New Design of Wireless Ad-Hoc Network (WAHCN) For Motorway Monitoring System

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TABLE OF CONTENTS

CHAPTER 2 LITERATURE REVIEW

CHAPTER 3 ROUTING IN MOBILE AD HOC NETWORK

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

I. Basic Units

Quantity	Unit	Symbol
Data Rate, Throughput	Bit per Second or Kilo bit per Second	bps, Kbps
Frequency	Hertz, Gigahertz	Hz, GHz
Packet Size	Byte, Kilobyte	B, KB
Packet Generation Frequency	Packet per Second	Pkt/s
Speed	Meter per Second	m/s
Speed	Kilometer per hour	km/h
Time	Second, Millisecond	s, ms

II. Abbreviations

AODV	Ad Hoc on Demand Distance Vector Routing Protocol
AS	Autonomous System
ABR	Associative Based Routing
ART	Active Route Timeout
BS	Base Station
CSMA	Carrier Sense Multiple Access
CSMA/CD	Carrier Sense Multiple Access with Collision Detection
CSMA/CA	Carrier Sense Multiple Access with Collision Avoidance
CBR	Constant Bit Rate
CIT	Camera Index Table

DSR	Dynamic Source Routing Protocol
DCF	Distribution Coordination Function
DSDV	Dynamic Destination-Sequenced Distance-Vector Routing
DC	Desired Camera
FIFO	First-in-First-out transmission queue
FSR	Fisheye State Routing Protocol
GPS	Global Positioning System
HOLSR	Heterogeneous Optimized Link State Routing Protocol
IP	Internet Protocol
IERP	Inter-zone Routing Protocol
IARP	Intra-zone Routing Protocol
IREQ	Image Request
IREP	Image Reply
LAN	Local Area Network
MSS	Motorway Surveillance System
MANET	Mobile Ad Hoc Network
MAODV	Modified AODV
MAC	Media Access Control
Mbps	Mega Bit per Second
MAN	Metropolitan Area Network
MPEG	Moving Picture Experts Group
MPR	Multipoint Relaying
NETT	Net Traversal Time
OLSR	Optimized Link State Routing Protocol

OSPF	Open Shortest Path First Routing Protocol
PoE	Power over Ethernet
PHY	Physical Layer
PC	Personal Computer
PRNET	Packet Radio Network
PDT	Path Discovery Time
PREQ	Position Request
PREP	Position Reply
PTR	Packet Transmission Ratio
QoS	Quality of Service
RREP	Route Reply
RREQ	Route Request
RERR	Route Error
RF	Radio Frequency
R-AODV	Reverse AODV
SFP	Selecting and Finding Position Protocol
SS	Surveillance System
SOTIS	Self Organizing Traffic Information System
SD	Safety Distance
STP	Shielded Twisted Pair
SCALLOPSNet	Scalable Large Optical Sensor Network
TIBPEA	Time-Bounded Parameter Estimation Accuracy
TSAM	Time-Synchronized Application MAC
TP	Twisted Pair

TCP	Transmission Control Protocol
TTI	Traffic and Travel Information
TORA	Temporally Ordered Routing Algorithm
TC	Topology Control
TTL	Time to Live
UDP	User Datagram Protocol
UTP	Unshielded Twisted Pair
VBR	Variable Bit Rate
VANET	Vehicular Network
VGA	Video Graphics Array
WAHCN	Wireless Ad Hoc Camera Network
WCN	Wired Camera Network
ZRP	Zone Routing Protocol
ZHLS	Zone-Based Hierarchical Link State Routing Protocol

LIST OF SYMBOLS

DC	Desired Camera
ID	Camera Identification Number
RD	Requested Distance between Vehicle and Desired Camera
d	Distance between Each Two Cameras
Vi	The i th Vehicle that Requires Image Data from Desired Camera
M	Number of Camera Nodes Existing In Transmission Range of Vehicle Vi
SeqN	Sequence Number Related To Each Vehicle Vi
T	Time Period between Each Two Successive Control Messages
N	Total number of nodes within the network
n	Current node index
C(n)	Connectivity index parameter of node n with its Neighbors
S(n)	Stationary index parameter for node n
P	Path of n nodes index parameter
D(n)	Data at node n (data or control messages)
X	Cameras nodes index
PKn	Packet at node n
Jn	Total number of packets at node n at specific time
Yn	Total number of neighbors of node n
Des(seq no)	Destination sequence number (parameter belongs to AODV Protocol)
PD	Path Duration Time
ρ	Proportionality Constant
Lp	Probability of Link Breakage

Vs	Vehicle Speed
R	Transmission Range
h	Number of Hops on Path

Rekabentuk Baru Rangkaian Kamera Ad-Hoc (WAHCN) Untuk Sistem Pengawasan Lebuhraya

