A literature review on Human Factors research using motorcycle simulators


* Department of Biomechanical Engineering, Delft University of Technology, Mekelweg 2, 2628 CD Delft, the Netherlands
b Simulation & Test Solutions, Siemens Industry Software NV, Research Park 1237, Interviewlaan 68, 3001 Leuven, Belgium
c Department of Transport & Planning, Delft University of Technology, Stevinweg 1, 2628 CN Delft, the Netherlands

* These authors contributed equally to this work.

1. Introduction

Over the past several decades, motorcycle simulators have been introduced worldwide. Although a large number of research papers are available describing the hardware features of special motorcycle simulators [7], comparatively little knowledge is available on the actual use and validity of these simulators.

The aim of the present review is fourfold:
(1) to summarise the results of objective and subjective evaluations of motorcycle simulators used in human-oriented research,
(2) to summarise which rider characteristics and behaviors have been studied on these simulators,
(3) to investigate how motorcycle simulators are used for training,
(4) to review studies examining rider assistance systems.

Evaluation of simulators

- Three main characteristics of a motorcycle simulator evaluation were distinguished:
  o characteristics associated with functional fidelity: (1) simulator leaning and (2) steering
  o characteristics associated with physical fidelity: (3) scenery tilting
  Subjective impressions of acceleration and deceleration are often poor (e.g., [8]).
  A wider field of view, a foot peg control, and a washout filter on a motion-base simulator have been proposed for increasing the feeling of movement [9].

Evaluation of simulators

- Rider training
  - The majority of training studies used the low-cost Honda Rider Trainer (HRT) simulator:
    o for improving hazard/risk perception skills among novice riders (e.g., [13])
    o for learning how to operate a moped and to master a motorcycle license (e.g., [14]).
    - Longitudinal research exists showing that hazard perception skills are retained in the long term [15].
    - Long-term studies investigating the transfer of training to the real road were not found.

Rider training

- Rider assistance systems
  - Examples of evaluated rider assistance systems (e.g., [5], [16]):
    o curve warning
    o intersection support
    o lane change support
    o feedback of various modalities was examined:
      o flashing signals
      o visual icon
      o beeping and ‘emotional’ sounds
      o a vibrating helmet
      o a force feedback throttle
      o a haptic glove

2. Method

- A literature search was performed using (1) Google Scholar, Scopus, and the Transportation Research Board search engine, (2) conference proceedings of a visual simulation conference, the International Motorcycle Conference, and the International Motorcycle Safety Conference, (3) the reference lists of collected papers.
- Search terms: motorcycle simulator, riding trainer, powered two wheelers, PTW simulator, single track vehicle simulator, in combination with one of three keywords: behaviour, training, and evaluation.
- Studies were included when conducted on a simulator providing a physical Human Machine Interface (HMI), and when the virtual environment was presented on a screen, wall, or monitor. Studies not containing a description of participants or which lacked a research design were excluded.

3. Results

Rider behaviour and characteristics

- Studies assessing rider behaviour focused on:
  o riding under the influence of alcohol [3]

- The simulator was used as an assessment tool for comparing groups of riders (e.g., experienced, non-experienced, riders with advanced training) or for comparing riders with car drivers.

4. Discussion

- High fidelity simulators were mostly used for research purposes, whereas low fidelity simulators were mostly used for training.
- Simulator motion may not always be required or desirable in behavioural research and training.

A lack of research in which recorded motorcycle rider behaviour in the simulator is statistically associated with recorded-on-the-road rider behaviour.

A lack of studies that measure transfer of training to the road.

References