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MOTOrcycle Rider Integrated Safety

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Artificial perception system for preventive safety in motorcycles

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Executive summary

In this project I developed a prototype to enable artificial perception for preventive safety in motorcycles, a crucial element for the further development of Advanced Rider Assistive Systems (ARAS). The original project title conceived for deliverable 2.6 was "Safety systems with rider model implementation" however, in order to solve the most pressing problems regarding implementation of artificial perception of the 3D traffic scenario in a tilting vehicle, it was not necessary to incorporate a rider model from the point-of-view of Control theory. Thus the focus of my research activities in preventive safety systems for PTW (Powered-Two-Wheelers), was the design of camera-based remote sensor (multifocal stereo vision sensor and its algorithms) that allow the host motorcycle to perceive the 3D environment for interpretation of the dynamic traffic environment. An example is shown in Figure 1.

The last part of this document describes the main outcomes. The results belong to field tests conducted in real traffic conditions with the motorcycle demonstrator of the University of Florence. In the results, also is presented an exploratory study in which our technological approach was implemented to an electrical bicycle (pedelec). This allowed to assess the performance of the sensor in real cycling traffic too.

The studies presented in this document were well received by the scientific community (see Table 1), with 2 journal publication and 4 conference articles. Consequently, we believe that motorcycle industry will find the outcomes of this project useful, and surely, they will contribute to improving motorcycling safety.

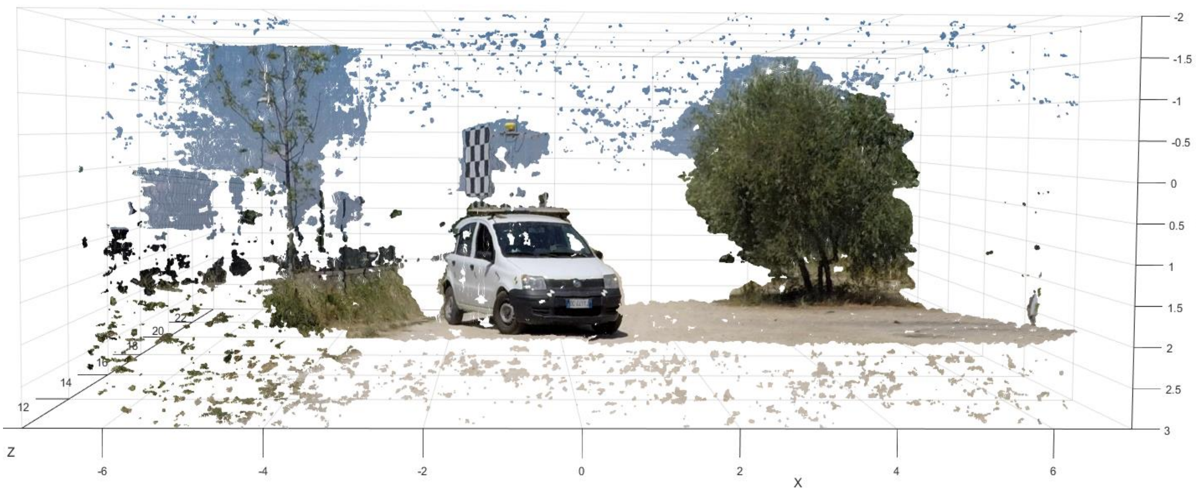

Figure 1. Example of the scene perceived for the system in the motorcycle (3D depth measurement up to 22 m).

Table 1. List of scientific articles published

Paper title	Publication
Are automatic systems the future of motorcycle safety? A novel methodology to prioritize potential safety solutions based on their projected effectiveness	Journal: Traffic Injury Prevention 2017
Obstacle detection tests in real-world traffic contexts for the purposes of motorcycle autonomous emergency braking (MAEB)	25th International Technical Conference on the Enhanced Safety of Vehicles (2017). Paper Number 17-0047
Satellite Markers: a simple method for ground truth car pose on stereo video	10th International Conference on Machine Vision. SPIE Digital Library 2017
First stereo video dataset with ground truth for remote car pose estimation using satellite markers	10th International Conference on Machine Vision. SPIE Digital Library 2017
Is stereo vision a suitable remote sensing approach for motorcycle safety? An analysis of LIDAR, RADAR, and computer vision technologies subjected to the dynamics of a tilting vehicle	Transport Research Arena 2018 (TRA 2018) Section: 10. Safe, Secure and Resilient Transport Systems
Motorcycle that see: multifocal stereo vision sensor for advanced safety systems in tilting vehicles	Sensors for Transportation (Open Access Journal) Sensors (ISSN 1424-8220) belonging to the section "Physical Sensors" 2017

Glossary

ACC	Adaptive Cruise Control
ADAS	Advanced Driver Assistance Systems
AEB	Autonomous Emergency Braking
AI	Artificial Intelligence
ALU	Arithmetic Logic Unit
API	Application Program Interface
ARAS	Advanced Rider Assistance Systems
ASIC	Application Specific Integrated Circuit
B	Bandwidth
BSD	Blind-Spot Detection
CV	Computer Vision
DM	Disparity Map
DNN	Deep Neural Networks
DRAM	Dynamic Random Access Memory
DSP	Digital Signal Processors
EC	European Commission
ECU	Electronic Control Unit
EIE	Efficient Inference Engine
EU	Europe Union
FMCW	Frequency Modulated Continuous Wave
FoV	Field of View
FPGA	Field Programmable Gate Array
GPU	Graphics Processing Unit
LCA	Lane-Change Assist
M-AEB	Motorcycle Autonomous Emergency Braking
MEMS	Microelectromechanical Systems
MV	Machine Vision
NCS	Neural Computer Stick
OD	Obstacle Detector
OEM	Original Equipment Manufacturer

OPA	Optical Phased Arrays
PC	Personal Computer
PTW	Powered-Two Wheeler
RCS	Radar Cross-Section
RF SOI	Radio Frequency Silicon-On-Insulator
ROS	Robotic Operating System
RTL	Register-Transfer Level
SDK	Software Development Kit
SF	Safety Function
SiGe	Silicon Germanium
SoC	System on Chip
SRAM	Static Random Access Memory
TEM	Transverse Electromagnetic Mode
TFLOPS	Tera Floating Point Operations
TOF	Time-Of-Flight
UNIFI	University of Florence
VPU	Vision Processor Unit

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