IATSS Research 39 (2015) 79–85

Contents lists available at ScienceDirect

IATSS Research

Development of an onboard system to measure the on-road driving pattern for developing motorcycle driving cycle in Khon Kaen city, Thailand

Atthapol Seedam [a], Thaned Satiennam [b,*,1], Thana Radpukdee [c], Wichuda Satiennam [b]

[a] Mechanical Engineering Department, Engineering Faculty, Khon Kaen University, 40002, Thailand
[b] Civil Engineering Department, Engineering Faculty, Khon Kaen University, 40002, Thailand
[c] Industrial Engineering Department, Engineering Faculty, Khon Kaen University, 40002, Thailand

ARTICLE INFO

Available online 22 May 2015

Keywords:
Onboard measurement system
On-road driving cycle
Motorcycle
Khon Kaen city

ABSTRACT

This study developed an onboard system to measure the on-road driving pattern for a motorcycle driving cycle in Khon Kaen city, Thailand. The developed system, validated with high accuracy results, could measure and record a driving pattern, i.e. a speed profile of a driving motorcycle. The selected motorcycle was driven along selected routes in Khon Kaen city under the existing traffic conditions to collect the on-road driving pattern. The Khon Kaen motorcycle driving cycle (KMDC) was developed by a repetitive algorithm using the principle of least total variance in the target parameters. The developed KMDC was compared with the existing motorcycle driving cycles for Bangkok and other cities. The result reveals that the KMDC is different from those of other cities.

1. Introduction

In many developing cities, the motorcycle is a vital mode of transportation for low-income workers and students traveling to work and study due to its high door-to-door accessibility and economic cost [1]. Also, the motorcycle becomes an attractive paratransit with a high accessibility for short travel distances in congested developing cities [2]. In contrast, the motorcycle brings with its several problems, including high involvement in traffic accidents, high violation of traffic rules and especially high air pollution emission in congested developing cities. There are several main research directions to reduce the emissions from motorcycles, including development of innovative engine technology, development of alternative cleaner energy and planning policy of transportation and energy usage for the motorcycle.

The motorcycle driving cycle is an important indicator representing on-road driving data of the motorcycle and reflecting the traffic conditions as well as the city driver's behavior. The driving cycle is applied with a chassis dynamometer to develop the emission factors and to evaluate the innovative engine technology or the cleaner energy of the motorcycle in terms of emission reduction and standard requirements. Moreover, the emission factors are applied with the transportation model to evaluate public transit systems and alternative cleaner energies in terms of the reduction of emissions as an entire road network [3–5].

The motorcycle driving cycle is developed from the on-road driving data of the motorcycle. The specific measurement system for the motorcycle is necessarily installed on the motorcycle to measure and record the on-road driving pattern while the motorcycle is driven. Currently, many commercial types of onboard equipment for measuring an on-road driving pattern of a motorcycle are available. However, they were mostly produced for the high engine capacity motorcycle with the on-board diagnostics, but not applicable for the low engine capacity motorcycle without the on-board diagnostics, commonly used in developing countries. Also, they are closed systems, they cannot further be modified or improved to collect other interesting and relating on-road driving data. This study therefore decided to develop an open onboard measurement system for a motorcycle to collect the on-road driving pattern since there are plans to further develop the onboard system by integrating additional measurement devices to collect other on-road driving data, such as exhaust emission and fuel consumption for a future study.

The objectives of this study are to develop the motorcycle onboard system measuring on-road driving pattern and to develop the motorcycle

* Corresponding author.
E-mail address: sthaned@kku.ac.th (T. Satiennam).
[1] Tel.: +66 43 202847; fax: +66 43 202847x102.
Peer review under responsibility of International Association of Traffic and Safety Sciences.

Production and hosting by Elsevier

http://dx.doi.org/10.1016/j.iatssr.2015.05.003

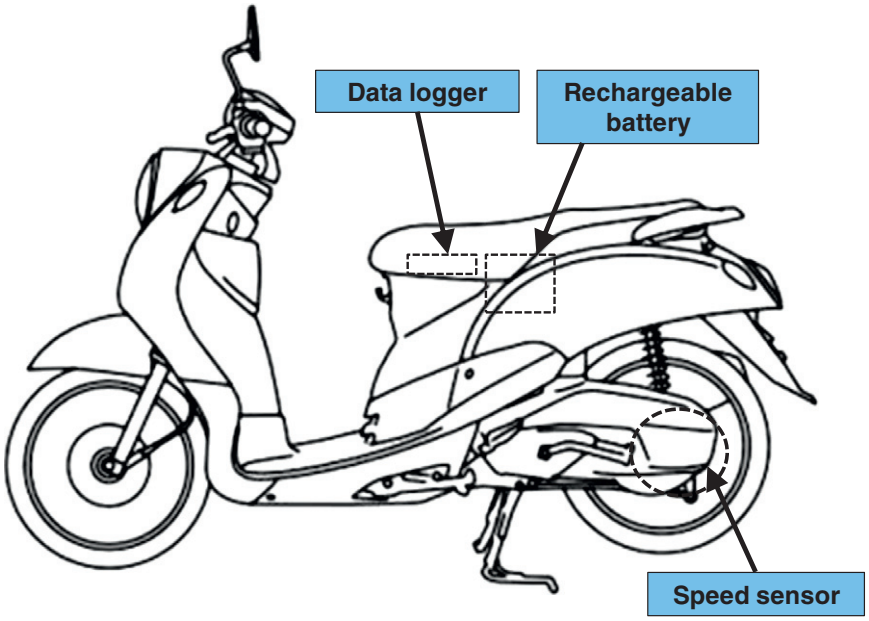

Fig. 1. Component units of developed onboard measurement system.

driving cycle in Khon Kaen city, Thailand and to compare the developed Khon Kaen motorcycle driving cycle with the previous developed motorcycle driving cycles of Bangkok and other cities.

The contents of this paper are arranged as follows: the second section presents the literature review; the third section describes the development of an onboard system for measuring the road driving pattern; the fourth section mentions the selection of the city and routes; the fifth section describes the collection and analysis of on-road driving data; the sixth section presents the development of the motorcycle driving cycle; the seventh section presents the comparison of the developed motorcycle driving cycle with other worldwide driving cycles; and the final section describes the conclusions and future studies.

2. Literature review

There are many previous researches exploring the issues concerning the collection of on-road driving data and the development of driving cycles of motorcycle as follow.

Tzeng and Chen [6] developed the Taipei motorcycle driving cycle (TMDC) for estimating emissions and fuel consumption of the cycle. This study conducted the on-road driving data by a chasing vehicle technique. Magnetic speedometers were installed on the chasing motorcycles for recording their speed. The driving cycle was developed by applying the statistic and repetitive approach to find a representative driving cycle whose characteristics are most similar to those of all the driving data. The motorcycles were tested in a laboratory by using the Economic Commission of Europe (ECE) and TMDC. The study result showed that the emissions of both two-stroke and four-stroke engine motorcycles tested by TMDC were higher than those of the ECE. The fuel consumption of two-stroke engine motorcycles tested by TMDC was lower than that of the ECE, but the fuel consumption of four-stroke engine motorcycles tested by TMDC was higher than that of the ECE.

Chen et al. [7] developed motorcycle driving cycles for individual regions in Taiwan to compare their emission factors and fuel consumption. This research developed a recording system, consisting of four magnets and one magnetic sensor on the front wheel, a cassette data logger and a laptop computer, for installation on the on-road driving motorcycle to record its speed. The developed driving cycles were simulated on a chassis dynamometer to determine the emission factors and the fuel consumption. Comparison of the results revealed that the representative driving cycles were almost same in the three largest cities in Taiwan, but they differed significantly from the rural driving cycle. The emission factors differed insignificantly between the urban and rural regions at a 95% confidence level, irrespective of driving conditions. However, the fuel consumption in urban centers was approximately 30% higher than in the rural regions.

Tsai et al. [8] developed the Kaohsiung Driving Cycle (KHM) of the motorcycle in Kaohsiung city, Taiwan for development of emission factors and compared the developed driving cycle and emission factors with others from previous studies. This study equipped the driving motorcycle with a frequency-voltage transducer and data acquisition system to collect the time-speed data during the testing period. The device was mounted in the front wheel. Five magnetic chips were glued to the front wheel disk and the magnetic sensor was firmly placed in a hole on the outer hubcap of the front wheel. The magnetic sensor detected the passage of the magnets during wheel rotation, and the transducer transmitted the signal to the data acquisition system. The driving cycle was developed by using a linear combination of the randomly selected micro-trips from the real speed-time data. The emission factors were developed from the dynamometer testing. Comparison of the results indicated that the driving characteristic parameters, emission factors and fuel consumption of the KHM were completely different from those of the Economic Commission of Europe Driving Cycle (ECE) and

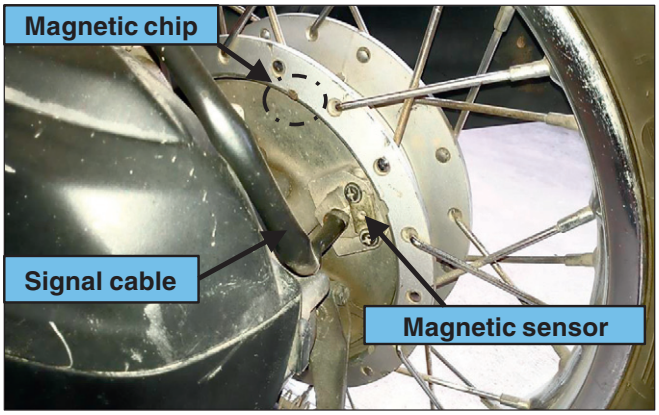

Fig. 2. Magnetic speed sensor on rear wheel of motorcycle.