, we have observed a decrease in the number of deaths on the roads. However, this reduction is not equal for all the different road users. If we take a look at the evolution of the mortality depending of the type of road user we see that, while in the case of cars it has been reduced by 50%, in the case of the motorcyclist this reduction it has been only of the 30%. (European Comission, Directorate General for Transport, 2016)

Concerned by this problematic, the French Government decide in 2015 to perform a study in collaboration with UTAC to evaluate the accidentology of the motorcyclists and the possibility of avoiding them or mitigating the consequences using the new ADAS systems. Knowing the importance of Euro NCAP in motivating the OEMs to invest in safety, in May 2016 the Interior Minister Mr. Bernard Cazeneuve and the Transport Minister Mrs. Ségolène Royal write a letter to Euro NCAP claiming for a safety rating involving PTWs. At the beginning of 2017 Euro NCAP includes the scenarios with motorcycles in their Roadmap 2020/2025 and the possibility of start to assess the presence of security systems in motorcycles.

However, how will it be possible to evaluate the systems without the necessary tools to do so? At the beginning of the project it did not exists the testing equipment who will allow us to evaluate the systems, not even a protocol in which the main scenarios and their characteristics are defined.

Furthermore, which will be the best systems to avoid the accidents? Will it generate new accidents? What about ADAS systems in the motorcycle? Is it feasible to perform real test to assess the systems?

The aim of this project was to answer these issues and to provide the OEMs and TIERs1 the tools that will enable them to develop and evaluate their systems. A first task consisted in studying the main accident scenarios and possible systems that could help to avoid them or, at least, reduce their consequences. Simultaneously, tools enabling to improve these systems and to evaluate their performances were developed.

1.2 Objectives of this report

We knew from previous studies that the most part of the accidents with motorcycles happen at speeds higher than the ones of pedestrian or bicycles. It was then necessary to look for other solutions for the propulsion system that the ones used for the other VRUs.

In a first in step it was necessary to study whether the solutions on the market were able to meet the requirements of WP4 and, in case of not finding an adequate solution, to collaborate with the providers of this kind of equipment to develop a suitable solution.

This was a complicated task, as far as the propulsion systems must be able to reproduce the scenarios in an adequate manner and, at the same time, they must not affect to the detection characteristics of the target by itself. In addition, in the context of Euro NCAP or regulatory tests, where these systems may be brought into use, it is essential to ensure repeatability.

For these reasons, discussions between industry and platform providers have taken place in order to find the right balance between requirements and technical feasibility and to help in the development of these systems.

The final objective of this report is to sum up the discussions carried out within the project and to propose the specifications agreed taking into account the current capabilities of the platforms.

2 Propulsion system

The requirements for the propulsion system have been split in two different groups. One concerning the detection characteristics and another one related with the dynamic properties.

2.1 Detection:

At the beginning of the project, it was decided that it should be possible to use the dummy in different platforms and to develop their detection characteristics independently of the propulsion system. For this reason, the dummy should be representative of a real motorbike by itself and the requirement for the propulsion system should be to not affect, or just inside some corridors, the detection characteristics of the dummy. The main objective was to assure the representation of the dummy of a real motorbike independently of the platform in which it is mounted. In this way, several characteristics to respect were identified.

2.1.1 Dimensions:

Not specifics values has been defined for this specific characteristic, the size of the platform is not relevant as far as it does not affect visually to the detection of the dummy. The possibility of using big propulsions systems as the ones used for 3D car balloons was studied and finally refused due to the “flying carpet” effect, in addition of the higher RCS values of these platforms.

2.1.2 Height:

It was not defined a maximum value for the height of the platform as far as the radar reflections are inside the defined levels and the distance of the wheels of the motorcycle dummy to the ground is under 10 mm.

In the context of the test it is probable that the car will need to roll over the platform, an important height could damage the car so a big height is discouraged.

2.1.3 Colour:

The platform should be coloured in grey colours similar to the common asphalt in order to reduce as maximum their optical impact.

