COMPRESSION-BASED FRAMEWORK FOR MULTIMEDIA RESOURCE-LIMITED MOBILE COMMUNICATION

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COMPRESSION-BASED FRAMEWORK FOR MULTIMEDIA RESOURCE-LIMITED MOBILE COMMUNICATION

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DECLARATION

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_____

Andik Setyono

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DEDICATION

In the memory of my late mother and father

To my colleagues in Dian Nuswantoro University

To my Brothers and sisters

To my future wife

To all friends

Andik Setyono, 2012

ABSTRACT

Multimedia computing and communication using mobile devices in limited bandwidth networks have become interesting topics in recent years. Many challenges are still remaining in the area of mobile multimedia computing on resource-limited systems. The existing mobile multimedia computing and communication framework has several constraints for transmitting large multimedia file. The constraints are generally due to protocols (maximum size), networks (limited bandwidth) and devices (limited memory, low-processing power and small screen for display). To solve these problems, this research proposes a new framework for developing and adapting several techniques such as compression, splitting, cropping and masking techniques to enhance the capability of the mobile application for sending multimedia data in mobile environments. The developed framework can be used not only for MMS protocol, but also for web-based and streaming protocols for multimedia communication with limited bandwidth in mobile environments.

The objectives of this research are: (i) to design an efficient and adaptive framework for mobile multimedia computing and communication using mobile technology (ii) to develop and adapt the techniques such as compression, splitting, cropping and masking for implementing mobile multimedia computing and communications (iii) to develop mobile telemedicine application for telediagnosis, teleconsultation and telemonitoring based on the proposed framework using real medical data and (iv) to evaluate the performance of the proposed framework by conducting experiments using medical images such as skin diseases, wound and dengue symptom.

The proposed framework is developed for client-server mobile system applications. On the client side, MMS applications are developed using adapted techniques such as compression, splitting, cropping and masking. Telemedicine system for telediagnosis, teleconsultation and telemonitoring applications is developed on the server side. On the client side, the proposed techniques are to

perform mobile multimedia computing and communication using mobile devices. A header is added for each split-file for the purpose of identification at the MMSC. On the server side, merging and decompression techniques are used. The header introduced by the masking technique on the client side is removed on the server side before merging the split files. Performance evaluation and analysis are presented by using measurements, simulations and experiments to evaluate the performance of the proposed framework.

The experimental results show that the proposed techniques can be implemented and executed on the mobile phone successfully. For measuring the image quality, two indicators, namely, peak-signal to noise ratio (PSNR) and universal index quality of image (UIQI) are used. The compression results show that the PSNR values are more than +30 dB and UIQI values are more than 0.5 for both mobile and desktop devices. This means that the quality of the image is good enough for interpretation by the human eye. On the desktop computer, the Splitting-Compression (SC) technique yields better PSNR and UIQI results than the Compression-Splitting (CS) technique. For mobile communication system, the CS technique is more effective and efficient.

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LIST OF ABBREVIATIONS

3G	3rd Generation Mobile Telecommunications
3GPP	Third Generation Partnership Project
4G	3rd Generation Mobile Telecommunications
AMPS	Advanced Mobile Phone System
AMR	Adaptive Multi Rate
Auc	Authentication Center
AVC	Advanced Video Coding
BSC	Base Station Controller
BSS	Base Station Subsystem
BTS	Base Transceiver Station
CDMA	Code division multiple access
CGI	Common Gateway Interface
CLDC	Connected-Limited Device Configuration
DCT	Discrete Cosine Transform
DWT	Discrete Wavelet Transform
EDGE	Enhanced Data rates for GSM Evolution
EIR	Equipment Identity Register
EMS	Enhanced Message Service
FTP	File Transfer Protocol
GGSN	Gateway GPRS Support Node
GIF	Graphics Interchange Format
GPRS	General Packet Radio Service
GSM	Global System for Mobile Communications
HDTV	High-Definition Television
HLR	Home Location Register
HSDPA	High-Speed Download Packet Access
HSPA	High Speed Packet Access
HSUPA	High-Speed Uplink Packet Access
HTTP	Hypertext Transfer Protocol

