Development of Mobile Streaming Application using Multimedia Messaging Service Technology for Supporting Mobile Telemedicine System

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***Abstract*—MMS is a sophisticated multimedia messaging service which can be used to send all forms of multimedia messages. MMS can also be used to stream audio and video files in mobile environment. In this paper, we propose the architecture, algorithm and mobile streaming system application to support a mobile telemedicine system using MMS technology. Streaming technique is used to enhance the capacity of the system to send large-size audio and video files using MMS. With the developed system, the doctor can perform the diagnosis without the need for staying at the hospital. The experimental results demonstrate that the proposed system performs better compared to the conventional MMS for streaming audio and video files.**

***Index Terms*—MMS; Streaming; Mobile telemedicine system; Multimedia message**

I. Introduction

Mobile technology has been growing rapidly in recent years. Mobile services have become very popular among the people due to the development of mobile devices, mobile networks and mobile applications. The availability of mobile network and mobile devices encourages people to create new applications that can be accessed in mobile environment. With the availability of 3G networks, people can access internet, mobile intranet and extranet access, multimedia messaging services and streaming audio and video file [1]. Mobile networks are also growing and are now at the verge of migrating into 4G network that offers wide bandwidth and high speed communications in a mobile environment [2].

The progress of mobile technology opens the opportunity to create mobile system by using mobile devices and networks that are more sophisticated. In this research, we have developed mobile streaming to deliver audio and video files using MMS technology. Streaming is a technique that is used to transfer and display a large file size (audio and video). The various issues related to sending large size multimedia messages have already been reported in [3]-[5]. MMS has limitation in message delivery of audio and video files. The maximum limit for each transmission is only 100 KB for MMS version 1.1 [6], 300 KB for MMS version 1.2 [7] and 600 KB for MMS version 1.3 [8]. Currently, MMS version 1.3 still remains as candidate version, and hence only a few mobile devices have these features. Each MMS phone has different maximum size limits for the MMS message that can be supported. Basic phones without video feature can only send multimedia message less than 30 KB [9]. They are not only influenced by MMS phone capability, but also limited by the operator system. Currently, the mobile devices can send at least 100 KB for each sending [10]. By using the proposed streaming technique, it is expected that the system will be able to transfer audio and video files larger than the usual multimedia message that can be sent using MMS protocol. Besides that, the file can be retrieved in mobile environment by recipient mobile terminal. Streaming audio and video files using mobile phone and MMS technology is not standardized yet [11] and many researchers have been developing the application. Generally, the streaming process uses the HTTP protocol developed by content provider. Media content can be uploaded to the media server so that it can be accessed by users using computer with internet connection. The simple example is YouTube site. We can upload the video files to the server and we can access them using streaming technique.

The main goals of this research are: (i) to propose a MMS framework for mobile streaming application, (ii) to make a system prototype to simulate the proposed framework and (iii) to evaluate the performance of the system. The system which is developed will be used to support the mobile telemedicine system, where the system can be accessed in mobile environment. The developed system can support the telemedicine system processes such as: (a) nurse can send the large size audio and video files that cannot be sent using the MMS protocol, (b) doctor can diagnose and process the streaming data in mobile environment and (c) nurse can request to the streaming server using SMS technology to carry out streaming of audio and video files.

The rest of the paper is organized as follows: Section 2 discusses literature review. The proposed framework and discussion are presented in Section 3. Simulation and evaluation details are presented in Section 4 and finally conclusion and future work are given in Section 5.

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II. Literature Review

Streaming denotes a method for real-time transferring of data so that the recipient can start viewing the presentation before the entire contents have been transmitted [12]. Streaming facilitates presenting data to user while the data being transmitted [13]. Streaming refers to the ability of an application to play synchronized media like audio and video in a continuous way while the streaming data are being transmitted to the client over a data network [14]. In this section, we discuss about the existing mobile streaming technology, MMS in streaming and MMS streaming for mobile telemedicine system.

