

**PERFORMANCE EVALUATION OF MOBILE
AD HOC NETWORK BASED COMMUNICATIONS
FOR FUTURE MOBILE TELE-EMERGENCY
SYSTEM**

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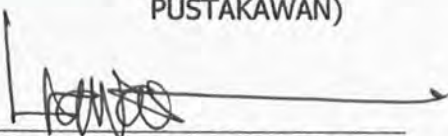
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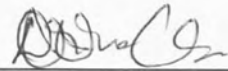


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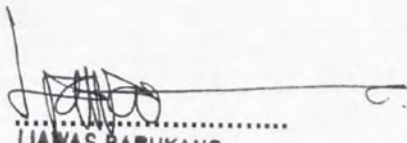
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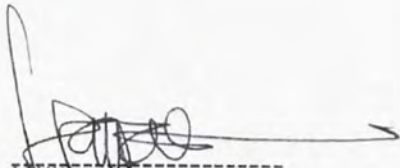
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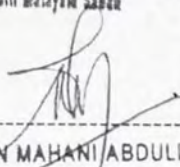
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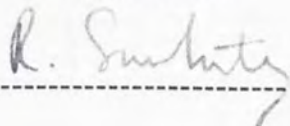
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ABSTRACT

PERFORMANCE EVALUATION OF MOBILE ADHOC NETWORK BASED COMMUNICATIONS FOR FUTURE MOBILE TELE-EMERGENCY SYSTEM

The needs to provide medical services in remote areas have motivated researchers to develop tele emergency systems. The tele-emergency is defined as the delivery of health care and sharing of medical knowledge over a distance using the telecommunication applications in emergency situations. In most cases, it is very likely that very remote areas and disaster struck areas lack telecommunication infrastructure. Tele-emergency system operating in such areas must have advanced wireless technology supporting it. The previous researchers on telemedicine system totally depended on WLAN transmission and satellite communications only for patient to doctor consultation and inter hospital services. In disastrous conditions such as earthquakes, floods and natural calamities the telecommunication infrastructure deteriorates then an emergency ad hoc setup should be installed to save many valuable lives. The satellite communications help for some extent in communication, but in rural areas those base station setup is not possible and very expensive for implementation. Our present work is based on mobile ad hoc network, which is the latest technology in form with less implementation costs rather than satellite communication. The mobile ad hoc network is combined with the mobile IP and MIPv6 to form the architecture of the proposed mobile tele-emergency system. Apart from the other existing models of the telemedicine systems, the proposed architecture has more advantages in terms of infrastructure costs, easily accessible to the users and more reliable for transmission. The tele-emergency system requires data, voice and video transmission in its network. Our evaluation is based on simulation of the various ITU-T standard CODECs of VoIP, video over MANET using discrete event simulator NS-2. In our simulation results we observed that ITU-T G723.1 works well in the MANET environment bettering from the other CODECs for VoIP in fixed and mobility environments, in fixed network for packet delivery fraction it showed a varying performance of 84.3% to 40% for increasing number of connections from 4 to 20. For average end to end delay G723.A recorded a more stable delay rate in all connections ranging from 0.22 to 0.58 second. G723.A also worked well for normalized routing load, the transmission quality of the CODEC is also good for more number of connections. From the simulation of video CODEC performance evaluation, it is observed that H.263 works well in random small scale environment and also in multiple video flow of 57.6kbps speed video transmission. In MANET routing, the mobile wireless nodes suffer signal interference due to the existence of the other active nodes. In an emergency scenario, there should be a method to route the traffic from and to the gateway without presenting extra load to the area, while maintaining the quality of the links from the gateway to the destinations within an acceptable level. We proposed the gateway routing optimization using genetic algorithm, the result of our simulation in gateway routing of mobile nodes over MANET shows that the best alternative routes given by GA can replace the routing given by the conventional MANET routing protocol.