2.1.4 Radar Cross Section:

According to the preliminary ISO/CD 19206-3 Requirement for passenger vehicle 3D target:

The radar reflectivity of the target carrier shall be at least lower than 0 dB/m². This also applies to a metallic target carrier based on a state-of-the-art construction. An adapted ramp (22°) might be used to reduce radar reflectivity.

(International Organization for Standardization, 2019)

In the case of the Global Motorcycle Dummy, that does not cover the propulsion system, the effect that the platform could have in the RCS could be even higher.

For the propulsion system of the Global Motorbike Target it was decided to not define specific values but to ask for the combinations of dummy plus propulsion system to be inside the boundaries defined for the dummy.

Within the project we performed different measurements in which the participant approached the dummy mounted in the different propulsion systems to evaluate the RCS. Moving measurements with the dummy on the different propulsion systems were carried out and compared with the measurements of a real motorbike. Both propulsion systems seemed to be adequate and not affecting too much to the global RCS of the dummy.

It was not possible in the context of the project but for a final validation of the propulsion system in terms of RCS it would be recommended to perform measurements of the combination of the propulsion system plus the Global Motorbike Target following the procedures defined in the ISO/CD 19206-3 (International Organization for Standardization, 2019).

2.2 Dynamic Properties:

In order to assure the repeatability of the test the platform should perform their paths always in a similar manner. For this reason, some key variables have been identified within the project.

2.2.1 Speed:

It should be possible to perform test at speeds from 10 km/h up to 50 km/h. The speed should not have a deviation from the set speed of more than 1 km/h and it must be maintained for a sufficient time.

2.2.2 Acceleration:

The maximal acceleration of the platform should be high enough to allow the performance of test without requesting a long distance before reaching the test speed.

For the scenarios in which the motorbike is braking the control of the deceleration should be precise enough to assure the respect of the corridors defined in the Car to PTW AEB protocol (Núñez Miguel, D4.1 Car To PTW AEB Test Protocol, 2019).

2.2.3 Lateral Deviation from Path:

In the most part of the accidents identified in WP1 (Brookes, et al., 2019) the accident occurs when the car come into the trajectory of the motorbike, for this reason, in the assessment of the scenarios of WP4 (Núñez Miguel, D4.3 Car To PTW Assesment Protocol, 2019) in the most part of the cases a complete avoidance of the impact with the motorbike is requested. Considering that ADAS systems are supposed to react in the last moment the marge between the car when stopped and the motorbike is supposed to be limited. For this reason, the lateral deviation from the original path of the propulsion system is important.

A maximum lateral deviation of ±0.15m was defined.

2.2.4 Yaw Rate:

The deviation from the original cap of the target is a critical value for the systems in order to foresee the path of the motorbike and the possibility of a critical situation. In this way, the scenario CMFscp-L, as defined in the Car to PTW AEB protocol (Núñez Miguel, D4.1 Car To PTW AEB Test Protocol, 2019), is the most critical one.