A. The Existing Mobile Streaming Technology

Currently, the fixed-IP networks are widely used for streaming. This is different from the mobile-IP networks. There is no communication standard between media server and MMS center for streaming framework yet. In 3G system, the 3G packet-switched streaming service (PSS) fills the gap for 3G MMS, such as downloading and conversational services [14]-[15]. Streaming technique has an advantage such as good quality in 2G and 3G mobile communications. Streaming works in real time that can handle the limitation of storage space without the need for storing the whole data into the database before it is presented [13].

The streaming service needs at least a media server and a streaming client [1]. The additional components such as portals, profile servers, caching server and proxies are used to provide additional services to enhance the overall quality of services. Specific user preference attributes have not yet been defined for PSS. The 3GPP has been working to bring streaming in mobile environment. Fig. 1 shows the streaming framework for mobile environment.

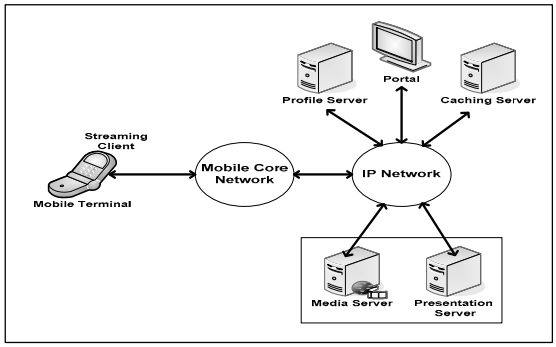


Fig. 1. The streaming framework for the mobile environment [14]

B. MMS in Streaming

MMS is a sophisticated multimedia messaging service that has required a tremendous standardization workload [1]. MMS technology is used not only to send multimedia messages but it can also be used to stream audio and video file. In the person-to-person scenario, the delivery of multimedia message consists of notification to the recipient MMS client and retrieval of the complete multimedia file (immediate or deferred retrieval). While audio and video files are successfully received, the contents can be rendered on the recipient device based on user demand. The large content of the file can be split into small data chunks and sent using streaming one by one to recipient device [1]. By this process, the data chunks can be rendered directly on the recipient device without waiting for the retrieval of the complete data. Fig. 2 shows the concept of streaming using MMS technology.

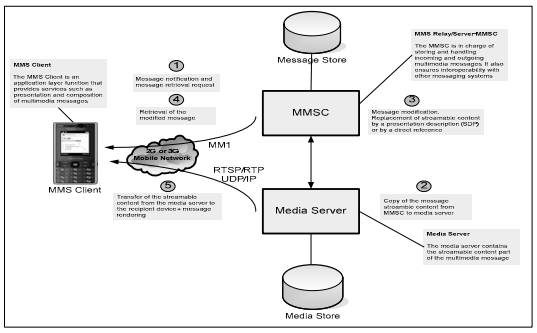


Fig. 2. The concept of streaming using MMS technology [1]

It is possible to use streaming technique in MMS environment to send audio and video files. For this purpose, the recipient MMS client terminal must have streaming capability. The streaming process needs the media server which is used to collect the streamable content part of the file, and then this data are transferred to the recipient device. In this case, the streamable content is stored already on the MMS center. The first process is sending message notification and message retrieval request from MMS center to the recipient. The streaming application on server of the service provider cannot be modified because we do not have the authority to add command or application on the server. Fig. 2 does not discuss about sending or uploading audio and video file to the media server, this method is usually for broadcasting the audio and video files that are controlled by service provider.

There are two protocols that can be used to retrieve the streamable content from media server namely real-time transport protocol (RTP) and real-time streaming protocol (RTSP). RTP is a generic transport protocol allowing the transfer of real-time data from server. RTP enables one-way communication from the media server to the MMS client [1]. With RTSP, the MMS client can control the manner in which the streamable content is delivered from the media server. MMS client can give instructions to the media server such as start, pause and play the audio or video file during the content delivery and rendering.

The architecture reported in [13] for the interworking between MMS and streaming has described the optimum interworking between MMS and streaming in a simplified mobile network for both person-to-person and content-to-person messaging as shown in Fig. 3.