ABSTRAK

Keperluan untuk membekal perkhidmatan perubatan dalam daerah yang terpencil telah mendorong penyelidik untuk membangunkan sistem tele-kecemasan. Tele-kecemasan boleh didefinisikan sebagai penyaluran healthcare dan perkongsian pengetahuan perubatan pada jarak yang berjauhan menggunakan aplikasi telekomunikasi. Dalam kebanyakan kes, kawasan yang dilanda malapetaka adalah memerlukan infrastruktur sistem komunikasi. Sistem tele-kecemasan yang beroperasi dalam kawasan berkenaan adalah memerlukan sistem komunikasi tanpa wayar yang maju. Penyelidikan sistem tele-kecemasan terdahulu menumpukan perhatian terhadap penggunaan transmisi WLAN dan komunikasi satelit untuk perhubungan di antara pesakit dan hospital untuk pemeriksaan doktor. Walaubagaimanapun, dalam masa bencana seperti banjir, gempa bumi dan bencana alam yang lain, infrastruktur komunikasi akan musnah dan sistem ad-hoc perlu dipasang. Sistem komunikasi satelit amat berkesan bagi kawasan terpencil, tetapi ianya amat mahal untuk dibina. Penyelidikan yang telah kami lakukan adalah rangkaian berasaskan rangkaian mudah-alih ad hoc, merupakan teknologi terkini bagi sistem komunikasi mudah-alih tanpa wayar, yang memerlukan kos pemasangan yang amat rendah berbanding dengan sistem komunikasi berasaskan satelit. Rangkaian mudah-alih ad-hoc, bersama dengan IP mudah-alih dan MIPv6 telah dibentuk sebagai senibina sistem komunikasi tele-kecemasan yang dicadangkan. Sistem tele-kecemasan memerlukan transmisi data, suara dan video melalui rangkaian. Penilaian kami terhadap prestasi adalah dalam bentuk simulasi berbagai codec piawai ITU-T untuk VoIP dan video melalui MANET, menggunakan perisian simulasi NS-2. Keputusan simulasi menunjukkan bahawa codec ITU-T G723.1 mempunyai prestasi yang lebih baik berbanding dengan codec VoIP yang lain dalam keadaan persekitaran pegun dan mudah-alih. Dalam keadaan persekitaran pegun, packet delivery fraction menunjukkan prestasi 84.3% ke 40% untuk bilangan connection dari 4 ke 20. Untuk purata end-to-end delay, G723.A menunjukkan delay yang agak stabil iaitu di antara 0.3 ke 0.58 saat. G723.A juga sesuai bagi normalized routing load, and kualiti transmisi juga baik bagi connection yang banyak. Berkenaan dengan prestasi codec video, H.263 amat baik dalam persekitaran yang berskala kecil dan juga dalam aliran video pelbagai untuk kelajuan transmisi video 57.6kbps. Dalam routing MANET, terminal mudah-alih tanpa wayar adalah dipengaruhi oleh interference disebabkan adanya sumber transmisi yang lain berada di sekitarnya. Semestinya perlu ada cara untuk mengalirkan trafik rangkaian dari dan ke gateway tanpa pertambahan beban pada rangkaian, dan mengekalkan kualiti komunikasi dari gateway ke destinasi pada tahap yang memuaskan. Adalah dicadangkan mencadangkan gateway routing optimization menggunakan algoritma genetic, dan memetakan perbandingan di antara gateway routing menggunakan GA, dan fungsi kos laluan yang dipilih dalam sistem yang menggunakan AODV. Hasil simulasi menunjukkan bahawa gateway routing untuk nod mudah-alih dalam MANET boleh menggantikan routing yang sediaada.

CONTENTS

TITLE	i
DECLARATION	ii
CONFIRMATION	iii
CERTIFICATE	iv
ACKNOWLEDGEMENT	v
ABSTRACT	vi
<i>ABSTRAK</i>	vii
CONTENTS	viii
LIST OF FIGURES	xiii
LIST OF TABLES	xv
LIST OF ABBREVIATIONS	xvi
CHAPTER 1: INTRODUCTION	1
1.1 OVERVIEW	1
1.2 RESEARCH OBJECTIVES	2
1.3 SCOPE OF RESEARCH	3
1.4 RESEARCH METHODOLOGY	2
1.4.1 Literature Survey	2
1.4.2 Design and Modelling of The Tele-Emergency System	3
1.4.3 The Performance Evaluation of VoIP Over MANET For Mobile Tele-Emergency System	3
1.4.4 The Performance Evaluation of Video Transmission Over MANET For Mobile Tele-emergency System	3
1.4.5 Using Genetic Algorithm Gateway Routing Optimization in Mobile Ad Hoc Network For Mobile Tele-emergency System	3
1.5 THESIS ORGANISATION	3
CHAPTER 2: LITERATURE REVIEW	5
2.1 INTRODUCTION	5
2.2 TELEMEDICINE PAST AND PRESENT	5
2.2.1 Overview of Telemedicine in Developing Countries	7
2.3 BRANCHES OF TELEMEDICINE	11