ICT	Information and Communications Technology
ITU	International Telecommunication Union
J2EE	Java 2 Enterprise Edition
J2ME	Java 2 Micro/Mobile Edition
J2SE	Java 2 Standard Edition
JPEG	Joint Photographic Experts Group
JPEG-LS	JPEG Lossless
LTE	Long Term Evolution
MANET	Mobile Ad Hoc Network
MIDP	Mobile Information Device Profile
MIME	Multipurpose Internet Mail Extensions
MMS	Multimedia Messaging Service
MMSC	Multimedia Messaging Service Center
MPEG	Moving Picture Experts Group
MSC	Mobile Service Switching Service
MSE	Mean Square Error
MTS	Mobile Telemedicine System
NSS	Network and Switching Subsystem
OMA	Open Mobile Alliance
OSS	Operation Subsystem
PDA	Personal Data Assistant
PNG	Portable Network Graphics
PSNR	Peak-Signal to Noise Ratio
PSTN	Public Switched Telephone Network
RLC	Run-Length Coding
RFID	Radio Frequency Identification
RTMP	Real-Time Messaging Protocol
RTP	Real-Time Transport Protocol
RTSP	Real-Time Streaming Protocol
SDP	Session Description Protocol
SGSN	Serving GPRS Support Node
SIM	Subcriber Identity Module

SMTP	Simple Mail Transfer Protocol
TDMA	Time division multiple access
UIQI	Universal Index Quality of Image
UMTS	Universal Mobile Telecommunications System
VASP	Value Added Service Provider MMS
DPCM	Diffrential Pulse Code Modulation
UWB	Ultra Wide Band
VLR	Visitor Location Register
WAE	Wireless Application Environment
WAP	Wireless Application Protocol
WBMP	Wireless Bitmap Image
WCDMA	Wideband Code Division Multiple Access
WiMAX	Worldwide Interoperability for Microwave Access
WSN	Wireless Sensor Network

CHAPTER 1

INTRODUCTION

1.1 Background and Motivation

In recent years, Information and Communication Technology (ICT) including mobile technology with an extensive network and numerous customers is developing very fast. Mobile multimedia communication is needed to accelerate and facilitate the human activities. The multimedia files can be transmitted over mobile network at low cost. These facilities provided by powerful mobile devices (PDA, mobile phone and notebook) should be utilised by people to make communication easier. A mobile phone is not only useful for making calls but it also offers other kinds of features such as messaging (SMS, MMS and email), music and video players, entertainment applications and network connectivity. Currently, many mobile phones are manufactured with cameras and videos enabling a user to exchange multimedia data by using mobile messaging system including MMS.

Mobile telecommunication networks will evolve to a great extent in the future offering higher data rates and providing new services for mobile users with a variety of features with time to time (Sevanto, 1999). The development of the packet switched data bearers for GPRS and 3G mobile networks supports multimedia applications using mobile devices. Mobile services have become very popular due to the development of mobile devices, mobile networks and mobile applications. The availability of mobile networks and mobile devices encourages people to create new Internet applications which can be accessed in the mobile environments. With the availability of 3G networks, people can access the Internet, mobile intranet and extranet services, multimedia messaging services and stream audio and video files (Bodic, 2005). Mobile networks are also growing and are now at the verge of migrating into 4G networks that offer a wide bandwidth and high speed

communications (Maria, 2008). The progress of mobile technology has made it possible to create sophisticated mobile systems with the help of mobile devices and mobile telecommunication networks.

The processing power of mobile devices is still limited for traditional multimedia computing tasks. There is a huge demand for mobile multimedia computing using adapted techniques on resource-limited systems, which would enable many practical applications, for example compression, splitting, cropping and masking techniques for enhancing mobile multimedia computing and communication on mobile networks. Existing mobile multimedia computing mainly focuses on high-performance systems such as PDA, notebook or smart phone, where processing of high quality multimedia data is performed on powerful computing platforms. There are many challenges when addressing mobile multimedia computing on resource-limited mobile systems. In this research, the existing techniques developed for high-performance systems are adopted to propose new approaches that are suitable for resource-limited systems. This research presents new techniques in the area of mobile multimedia computing on resource-limited systems and communication in limited bandwidth and mobile environments.