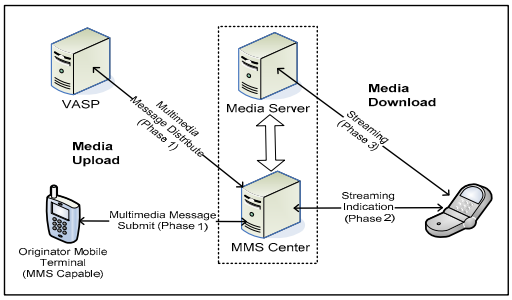


Fig. 3. The optimum interworking between MMS and streaming [13]

The architecture network shown in Fig. 3 consists of three phases that are (1) multimedia message is sent from originator mobile terminal to MMS center for person-to-person method and from value added service provider (VASP) residing on the server for content-to-person method using MMS technology, (2) streaming indication, that is MMS center send message notification and message retrieval request to recipient and copy of the message streamable content from MMS center to media server and (3) streaming process, this phase is to transfer streamable content from media server to the recipient mobile phone and message rendering. Multimedia message that is sent by originator mobile terminal using MMS protocol is limited by file size, each time only up to 300 KB data can be sent, so that the file that is sent has short duration. From this framework, we get the ideas to combine some methods for this mobile streaming application. We use the HTTP protocol to upload data to the server, and then the MMS protocol to send a message notification and RTSP to stream audio or video files from media servers to recipient mobile client terminal.

C. Mobile Telemedicine System

Mobile telemedicine system is useful for the delivery of healthcare and sharing of medical knowledge over a distance using telecommunication means. The aim of the telemedicine system is to provide expert-based healthcare to patients at remote sites and to provide advanced emergency care through modern telecommunication and information technologies [16].

The growth of information and communication technologies (ICTs) has made a tremendous impact on our society. MMS is one of the branches of mobile messaging technologies, which is used for sending not only text but also image, voice, audio, video or combination of them. Multimedia messages can be sent to mobile phones and also to email server using MMS technology. MMS is used widely for many purposes, such as streaming [17-19], mobile learning [20-21], mobile commerce [22], mobile banking [23] and mobile telemedicine [24-27]. Fig. 4 shows the overview of the network architecture for a mobile telemedicine system.

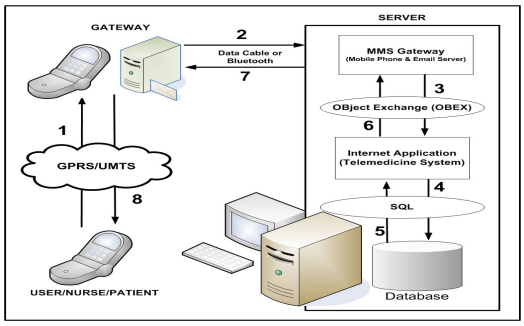


Fig. 4. Overview of network architerture.

Building a mobile telemedicine system application is not an easy task. Many aspects must be considered such as technique enablers, ethics, feasibility and usability. Mobile telemedicine is a field that has a vast potential to enhance accessibility of service, quality and continuity of care and significant cost savings in overall healthcare management. But mobile telemedicine is still not well developed and is not widely socialized. This may be due to the fact that it needs an expensive technology and data transfer capabilities and also an approved data quality.

Currently, wireless and cellular technologies are used to build mobile telemedicine system. Table I shows a comparison of different technologies that are being used to build a mobile telemedicine system. In this research, we develop MMS application on mobile phone to support mobile telemedicine system. We also investigate new techniques for implementing an adaptive MMS framework for mobile telemedicine system.

TABLE I: TECHNOLOGIES FOR MOBILE TELEMEDICINE SYSTEM

Technology	Data Rate	Frequency	Max. Range
IrDA (Infrared Data Association)	4 Mbps	IR Spectrum	2 m
WLAN (Wireless Local Area Network			
IEEE 802.11a	54 Mbps	5.8 GHz	< 600 m
IEEE 802.11b	11 Mbps	2.4 GHz	
IEEE 802.11g	54 Mbps	2.4 GHz	
MAN (Metropolitan Area Network)			
IEEE 802.16 (line-of-sight)	< 75 Mbps	10 – 66 GHz	5 – 10 km
IEEE 802.16a (non-line-of-sight)	< 75 Mbps	2 – 11 GHz	
Bluetooth IEEE 802.15 (Personal Area Network)	723 kbps	2.4 GHz	10 – 100m
Home RF (Home Radio Frequency)	1 Mbps	2.4 GHz	< 40 m
Mobile Technology			
GSM	9.6 kbps	900/1800/1900MHz	
GPRS	171.2 kbps	900/1800/1900MHz	
EDGE	384 kbps	900/1800/1900MHz	
3G / UMTS	2 Mbps	1885 – 2200 MHz	