2.3.1	Tele-Consultation	11
2.3.2	Tele-Education	12
2.3.3	Tele-Monitoring	13
2.3.4	Tele-Surgery	14
2.4	CONCLUSIONS	17

CHAPTER 3: MOBILE AD HOC NETWORKS, MOBILE IP AND MOBILE IPV6

		19
3.1	INTRODUCTION	19
3.2	MOBILE AD HOC NETWORKS	20
3.3	TECHNOLOGIES FOR AD HOC NETWORKS	23
3.3.1	THE IEEE 802.11 Protocol	23
a.	Specifications	23
b.	The IEEE 802.11 Architecture	24
c.	Key IEEE 802.11 Medium Access Control Layer Features	28
d.	The IEEE 802.11 DCF Method for Medium Access in Infrastructureless Wireless Networks	29
3.3.2	The Hidden Terminal Problem	31
a.	Approaches to Mitigate The Hidden and Exposed Terminal Problem	33
b.	Tackling The Problem at The MAC Layer	33
c.	RTS/CTS Collisions and Loss of State Information	35
d.	IEEE 802.11 as Ad Hoc Network	37
3.4	A SIMPLE MANET ARCHITECTURE	38
3.5	VARIOUS PROTOCOLS IN AD HOC NETWORKS	39
3.5.1	Table Driven (Proactive) Routing Protocols	41
a.	DSDV	42
b.	WRP	43
c.	OLSR	45
3.5.2	Reactive (On Demand) Routing	46
a.	AODV	47
i.	Path Discovery Process	47
ii.	Maintaining Routes	48
b.	DSR	49

	i.	Route Discovery-Route Selection	49
	ii.	Route Maintenance	50
3.6		MOBILE IP	51
	3.6.1	Introduction	51
	3.6.2	Mobile IP Components	54
		a. Mobile Node	54
		b. Home Network and Home Address	56
		c. Home Agent	57
		d. Care-of Address	57
		e. Foreign Agent care of address	58
		f. Foreign Agent	58
		g. Correspondent Node	59
	3.6.3	Mobile IP Protocol Concepts	59
3.7		MOBILE IPV6 OVERVIEW	60
	3.7.1	Home Link	62
	3.7.2	Home Address	62
	3.7.3	Home Agent	63
	3.7.4	Mobile Node	63
	3.7.5	Foreign Link	63
	3.7.6	Care-Of Address	63
	3.7.7	Correspondent Node	64
	3.7.8	Mobile IPv6 Transport Layer Transparency	64
3.8		CONCLUSIONS	65

CHAPTER 4: ARCHITECTURE OF THE MOBILE TELE-EMERGENCY

	SYSTEM	66
4.1	INTRODUCTION	66
4.2	NETWORK ARCHITECTURE	67
4.3	TELE-EMERGENCY'S MOBILITY WITH MIPV6 AND MANET	67
4.4	TELE-EMERGENCY PROTOCOL ARCHITECTURE	70
4.5	MOBILE NODE INFRASTRUCTURE	72
4.6	CONCLUSIONS	73

CHAPTER 5: SIMULATION OF VOIP OVER MANET FOR MOBILE

TELE-EMERGENCY SYSTEM	74
5.1 INTRODUCTION	74
5.2 OVERVIEW OF VOIP CODECS	74
5.2.1 ITU-T G.711	74
5.2.2 ITU-T G.723.1	75
5.2.3 ITU-T G.729A	75
5.3 OVERVIEW OF PERFORMANCE EVALUATION FACTORS	76
5.3.1 Packet Delivery Fraction	76
5.3.2 Average End-To-End Delay	76
5.3.3 Normalized Routing Load	76
5.4 SIMULATION OF MANET	77
5.5 SIMULATION RESULTS AND ANALYSIS	78
5.6 SIMULATIONS OF MULTIPLE VOIP FLOW OVER MANET	82
5.7 SIMULATION RESULTS AND ANALYSIS	83
5.8 SIMULATIONS OF VOIP OVER MANET IN LIMITED MOBILITY ENVIRONMENT	86
5.9 SIMULATION RESULTS AND ANALYSIS	89
5.10 CONCLUSIONS	92

CHAPTER 6: SIMULATION OF VIDEO TRANSMISSION OVER MANET FOR

MOBILE TELE-EMERGENCY SYSTEM	94
6.1 INTRODUCTION	94
6.2 OVERVIEW OF H.263 VIDEO CODEC	94
6.3 SIMULATION RESULTS AND ANALYSIS	95
6.4 CONCLUSIONS	100