Mobile multimedia computing and communication has currently become a very hot topic with many interesting applications. Mobile system platforms generally have limited computational power, memory, displays or screens, and the applications require a fast response. Therefore it is necessary to develop efficient mobile multimedia computing algorithms to accelerate the growth of mobile applications. In this research, MMS protocol is used to perform multimedia computing and communication using resource-limited mobile system. MMS is the enhanced edition of SMS which is designed to overcome the limitations of both SMS and email. MMS is mobile messaging technology that can send text as well as images, audio, and videos or combinations of them. The limitations of message size on MMS protocol is one factor making this technology less attractive and holding back its development. Theoretically, MMS protocol can transfer multimedia data up to 300 KB depending on the mobile network service provider and MMS feature on the mobile phone

(Bodic, 2005). Almost all of the mobile network service providers offer MMS facilities. They use different bearer technology, such as the network and system specification, which influences the capability of the MMS to transfer data. Many service providers use general packet radio service (GPRS), which can transmit data up to 115 Kbps, and some of them use universal mobile telecommunications system (UMTS) with a speed of 384 Kbps. They also have different maximum data sizes for sending multimedia messages to a mobile phone and email server, and it is in the range of 50–100 KB (Setyono, Alam, & Saqour, 2009).

Existing MMS technology can be used to develop various kinds of applications such as mobile device to mobile device applications, web-based to mobile device applications and Internet to or from mobile device applications (Stephane & Guido, 2004). The proposed research develops and adapts several techniques to enhance the capability of MMS application for sending multimedia data in a mobile environment. The proposed techniques are used for performing mobile multimedia computing and communication using resource-limited mobile system, especially for MMS application. The developed framework is not only for MMS protocol, but also for implementing other mobile technologies using FTP or HTTP protocols for mobile multimedia communications. It provides several alternatives to transmit large multimedia data by adapting protocols, bandwidth and media storage.

This research provides an efficient and adaptive mobile multimedia computing and communication framework for client-server system applications. The term ‘adaptive’ is used in the sense that the developed system can send multimedia files of different formats and sizes. These techniques not only enable the user to transmit large multimedia file sizes through mobile network but they also help to preserve data quality. Besides that, the developed system is also adaptive to develop a variety of mobile client-server applications (Internet based applications) and operating system platforms, because it is developed using open source software. The developed framework results in greater efficiency compared to the existing frameworks with respect to process speed, data quality, cost, and bandwidth usage.

This framework is suitable for implementation in rural and remote areas and islands which are still sparsely populated where 3G and latest mobile networks technologies have not been well established. The development of these technologies requires considerable cost and therefore the network operators have not been able to spread to these remote areas. On the other hand, the use of general packet radio service (GPRS) network has been well established in conjunction with the GSM mobile network in these areas.

This research investigates solutions for producing an efficient and adaptive mobile multimedia computing and communication for client-server system applications. To realise that, several solutions are proposed. A mobile multimedia computing and communication with limited bandwidth in mobile environments is focused. The proposed framework in developing architectures, algorithms and applications is studied and examined. Some techniques are proposed for algorithms and applications to enhance the capability of mobile multimedia applications (MMS application) on the client side for pre-processing mobile multimedia communication. Furthermore, mobile multimedia communication using mobile networks from client to server side and also from server to client side are reviewed, as well as techniques and algorithms to develop client-server system applications on the server side for post-processing communication. Several experiments are performed to evaluate the performance of the developed framework, to determine whether it is more efficient and adaptive than the existing frameworks. A prototype of a mobile telemedicine system is developed to integrate and verify the developed mobile multimedia computing and communication framework for client-server system applications.

1.2 Research Issues

In this section, the various issues that exist with the current mobile multimedia computing and communication on resource limited system are discussed.

1. Maximum size due to MMS protocol. There exist limitations on the maximum size of data that can be transmitted due to MMS protocol. According to MMS

V.1.2, the maximum size of data file that can be transmitted is only up to 300 KB.

2. Limited bandwidth due to network. The bandwidth availability which is provided by the mobile network operator is not widely spread across all places yet. In urban and city areas, the availability of bandwidth is high enough that the user can perform mobile multimedia computing and communication smoothly without any restrictions. In the areas where only limited-bandwidth is available, the user will have difficulty to perform mobile multimedia communication.
3. Limited Memory due to device. Mobile phone generally has limited-memory. A mobile phone is only capable of performing low-level data computation. To run an application involving high volume of data, the mobile system will require more memory.
4. Low processing power due to device. Mobile phone generally has low processing power and it will lead to slow processing speed in performing mobile computing. With low processing power, multimedia computing on the mobile phone to execute internet applications will be very slow and difficult.
5. Small screen size due to device. Mobile phone generally has a small screen or display. With small screen, the information is presented on small size and therefore the user has difficulty to understand the information and also to interact with the system. Moreover, if the keypad is also small, the user will have difficulty to input or type text and its navigation.

