# DIFFERENCES IN STEERING BEHAVIOUR BETWEEN EXPERTS, EXPERIENCED AND NOVICE DRIVERS: A DRIVING SIMULATOR STUDY

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# PRESENTATION OUTLINE

- 1.INTRODUCTION TO THE TOPIC2.PAST RESEARCH3.OBJECTIVES4.FXPERIMENTS
  - a) RACING EXPERIMENT
  - b) DOUBLE LANE CHANGE EXPERIMENT
  - c) HIGH SPEED CORNERING EXPERIMENT
- **5.RESULTS AND DISCUSSION**
- 6.GENERAL DISCUSSION
  - a) COMBINED SUMMARY OF THE 3 EXPERIMENTS
  - b) PROS AND CONS OF THE EXPERIMENTS
- 7. FUTURE RESEARCH

Growth Of The Automotive Industry 1886 Benz patent "vehicle powered by a gas engine"





1908 Launch of Model-T

1913-1914 Conveyor belt-based assembly line



1927 A total of 15 million Model T's sold

#### The Rising Issue of Safety

Road crashes

nearly 1.3 million people die each year
average 3,287 deaths a day

➢9th leading cause of death➢2.2% of all deaths globally

cost USD \$518 billion globallyequivalent to1-2% annual GDP

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### SAFETY LEGISLATION AND MEASURES



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#### **ADVANCED DRIVER ASSIST SYSTEM (ADAS)**

- Support the driver in completing a task
- Complete or Partial Automation of the task
- > Electronic Stability Control (ESC) System
- Issues
  - Setting the threshold
    - Different driver needs
    - > Nuisance ("Cry wolf effect")

# PAST RESEARCH

#### >NOVICE DRIVER

familiar with the task of drivinglimited driving experience

#### **>EXPERIENCED DRIVER**

certain level of expertisedriving experience

#### **>EXPERT DRIVERS**

high level of driving proficiency
 race car drivers, instructors in driving school

## **PAST RESEARCH**

Difference between drivers
 Performance
 Control Strategy and behavior
 Higher steering activity
 Steering wheel angle
 average steering jerk
 frequency of steering inputs
 Consistency and repeatability

# **OBJECTIVES**

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≻Focus

➢novice, experienced and expert drivers

➤steering behavior

Extreme driving (cornering and lane change)

Objective driver metrics

>performance

>behavior

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3 driving simulator based experiments

Expert race drivers versus normal driversHigh speed driving task in a racing environment

Experienced versus novice drivers
 Double lane change
 High speed cornering

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#### **RACING EXPERIMENT**



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#### **DOUBLE LANE CHANGE MANEUVER**



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#### **HIGH SPEED CORNERING**



# **RACING EXPERIMENT**



Curve 1: Long right hand curve, which turns through nearly 200 degrees

Curve 2: Combination of two fast curves

Curve 3: 180 degrees hairpin curve

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#### PERFORMANCE

≻experts

≻better performance

➤lower lap-times (5 - 7 %)

 $\geq$  higher lateral acceleration (10 – 15 %)

#### **STEERING BEHAVIOR**

>Experts

higher steering activity

Steering jerk 1.5-2 times higher in curve 1 and 2

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#### PATH STRATEGY



# **DOUBLE LANE CHANGE (DLC)**

- ➤3 main steering inputs
- ≻Maneuver A-C

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- ≻Maneuver C-D
- ≻Maneuver D-F



11.

#### ≻Novices

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offset from center position while entering the first lanedelay in control inputs



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#### PERFORMANCE



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REPEATABILITY EXPERIENCED vs NOVICES 0.45 -EXPERIENCED NOVICES 0.4 -0.35 -RMSD MEAN PATH (m) 0.3 -0.25 0.2 9 0.15 0.1 -0.05 ∟ 70 75 , 80 , 95 , 100 Т I. 85 90 105 SPEED (kmph) **Root Mean Square** 

**Deviation From Mean Path** 

# **CONTROL STRATEGY**

Novices

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#### >hig/eerinsitieering x intivities for the sense of the se





Novices

➢insufficient initial input

➤ imprecise timing

>lag behind in terms of input versus vehicle positioning

≻try to compensate for this lag

higher steering activity in the later stages

≻steering jerk (30%)

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#### HIGH SPEED CORNERING TASK



## PERFORMANCE

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Experienced drivers
 better performance
 lower lap-times (14%)
 maintain a higher lateral acceleration (14 %)
 similar to results from the racing experiment

#### **STEERING BEHAVIOR**

Experienced drivers
 higher steering activity
 steering jerk (12%)
 steering reversal rate(20%)
 similar to the results found in the racing experiment

## PATH STRATEGY

>No particular strategy

Novices
higher deviation from their mean path
0.68 meters (experts = 0.52 m)
p<0.05</p>

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# **GENERAL DISCUSSION**

#### COMBINED SUMMARY OF THE 3 EXPERIMENTS

# PERFORMANCE

➢Racing Experiment

≻experts

≻better performance

≻lap-times (5-7%) and lateral acceleration (10-14%)

High Speed Cornering

≻experienced

≻better performance

➤lap-times (14%) and lateral acceleration (14%)

Double Lane Change

≻experienced

≻better performance

➤average number of cones hit

>mean deviation from mid-path

# **GENERAL DISCUSSION**

#### COMBINED SUMMARY OF THE 3 EXPERIMENTS

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### **STEERING BEHAVIOR**

➢Racing

≻experts

higher steering activity

≻steering jerk (1.5-2 times)

High Speed Cornering

≻experienced

higher steering activity

Steering jerk (12%) and steering reversal rate (20%)

Double Lane Change :

≻experienced

>appropriate control inputs (steering angle)

➤accurate timing of steering input

## **GENERAL DISCUSSION**

#### COMBINED SUMMARY OF THE 3 EXPERIMENTS

# **OTHER RESULTS**

Steering metrics
 steering jerk
 steering rate
 steering reversal rate
 timing (position) of steering input
 Significant difference in
 path strategy
 consistency in following the strategy
 Overlap in performance

# **PROS & CONS OF THE PERFORMED EXPERIMENTS**

## Racing Experiment

>significant steering behavior differences

➢ high speed curve

➤steering jerk 1.5-2 times higher for experts

#### >High speed cornering

>significant steering behavior differences

≻12% difference in steering jerk

### ≻DLC test

no Degradation of performance with speed
 skill versus loss of control cannot be correlated
 significant steering behavior differences
 30% difference in steering jerk

# **FUTURE RESEARCH**

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- Adaptable ESC system
  optimal performance
  extreme conditions
- Driver performance monitoring
  real time
  uncontrolled driving
- >Assess skill in real life driving situations using all control inputs
- Include driver variability into driver models for computer simulation

# THANK YOU FOR YOUR ATTENTION

# QUERIES??