ABSTRAK

Sistem pengawasan lebuhraya merupakan salah satu teknologi penting yang digunakan pada masa kini untuk mendapatkan maklumat mengenai keadaan semasa trafik/lebuhraya. Kamera dalam sistem pengawasan lebuhraya tradisional menggunakan teknologi rangkaian infrastruktur dengan atau tanpa wayar; manakala sistem tersebut direkabentuk bagi menghantar maklumat (imej) ke lokasi yang ditentukan ("Stesen Pangkalan" - "Base Station"). Sistem tradisional tidak berkesan dalam menyediakan capaian ke rangkaian sistem pengawasan untuk pengguna lebuhraya. Dalam kajian ini, satu rekabentuk rangkaian sistem pengawasan lebuhraya yang baru dicadangkan, dimodelkan dan dianalisis, yang dikenali sebagai Rangkaian Kamera Ad-Hoc Tanpa Wayar (Wireless Ad-Hoc Camera Network - WAHCN). WAHCN membolehkan pengguna lebuhraya mengakses data imej yang diambil oleh rangkaian kamera yang dipasang di sepanjang lebuhraya. Ia dapat meningkatkan kesedaran tentang keselamatan jalan raya melalui paparan keadaan trafik dan lebuhraya yang dapat dilihat oleh pengguna lebuh raya. Rekabentuk topologi WAHCN menghadkan jumlah imej yang boleh dihantar melalui rangkaian, bergantung kepada saiz dan kadar paket yang dihasilkan oleh setiap kamera. Hasil kajian juga mendapati dengan adanya WAHCN, prestasi rangkaian adalah lebih baik, pada kelajuan kurang daripada 120 Km/j. Satu protokol baru berdasarkan julat penghantaran nod dibangunkan untuk memastikan keberkesanan pengurusan prosedur pemilihan, pengenalpastian dan permintaan capaian kamera yang diingini tanpa menggunakan peranti GPS. Protokol ini dinamakan sebagai protokol Posisi Pemilihan dan Pengenalpastian (Selecting and Finding Position (SFP)) yang menyediakan satu cara berkesan untuk memperoleh imej daripada mana-mana kamera dalam WAHCN. Dalam mana-mana sistem rangkaian, penghalaan adalah satu proses yang penting, terutamanya untuk WAHCN disebabkan oleh persekitaran yang sangat dinamik. Jenis protokol penghalaan yang berbeza menunjukkan prestasi rangkaian yang berbeza kerana perbezaan mekanisme dan fungsi. Penilaian, perbandingan dan analisis prestasi bagi tiga protokol penghalaan (AODV, DSR, dan OLSR) untuk WAHCN telah dilaksanakan dalam kajian ini. Penilaian dan analisis dijalankan berdasarkan pengukur prestasi yang berbeza dan di bawah keadaan rangkaian yang berbeza. Hasil kajian mendapati pada kelajuan kenderaan yang pelbagai serta beban rangkaian yang berbeza, protokol AODV menunjukkan prestasi yang lebih baik berbanding protokol DSR dan OLSR, dengan melihat kepada kadar celusan rangkaian (35.11% dan 10.24%) dan overhed protokol (20.51% dan 57.38%). Daripada keputusan ini, satu protokol penghalaan yang baru telah dicadangkan dan dinamakan sebagai Modified AODV (MAODV). Protokol MAODV mempunyai semua ciri protokol AODV yang asal memandangkan ianya melibatkan kesemua langkah yang sama dalam mekanisme pengenalpastian dan penyelenggaraan hala dalam AODV yang asal. Dalam protokol MAODV, salah satu kamera pada hala yang lama diarahkan untuk memulakan

proses pengenalpastian semula laluan yang baru ke destinasi yang sukar dicapai berbanding nod sumber apabila terputus sambungan. Pengubahsuaian AODV mengurangkan overhed protokol dan melancarkan proses penghantaran paket (dengan pengurangan lengahan), seterusnya meningkatkan prestasi WAHCN.

New Design of Wireless Ad-Hoc Network (WAHCN) For Motorway Monitoring System

ABSTRACT

Motorway surveillance system is one of the most important technologies used today to collect information about traffic conditions. Traditional camera motorway surveillance systems are based on wired or infrastructure wireless network technology; whereby the system is designed to send the information (images) to a predetermined location (the "Base Station"). The traditional system does not provide effective access to the surveillance system network for motorway users. In this thesis a newly designed motorway surveillance system network called Wireless Ad Hoc Camera Network (WAHCN) is proposed, modeled and analyzed. WAHCN enables motorway users to access image data taken by a network of cameras placed along the motorway. It provides improved safety awareness by allowing motorway users to view traffic and road conditions. The topology design of WAHCN imposes several constraints on the amount of images can be transmitted through the network depending on the size and the rate of the packets generated by each camera. Moreover, the results showed that the WAHCN provides better performance for vehicle speeds of less than 120 Km/h. A new protocol based on transmission range of the nodes is developed to effectively manage the operation of selecting, finding and requesting the desired camera without using GPS. This protocol is called Selecting and Finding Position (SFP) protocol and provides an effective way to acquire images from any camera within the WAHCN. Routing in any network system is a critical task, especially for WAHCN due to the highly dynamic environments. Different types of routing protocols may give different network performance due to the different functional mechanisms of these protocols. The performance evaluations, comparisons, and analysis for three routing protocols (AODV, DSR, and OLSR) for WAHCN are presented in this thesis. The evaluation and analysis are performed for different performance metrics and under different network conditions. The results showed that under various vehicle speeds and different network loads AODV outperforms DSR and OLSR protocols, with respect to network throughput (by 35.11% and 10.24%, respectively) and protocol overhead (by 20.51% and 57.38%, respectively). From these results a new routing protocols is proposed and called Modified AODV (MAODV). MAODV protocol has all the characteristics of the original AODV protocol since it follows all the steps of the route discovery and route maintenance mechanism of the original AODV. In MAODV, one of the cameras which belongs to the old route is forced to start the process of rediscovering a new path to the unreachable destination instead of the source node when link breakage occurs. The modification of AODV reduces protocol overhead and packet transmission time delay, which leads to an improvement in WAHCN performance.