1.3 Research Objectives

The objectives of this research are as follows:

1. To propose methods for increasing the data file size that can be transmitted (which is restricted by MMS protocol) without degrading the data quality.
2. To propose mobile streaming models for mobile multimedia communication (from Developed Sever to mobile client receiver) by combining streaming and MMS protocols.

3. To develop mobile telemedicine applications for telediagnosis, teleconsultation and telemonitoring based on the proposed framework using real medical data.
4. To evaluate the performance of the proposed framework by conducting experiments using medical images such as skin wound and dengue disease symptom.

This research focuses on enhancing mobile multimedia computing and communication for client-server system applications on resource-limited system. In this thesis, three components of mobile multimedia communication framework are discussed, namely, mobile client side, multimedia communication network and server side. The mobile client side framework is designed to perform mobile multimedia computing before the data is transmitted to developed server. The proposed framework is simulated and applied using MMS technology. Multimedia communication framework is designed to perform multimedia communication from mobile client sender to developed server and vice versa. The server side framework is designed to perform multimedia on the server side accommodating data from the mobile client. The three components are integrated to build a mobile telemedicine system. To achieve the goal, on the mobile client side, several techniques are proposed such as compression, splitting, cropping, masking techniques and its combinations.

The performance of the proposed framework is evaluated by conducting experiments using medical images such as skin wound and dengue disease symptom. In this research, image file (JPEG) is chosen for performance evaluation of the proposed framework because it can be done easily. There are several simulations, experiments and measurements that are applied on the desktop computer and mobile phone. The novelty of this research comes from the experimental results where several performance indicators such as processing speed, data quality (PSNR and UIQI), and compression ratio are evaluated. The experiments are also conducted using real medical data and therefore the proposed framework can be implemented in a real practical environment.

1.4 Research Contributions

The following are some of the novel contributions of this thesis:

1. A client side framework for mobile multimedia computing and communication on the mobile device (client side) is proposed. Mobile client side framework can be used to transmit large multimedia data with any file format without degrading the data quality in limited bandwidth and mobile environments. It can provide adaptive and cost-effective method for mobile multimedia communications by using the proposed techniques (e.g. compression, splitting, cropping, masking techniques and its combinations) under mobile environment. The proposed mobile client side framework is appropriate not only for MMS protocol but also for web-based and streaming protocols. It will provide several alternatives to transmit large multimedia data in mobile environments by adapting different protocols (e.g. MMS, web-based and streaming). The proposed framework is applied on the resource-limited system and environments. It is suitable for mobile telemedicine system that is focused for remote, rural, sea and island areas with limited bandwidth and mobile environments.
2. A multimedia communication framework over the mobile network for mobile client-server system applications is proposed. The multimedia communication framework is divided into two parts, namely, mobile client side to server side (developed server) and server side (developed server) to mobile client side. Multimedia communication from mobile client side to server side has several novelties such as (i) adaptive MMS protocol by developing and adapting several proposed techniques, (ii) adding header for each split file to be known by MMSC, and (iii) masked file for non-standard multimedia file to be known by MMSC using JPEG image format. Similarly Multimedia communication from server side to mobile client side has several novelties such as (i) mobile streaming method is proposed to retrieve multimedia file using mobile devices, (ii) the proposed streaming method is combined with MMS protocol to carry out the multimedia streaming and (iii) the proposed streaming framework is applied for telemedicine system.

3. A server side framework for performing multimedia computing and practical mobile telemedicine system based on the proposed framework is proposed. The server side framework is based on a high-performance system. On the server side, Internet applications (web-based) are developed which can be accessed by using a mobile phone in a limited bandwidth environment. Web-based services, streaming and MMS technology can be used to access and to retrieve multimedia data from the developed system using mobile phones. The details of the steps involved in retrieving multimedia data from a gateway, in merging and decompressing split files to retain data quality, merging and removing of masking headers for non-standard file formats and handling of failure messages are presented. The stored data in the database server can be used to develop different Internet applications. The system is developed based on the Java platform, where J2ME is used for the mobile client applications and J2EE for the server applications. The proposed framework will be very useful for developing a practical mobile telemedicine system which allows large data files to be sent without degradation of data quality for accurate diagnosis. The quality of data and the speed with which it is delivered play significant roles for successful healthcare management. Based on the proposed framework, different applications such as telediagnosis, teleconsultation and telemonitoring system have been developed and discussed.
4. The analysis and performance evaluation of the developed framework using simulations, experiments and measurements are carried out. This thesis contains several simulations, experiments and measurements that are applied on the desktop computer and on the mobile phone such as compression alone (CA), compression-splitting (CS) and splitting-compression (SC) methods. CS and SC methods are performed using simulations on desktop computer and mobile phone. The CS method produces higher image quality, processing speed and compression ratio than SC method on the mobile device and the CS method is appropriate for mobile multimedia computing and communication using ordinary mobile phone. The SC method produces higher image quality than CS method on the desktop computer. The SC method is appropriate for desktop computing and communications. This is because desktop can compute

multimedia file smoothly. Experiments are conducted on mobile phone to test CS technique by using real data medical images.

1.5 Justification of Study

Multimedia files containing images, audio and videos are generally very large in size. The limitations of the current mobile communications technology with respect to media storage and bandwidth make communication of large-size multimedia files very difficult. For transmitting multimedia data, large bandwidth is required. Currently, the use of 3G mobile wireless networks is widely used in developing the mobile communication systems. The communication process can be performed in a mobile environment, such as uploading data to the server using Internet protocols and streaming data from the server to mobile devices. With the current advancements in mobile technology, a mobile phone device can be used to access Internet applications easily, especially with the existence of smart phones that are flooding the market. Smart phones in general have wide display or screen, so that information can be seen more clearly than on an ordinary mobile phone. Web-based services using smart phones will be very helpful and provide facilities for mobile transactions. This method requires a large bandwidth and hence it needs the latest mobile technology, such as UMTS or HSDPA. If the only mobile network available is GPRS, Internet connection will be very slow and sites with large sized pages will not be opened. The connection timeout is around 30-60 seconds. This means web-based services are not suitable to be used in rural and remote areas, at sea and on islands that have limited bandwidths. In this case, MMS technology is the best solution for mobile multimedia communication with limited-bandwidth in a mobile environment.

There are several problems with the existing framework for mobile multimedia communication, such as maximum size (protocol), limited bandwidth (network), limited memory (device), low-processing power (device) and a small display or screen (device). A MMS protocol has a maximum size of up to 300 KB (MMS V.1.2,

2005) or 600 KB (MMS V.1.3, 2009). The MMS feature is provided by mobile phone vendors, and MMS center provided by operators generally still uses MMS V.1.2, and HTTP or FTP protocol, for which there is no maximum size but computer server application generally has a maximum size due to the consideration of media storage. 3G and the latest mobile networks are not widely spread. They are yet to reach rural, remote, sea and island based areas. In these areas, only GSM and GPRS networks are generally available which have a bandwidth of 14.4-171.2 Kbps. With the limited bandwidth, mobile multimedia communication will be difficult.

Due to limited memory, the computer server generally limits the file size that can be stored on the database server which is used to accommodate data from many users. Mobile phones generally have limited memory and because of this, it would be difficult to upload and download large amounts of multimedia data. With limited memory, it will be difficult to perform mobile multimedia computing. Multimedia data is generally of a large size and hence high processing power is needed for multimedia computing. Multimedia computing using a high performance system can be executed smoothly and better results can be obtained compared to using a resource-limited system. Mobile devices generally have low-processing power and hence multimedia computing is difficult. Mobile phones or smart phones generally have a small screen display. Only a few smart phones have a large display such as iPads and Android Tablets. With small display, it will be difficult to understand the information and also to interact with the system.