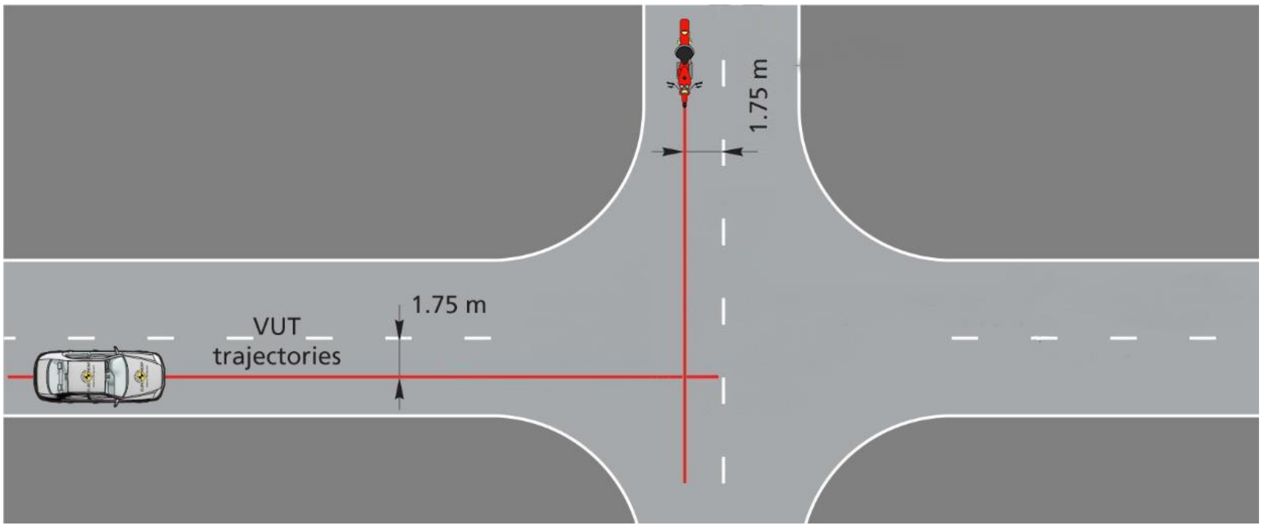

Figure 1 CMFscp-L

The acceptable values from the system point of view were estimated as follows:

$$Last\ Point\ to\ Trigger\ AEB = Recognition\ Time + Confidence\ Growth + Brake\ Delay + \frac{delta\ V}{a}$$

Considering the highest speed for this scenario (20 km/h) and considering as deceleration for the AEB 0.8 m/s²:

$$Last\ Point\ to\ Trigger\ AEB = 0.3 + 1 + 0.5 + 0.7 = 2.5\ s$$

The distance travelled by the target in this time for the highest speed defined in the protocol is:

$$Target\ Distance = LTPAEB * VmaxPTW = 2.5 * \frac{50}{3.6} = 34.7\ m$$

Considering as acceptable a maximum deviation of 0.4m:

$$Max\ Swiveling\ (Yaw)\ angle\ = \arctan\left(\frac{Maximum\ Deviation}{Target\ Distance}\right) = \arctan\left(\frac{0.4}{34.7}\right) = 0.61°$$

$$Max\ Swiveling\ (Yaw)\ rate\ = \frac{V}{R} = \frac{13.89}{34.7} = 0.4°/s$$

The performances of the propulsion systems at this moment are far of this value. Even if for some propulsion systems is not possible to see by eye any variation when we look at the data we find some overshoots up to 2°/s. These overshoots does not disappear even if we filter at 10Hz as defined in the Euro NCAP current protocols (Euro NCAP, 2019).

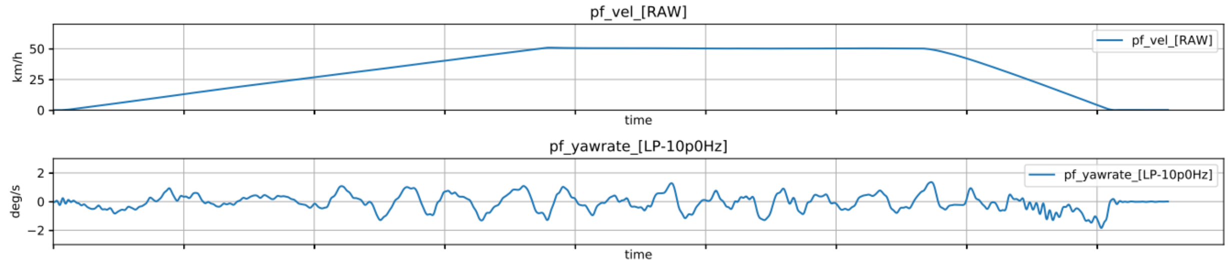

Figure 2 Yaw rate example at 50 km/h 4activeSystems Freeboard small

Measurements of a real motorbike equipped with an IMU (Inertial Measurement Unit) were performed by ABD to know the yaw rate values of a real motorbike as shown in Figure 3:

Figure 3 Real motorcycle Yaw Rate measurements

The results for the Motorcycle for a speed of 50 km/h are shown in Figure 4:

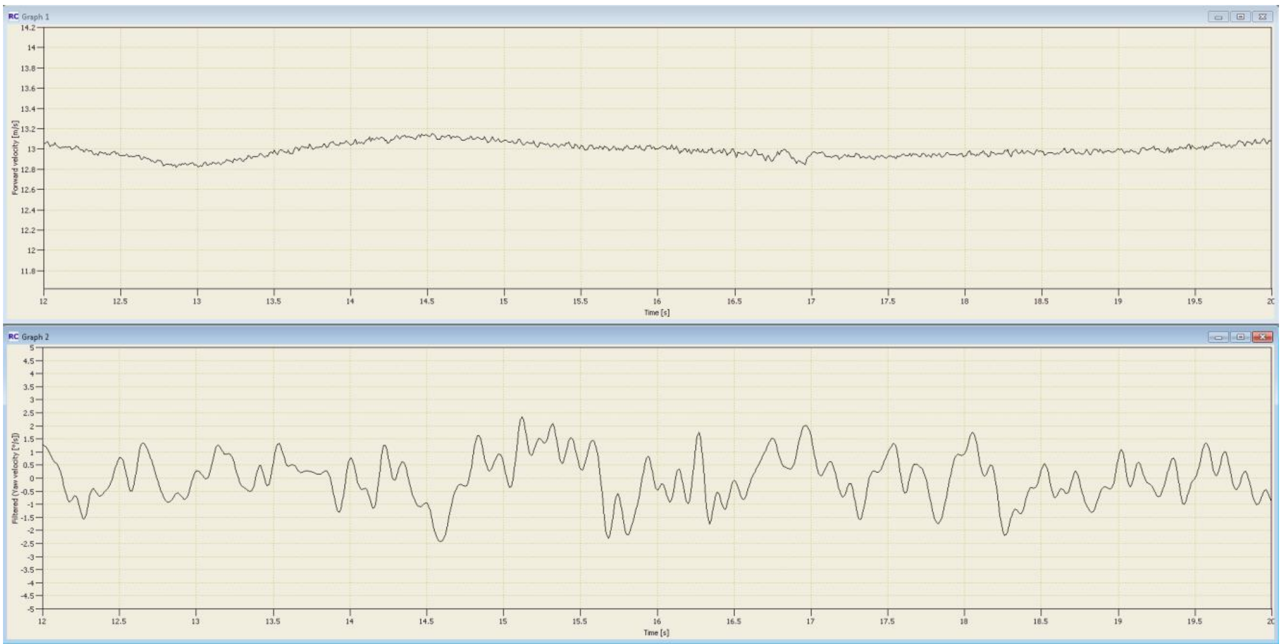

Figure 4 Real motorcycle Yaw Rate values for 50km/h

The Yaw Rate values of the real motorbike are between ±2°/s but in the context of official evaluations, to assure repeatability lower values could be requested.

Taking into account the exposed previously it was decided to fix a provisional maximal value of the Yaw Rate of ±2°/s. It is expected that the platforms improve their capabilities and their adaptation to the dummy in order to reach in the future a maximal deviation of ±1.5°/s.

2.2.5 Yaw Angle:

For the same reasons exposed for the Yaw Rate, to assure the repeatability of the test a low deviation from the desired cap is important for the systems.

A maximum deviation from set cap of ±1° was defined.

2.2.6 Summary Table:

Variable	Allowed Deviation
Speed	± 1 km/h
Yaw Rate	± 2°/s
Yaw Angle	± 1°
Lateral Deviation from Path	± 0.15m

4 Further Steps

For the correct validation of the different propulsion systems, measurements of the combination of the dummy with the propulsion system following the ISO procedure is recommended.

An improvement in the capabilities of the platforms regarding the yaw rate could be expected in order to assure the repeatability of testing.

A further study of the crashability of the platforms and their resistance to be rolled over could be appropriated.

5 References

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6 Acknowledgements:

The MUSE consortium would like to acknowledge for their support and work: