UNIVERSITY OF TECHNOLOGY SYDNEY

Doctorate Thesis

Key Techniques for Traffic Information Acquisition Sensor Networks

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CERTIFICATE OF ORIGINAL AUTHORSHIP

I, Zhiguo Li, declare that this thesis is submitted in fulfilment of the requirements for the award of Doctor of Philosophy, in the Faculty of Engineering and Information Technology at the University of Technology Sydney.

This thesis is wholly my own work unless otherwise reference or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

This document has not been submitted for qualifications at any other academic institution.

This research is supported by the Australian Government Research Training Program.

Signature:

Date:

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Abstract

Road traffic information acquisition technologies have the capability to provide important information for intelligent transportation systems (ITS) by employing sensor networks, especially for detecting the road network information in dots, sections or large-scale areas. Sensor network plays a vital role in acquiring road traffic information of ITS. By exploiting spatial-temporal models, traffic flow models or correlation models, the traffic information of road sections and networks can be derived from the traffic data of some key points in the road for the temporal and spatial correlation. Furthermore, because of the constraints of space-time correlation, project investment and construction cost, the investigation of traffic information acquisition by employing sensor network technologies has become an important research direction of ITS. As a result, the investigation of the theories, techniques, sensors, and methodologies of traffic information acquisition sensor network (TIASN) has been a significant research topic.

Based on specific requirements on real time, accuracy and completeness for traffic information acquisition, this thesis has focused on the following key challenges: (1) new algorithm to acquire traffic flow based on multi-functional geomagnetic sensor; (2) efficient optimization methods for TIASN; (3) efficient calibration method for Inertial Measurement Unit (IMU); (4) effective testing method for urban rail transit sectional passenger flow.

In this dissertation, motivated by the above challenges, a thorough investigation is presented on a novel multi-parameter sensing method of traffic information by using a multi-function geomagnetic sensor (MFGS). Furthermore, in order to improve the efficiency of IMU based traffic monitoring, the calibration and its associated experimental design schemes are developed for the two-key tri-axial sensors in an IMU, i.e. tri-axial magnetometers and tri-axial accelerometers. At the end , we study the short-term prediction methods of sectional passenger flow and selects Back-Propagation (BP) neural network combined with the characteristics of sectional passenger flow itself.

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List of Abbreviations

ITS	Intelligent transportation system
TIASN	Traffic information acquisition sensor network
MFGS	Multi-function Geomagnetic sensor
IMU	Inertial Measurement Unit
MTFs	Mix Traffic Flows
SN	Sensor Network
GPS	Global positioning system
INS	Inertial Navigation System
MEMS	Micro Electro Mechanical Systems
TAs	Tri-axial Accelerometers
TMs	Tri-axial Magnetometers
TGs	Tri-axial Gyroscopes
WSN	Wireless sensor network
DWVDA	Double window vehicle detection algorithm
GSVDA	Go-stop vehicle detection algorithm
ADWVDA	Adaptive DWVDA
SVDA	Stationary vehicle detection algorithm
IoT	the internet of things
ED	End device
RP	Repeater point
AP	Access point
FP	Fusion point

CP	Centre point
RFID	Radio Frequency IDentification
RIP	Routing Information Protocol
OSPF	Open Shortest Path First
OLSR	Optimized Link State Routing Protocol
AODV	Ad hoc On-Demand Distance Vector Routing
DoE	Design of Experiments
FIM	Fisher Information Matrix
CCD	Central Composite Design
BBD	Box-Behnken Design
MSE	Mean Square Error
OLS	Ordinary Least- Squares
AHRS	Attitude and Heading Reference System
A/D	Analog/Digital
SLP	Sensor location problem
TIC	Traffic information credibility
PoI	Point of Interest
PoS	Point of Sensor
ICF	Information credibility function
RICF	Road information credibility function

List of Publications

[1] Wenlong, Peng, Li Zhiguo, Pang Shaohuang, Jia Limin, Tian Yin, Chen Jianxiao, and Dong Honghui. "Access point research in rail train safety monitoring sensor network." In Digital Manufacturing and Automation (ICDMA), 2012 Third International Conference on, pp. 157-160. IEEE, 2012.

[2] Li, Qian, Yong Qin, Ziyang Wang, Zhongxin Zhao, Minghui Zhan, Yu Liu, and Zhiguo Li. "The research of urban rail transit sectional passenger flow prediction method." Journal of Intelligent Learning Systems and Applications 5, no. 04 (2013): 227.

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