CHAPTER 7: USING GENETIC ALGORITHM GATEWAY ROUTING

OPTIMIZATION IN MOBILE AD HOC NETWORK FOR MOBILE TELE-EMERGENCY SYSTEM	102
7.1 INTRODUCTION	102
7.2 GENETIC ALGORITHM	103
7.3 DENSITY PROBLEM IN A MANET	103
7.4 COST FUNCTION	104

7.5	PERMUTATIVE GA	107
7.6	SIMULATIONS	108
7.7	RESULTS AND DISCUSSIONS	110
7.8	CONCLUSIONS	112
CHAPTER 8: CONCLUSIONS		113
REFERENCES		115
APPENDIX A: NS-2 TCL SIMULATION FILE		122
APPENDIX B: NS-2 CBR TRAFFIC GENERATOR SIMULATION FILE		131
APPENDIX C: PERL FILE FOR DATA EXTRACTION FROM NS-2 TRACER		141
APPENDIX D: PUBLICATIONS		143

LIST OF FIGURES

Figure no		Page
Figure 3.1	Mobile Ad Hoc Network	22
Figure 3.2	Infrastructure Basic Service Set	25
Figure 3.3	IEEE 802.11 Reference model	27
Figure 3.4	IEEE 802.11 Architecture	29
Figure 3.5	Primary Access Mechanism	30
Figure 3.6	Illustration Of Hidden And Exposed Terminal Problem	33
Figure 3.7	The RTS/CTS Mechanism	34
Figure 3.8	The Four Way Hand Shake	35
Figure 3.9	Illustration of RTS-CTS loss	36
Figure 3.10	A Simple MANET Architecture	38
Figure 3.11	Ad Hoc Networks Transmission Range	39
Figure 3.12	(A) Source Node S Initiates The Path Discovery Process	50
Figure 3.12	(B) A RREP Packet Is Sent Back To The Source.	50
Figure 3.13	Components Of Mobile IP	56
Figure 3.14	Overview Of Mobile IP Components	57
Figure 3.15	Ipv6 Header Format	62
Figure 3.16	Components Of Mobile Ipv6	62
Figure 4.1	System Design	68
Figure 4.2	Tele-Emergency Mobility With MipV6	69
Figure 4.3	Simple Connection Of Tele-Emergency Network	71
Figure 4.4	Tele-Emergency MN Protocol Architecture	72
Figure 4.5	Illustration Of A Smart Mobile Node	73
Figure 5.1	Packet Delivery Fraction	80
Figure 5.2	Average End-To-End Delay	81
Figure 5.3	Normalized Routing Load	81
Figure 5.4	Packet Delivery Fraction	84
Figure 5.5	Average End-To-End Delay	85
Figure 5.6	Normalized Routing Load	86
Figure 5.7	Packet Delivery Fraction	89
Figure 5.8	Average End-To-End Delay	90

Figure 5.9	Normalized Routing Load	91
Figure 5.10	Packet Error Rate	92
Figure 6.1	Packet Delivery Fraction	98
Figure 6.2	Average End-To-End Delay	99
Figure 6.3	Normalized Routing Load	100
Figure 7.1	Emergency Situation In MANET	104
Figure 7.2	Permutative GA Flow Chart	108
Figure 7.3	Number Of Generation Vs Cost For The 5th Connections	111
Figure 7.4	Costs Comparisons GA Gateway Routing Vs AODV Gateway Routing	111

LIST OF TABLES

Table No		Page
Table 2.1	Comparison of Health Indicators	8
Table 5.1	VoIP CODECs	83
Table 5.2	Simulation Parameters	83
Table 5.3	VoIP CODECs	83
Table 5.4	Simulation Parameters	83
Table 5.5	VoIP CODECs	88
Table 5.6	Simulation Parameters	88
Table 6.1	Specifications	95
Table 6.2	Simulation Parameters	96
Table 7.1	Simulation Parameters	109

LIST OF ABBREVIATIONS

AODV	Ad hoc On Demand Distance Vector
A&E	Ambulance and Emergency ward
API	Application Programming Interface
ATM	Asynchronous Transfer Mode
BP	Blood Pressure
CA	Collision Avoidance
CIF	Common Intermediate Format (352x288 pixels)
CN	Correspondent Node
CoA	Care of Address
CODEC	Device or program capable of performing encoding and decoding on a digital data stream or signal
D1	Full resolution used for TV specifications
DCF	Distributed Coordination Function
DSSS	Direct Sequence Spread Spectrum
ECG	Electro Cardio Gram
FA	Foreign Agent
FEM	Finite Element Method
GA	Genetic Algorithm
GDP	Gross Domestic Product
GIPsi	General Physical simulation Interface
3GPP	3 rd Generation partnership Project
GSM	Global Systems for Mobile communications
HA	Host Agent
IETF	Internet Engineering Task Force