In this study, an efficient and adaptive mobile multimedia computing and communication for client-server system applications where MMS application is used to implement the proposed framework is proposed. It focuses on enhancing MMS application and protocol for sending large size multimedia files. There are several advantages for using MMS protocol compared to using web-based protocols such as HTTP or FTP for accessing Internet. Some of the advantages are as follows: (1) MMS uses GPRS network whereas web-based protocols require at least UMTS to connect to the Internet (2) MMS needs lower bandwidth compared to web-based protocols for data communication (3) MMS needs ordinary mobile phones with

lower cost compared to web-based protocols which require smart phones for accessing Internet (4) MMS uses a prepaid service whereas web-based protocols require an operator subscribed service for data communication (5) MMS is less expensive to send messages compared to web-based protocols for uploading and downloading data (6) MMS data is more secured and also protected from unauthorised users compared to sending data using web-based protocols and (7) almost all existing mobile phones have the MMS feature, and the developed MMS application can also be installed on smart phones to display the data on a wider screen.

This study focuses not only on the techniques to enhance the multimedia capabilities of MMS applications but also on the framework to implement and improve the developed system for a mobile telemedicine system. From the development of the MMS application, a variety of mobile client-server system applications can be developed. A mobile telemedicine system is selected because good quality of data is needed in the telemedicine application and hence there is a need to improve the existing MMS technology. The success of this system is influenced by the limitations of the ability of MMS technology, the mobile phone device and also the operator used. In the world of medicine, data quality is of prime concern because it greatly affects the results for diagnosis. This system uses a mobile phone device on the client side and a server computer with Internet connection on the server side. The development and adaptation of compression, splitting, masking and cropping techniques are expected to help the diagnostic process.

The developed mobile telemedicine system (MTS) can be applied in areas that have limited bandwidth. Ordinary mobile phone is used to develop the mobile telemedicine system. This is to show that with simple affordable equipment, the proposed framework can work smoothly and it will be effective and efficient and can also be widely reached by users. This facility is useful in countries where new technologies (3G or 3.5G) are still not fully developed. For example in countries like Indonesia and Malaysia, the coverage of GPRS mobile network reaches up to 98% of the areas (Telkomsel, 2007), while 3G and the latest mobile network is only available

in big cities and densely populated areas. Under these conditions, the use of MMS technology will be very helpful in implementing a mobile telemedicine system. Besides the network availability factor, another advantage of using MMS technology is the possibility of sending packaged and encoded files to the recipient. Furthermore, security is ensured as the message is not directly received by the database server, but is received by a mobile phone or email server as a gateway between the mobile client and computer server. It makes the telemedicine system on the server-side more secured since only authorised people such as administrators and registered doctors are allowed to access the system.

1.6 Research Methodology

This research provides some important contributions in mobile multimedia computing and communication. Chapter 2 presents literature review. This chapter describes the previous research and latest theories in mobile computing and communication for client-server system applications. In this area, there are three important parts, namely the mobile client side, data communication and computer server side. Chapter 3 presents the mobile client side applications such as compression, splitting, cropping, and masking techniques for mobile multimedia communication. The adaptation method from high-performance to resource-limited system is applied to develop the MMS application for transmitting large multimedia data. The multimedia communication framework over the mobile network for client-server system is discussed in Chapter 4. The computer server side framework for performing multimedia computing on the computer server side and developing Internet applications (web-based) is discussed in Chapter 5. The performance evaluation and analysis of the developed framework are reviewed in Chapter 6. The conclusions from the research and future work are discussed in Chapter 7. An overview of the research is shown in Figure 1.1.

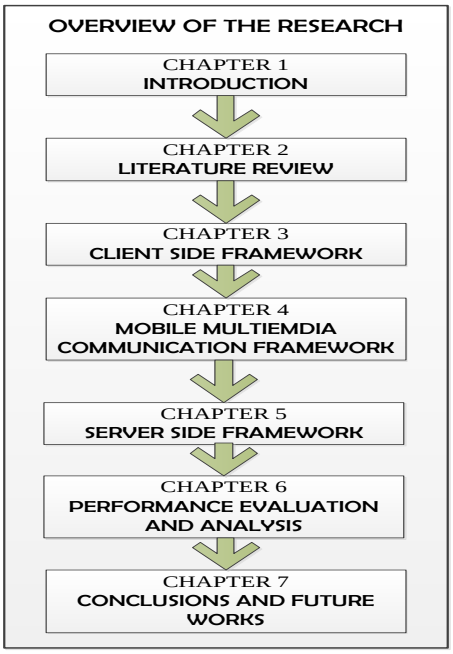

Figure 1.1: Overview of the research

1.7 Outline of Thesis

This thesis focuses on mobile multimedia communication on a mobile network using resource-limited mobile system. Three important areas are focused in this thesis, namely, pre-processing, data communication and post-processing framework. All the three topics are discussed in the context of mobile communication conditions. The proposed architectures, algorithms, techniques and applications for simulation and experiments of the proposed framework are presented. An outline of the important contributions of this thesis is shown in Figure 1.2.