ITU-T	International Telecommunications Union
J2EE	Java 2 platform Enterprise edition
LLC	Logical Link Control
MANET	Mobile Ad Hoc network
MAC	Medium Access control
MIPS	Million Instructions Per Second
MIPv6	Mobile Internet protocol version 6
MLME	MAC Layer Management Entity
M/M/1	A queue exponential inter-arrival and service time and a single Server
MN	Mobile Node
MSDU	MAC Service Data Unit
NS-2	Network simulator-2
PCMCIA	Personal Computer Memory Card international Association
PDA	Personal Digital Assistant
PLCP	Physical Layer Convergence Procedure
PMD	Physical Medium Dependent
PLM	Polling List Management
PRNET	Packet radio Network
QCIF	Quarter Common Intermediate Format (176x144 pixels)
QOS	Quality Of Service
RTS/CTS	Request To send/ Clear To send
RTP	Real Time Transfer Protocol
RREQ	Route Request
RREP	Route Reply

RRM	Radio Resource Management
SINR	Signal to Interference Noise Ratio
SNR	Signal to Noise Ratio
SPo2	SpO2 Is a measurement of the amount of oxygen attached to the haemoglobin cell in the circulatory system
SQCIF	Sub-Quarter Common Interchange Format (128x96 pixels)
SURAN	Survivable Adaptive Radio Networks
TCP	Transmission Control Protocol
TDMA	Time Division Multiple Access
VoIP	Voice over Internet protocol
WLAN	Wireless Local Area Network

CHAPTER 1

INTRODUCTION

1.1 OVERVIEW

According to the Malaysian act of telemedicine, Act-564, 1997, Telemedicine means the practice of medicine using audio, visual and data communications. The European Commission's Healthcare Telematics Program defines Telemedicine as the rapid access to share and remote medical expertise by means of telecommunications and information technologies, no matter where the patient or relevant information is located. Therefore, it involves the practice of delivering health care over distance using telecommunications equipment as simple as telephones and fax machines or as complex as PCs and full-motion interactive multimedia. The world's population continues to increase without commensurate increase in the funds available for health care. It is a known fact today, that citizens the world over tends to receive lower quality of care (especially specialist consultations) in the rural sectors. The needs to provide medical expertises in rural areas have increased the researchers to design the usage of tele-emergency system.

Telemedicine can help meet the increasing demand for universal access to high quality medicine, irrespective of geography. The tele-emergency system has been supported by lot of technologies such as satellite communications, mobile communications using WLAN, PSTN. By electronically connecting service providers (of primary, secondary and tertiary care) and patients, telemedicine allows the creation of virtual service networks potentially capable of addressing salient problems in modern healthcare, e.g., service accessibility, quality, performance, service providence, utilization effectiveness/efficiency and costs (Bashshur *et al.*, 1995). The research work in the fast growing development and implementation of telemedicine applications, (Istepanian, 1999), shows that the whole world is working after the telemedicine applications.

The research done by (Hajime *et al.*, 1994), shows that the medical data such as voice, video can be transmitted through satellite by wireless communication from emergency situation to the hospital, but needs very expensive equipment to setup the infrastructure in the rural areas and to maintain them.

The research done by (Konstantinos *et al.*, 2004), on MedLAN system is capable of connecting to an external device and transmits video, audio and still images and retransmission using static WLAN technology.

1.2 RESEARCH OBJECTIVES

The main objectives of this research are:

- i. To provide architectural infrastructural setup for the mobile tele-emergency system.
- ii. To investigate the performance of various voice CODECS such as G.711, G.723.1 and G.729A in voice over internet protocol over mobile ad hoc network for mobile tele-emergency system.
- iii. To investigate the performance of H.263 video transmission over mobile ad hoc network for mobile tele-emergency system.
- iv. Using genetic algorithm for gateway routing optimization in mobile ad hoc network for mobile tele-emergency.

1.3 SCOPE OF RESEARCH

Mobile ad hoc network is the rapidly growing technology without infrastructural setup, MANET was used for the design of the mobile tele-emergency system. Mobile ad hoc network was integrated with mobile IP and IPV6 to form the mobile tele-emergency, the performance evaluation of various voice over IP CODECs and video CODEC was evaluated through simulation of NS-2.