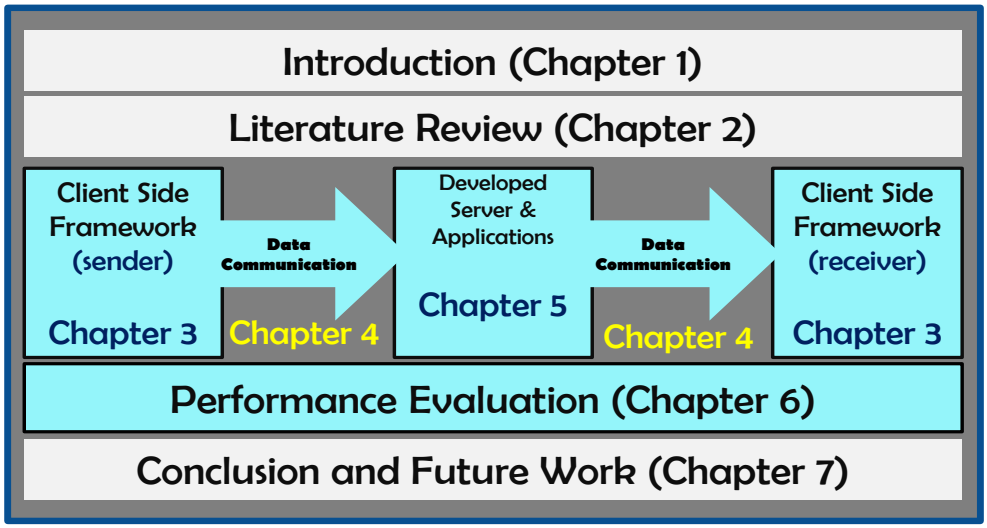

Figure 1.2: Outline of the thesis

The organisation of this thesis is explained in detail and the contributions are highlighted below.

Chapter 2: Literature Review

This chapter presents a review of the technologies that are used in this research, such as mobile multimedia, mobile communications network, mobile communication technologies, mobile client-server system applications and a review of the previous research.

Chapter 3: Client Side Framework for Mobile Multimedia Computing and Communication.

This chapter presents the proposed mobile computing and communication framework on the client side. The proposed framework is applied to enhance the MMS application for performing multimedia computing and communication on the client side like simulations and experiments. The developed system is adapted within the limitations of the mobile phone. The proposed framework can handle large multimedia file on the mobile phone with its limitations.

Chapter 4: Mobile Client-Server Communication Framework

This chapter contains several concepts about mobile multimedia communication, development of data transmission, video streaming for mobile communications. It presents a framework for multimedia communication from the mobile client to the server and also from the server to mobile client. A framework for mobile video streaming is also presented. Mobile video streaming is the main contribution of this chapter.

Chapter 5: Computer Server Side Framework for Multimedia Communication

This chapter describes several techniques for performing multimedia computing on the computer server side (developed server). The proposed framework contains architectures, techniques, algorithms and web-based Internet applications. The proposed techniques are paired with the proposed techniques on the client side. An Internet application is built to retrieve the stored data on the database. This chapter also discusses the development of system applications in practical usage. Several applications of the proposed framework for a mobile telemedicine system are presented. Applications such as Telediagnosis for skin disease, wound and ECG, e-Dengue teleconsultation and mobile streaming application for telemonitoring are discussed. This chapter provides several contributions towards developing server side applications.

Chapter 6: Performance Evaluation and Analysis of the Developed Frameworks.

This chapter presents measurement of data quality, evaluation and an analysis of the developed framework using JPEG image format. The measurement indicators are processing speed, image quality and compression ratio. For image quality, parameters such as Peak-Signal to Noise Ratio (PSNR) and Universal Index Quality are used. This chapter provides a justification for the development of an efficient and adaptive mobile computing and communication framework for client-server system applications.

Chapter 7: Conclusion and Future Works

This chapter contains the conclusion and suggested future directions for research for developing a mobile multimedia computing and communication framework. The outcome of this research is a more efficient and adaptive mobile communication system compared to the existing systems