1.4 RESEARCH METHODOLOGY

Systematic steps and iterations of work are carried out to accomplish the research objective. Thus, the research methodology is carefully laid out as in the following:

1.4.1 Literature Survey

Literature and biography of Tele emergency units are presented, overview of mobile ad hoc network, mobile IP and mobile IPV6 is studied and its characteristics are investigated. Studies on various VoIP and video CODECs in MANET implementation for mobile tele-emergency system are presented.

1.4.2 Design and Modelling of Mobile Tele-Emergency system

The mobile tele-emergency system is designed by combining the mobile ad hoc network with mobile IP and MIPv6.

1.4.3 Performance Evaluation Test on VoIP over MANET for Mobile Tele-Emergency system

The performance evaluation of VoIP CODECs such as G.711, G.723.1, G.729A are evaluated in fixed static networks, mobility networks and multiple VoIP flow over MANET. Various parameters such as average end to end delay, normalized routing load and packet delivery fraction are simulated using NS-2, a discrete event simulator for the mobile tele-emergency setup.

1.4.4 Performance Evaluation Test on Video transmission over MANET for Mobile Tele-Emergency system

The performance evaluation of video transmission based on H.263 CODEC over the MANET traffic is simulated on tele-emergency network evaluating static networks and mobility networks and multiple video flow by using NS-2, a discrete event simulator.

1.4.5 Using Genetic Algorithm Gateway Routing Optimization In Mobile Ad Hoc Network For Mobile Tele-Emergency System

This Chapter discusses the gateway routing optimization for a mobile ad hoc network (MANET). The result of our simulation in gateway routing of mobile nodes over MANET is presented. The result shows that the best alternative routes given by GA can replace the routing given by the conventional MANET routing protocol.

1.5 THESIS ORGANISATION

Chapter 1 starts with a background overview of tele-emergency system. This chapter covers the various telemedicine projects in the present implementation around the globe. The research objectives, scopes and methodology are also carefully laid out accordingly.

Chapter 2 presents the literature survey on the tele-emergency system. The chapter also explains the basic terms in experimental design applied for the designing of the mobile tele-emergency system.

Chapter 3 presents the description of mobile ad hoc network and various routing protocols used in it, mobile IP and MobileIPv6.

Chapter 4 presents the architecture of the mobile tele-emergency system using the combination of technologies i.e., mobile ad hoc network, mobile IP and mobileIPV6.

Chapter 5 presents the simulation of various voice over IP CODECs such as G.711, G.723.1 and G.729 in mobile ad hoc networking environment using NS-2, a discrete event simulator.

Chapter 6 presents the simulation of the H.263 video transmission over mobile ad hoc networking environment using NS-2 a discrete event simulator.

Chapter 7 concludes the gateway routing optimization in mobile ad hoc network using genetic algorithm, the technique used here is permutative genetic algorithm.

Chapter 8 concludes the summary of the research done and objectives for future works are discussed.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

"Tele-medicine" is derived from the Greek work "tele" that means "at a distance", an easy way of defining telemedicine would be to consider it as "medicine delivered at a distance". Since "tele" implies the existence of a telecommunication path and considers medicine at its broader sense, we can perceive telemedicine to be a science that "utilises information and telecommunication technology to deliver medical information for diagnosis, therapy and education" (Norris *et al.*, 2000). A term very closely related to telemedicine is "tele-emergency". The tele-emergency is defined as providing medical expertise using the telecommunication technologies in emergency situations like natural calamities, accidents etc.

2.2 TELEMEDICINE PAST AND PRESENT

Historically, access concerns have driven much of the work to develop clinical telemedicine. Early applications have focused on remote populations scattered across mountainous areas, islands, open plains, and arctic regions where medical specialists and sometimes primary care practitioners were not easily reached. Most of the telemedicine projects from the 1960s through the early 1980s failed, however, to survive the end of grant funding or trial financing. Telecommunications costs tended to be high, and the technologies were awkward to use. Few projects appeared to be guided by a business plan or an appreciation of the project features and results necessary for a sustainable program.

Recently, another wave of interest in telemedicine has prompted a range of new activities. Costs have dropped for many of the information and communications technologies supporting telemedicine, and the developing National Information Infrastructure (NII) is making these technologies more commonplace and more easily used.

Tele-radiology appears to be the most common application, in part because Medicare and other payers reimburse for radiology consultations without demanding the face-to-face relationship required for most other consultations.

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