D. Streaming for Mobile Telemedicine System Using MMS

A mobile phone is used as an MMS client that contains the application for implementing the compression and file-split techniques before transmitting the multimedia messages. After going through the 3G network, the multimedia messages are received by the MMS gateway. By using a data cable or Bluetooth connectivity, the data is retrieved with the applications in OBject EXchange (OBEX) one by one and then the multimedia message files are merged and decompressed before storing the data into the database server. In this case MySQL is used as the database server.

Building a mobile telemedicine system application is not an easy task. Many aspects must be considered such as technique enablers, ethics, feasibility and usability. Mobile telemedicine is a field that has a vast potential to enhance accessibility of service, quality and continuity of care and significant cost savings in overall health care costs. But mobile telemedicine is still not well developed and is not widely socialized. This may be due to the fact that it needs an expensive technology and data transfer capabilities and also an approved data quality.

The developed mobile telemedicine system can be used by patient or nurse at the patient's home to make telediagnosis and teleconsultation with the doctor in hospital or mobile condition. The system can be used to send large audio and video file size using MMS protocol and streaming technique using MMS technology. We have developed the system using Java technology, where currently, Java does not support to develop MMS application for sending audio and video files [28]. By using streaming technique, we can solve the problem of transferring audio and video files. This method is an alternative in message delivery of audio and video files. With this technique, doctor can get patient data in mobile environment and can also diagnose and make consultation with the nurse at patient's home. Fig. 5 shows

the model of streaming application for mobile telemedicine system

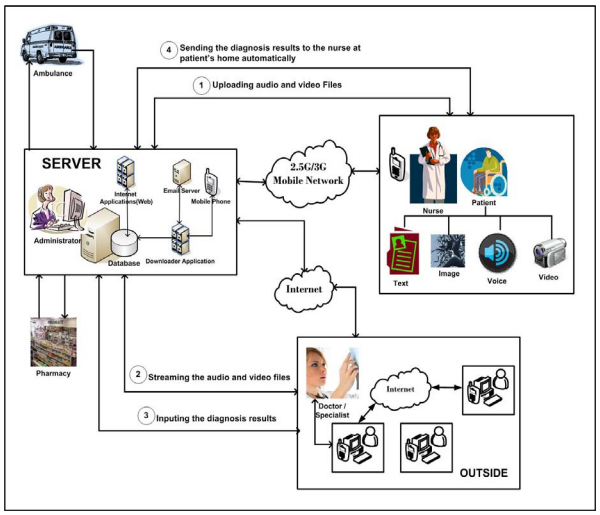


Fig. 5. Model of streaming application for mobile telemedicine system.

III. Proposed Framework and Discussion

A. Sending Audio and Video Files

We use Java technology to simulate the algorithm for sending audio and video files. We use byte-split technique to split the compressed file, and then we use image header to mask audio and video files.

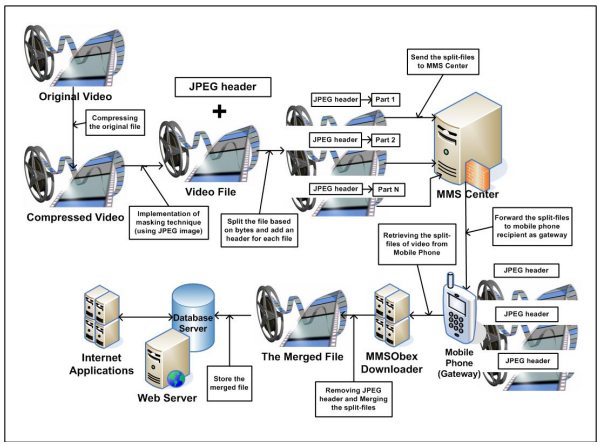


Fig. 6. Model of sending audio and video files using MMS technology

The image header is added in each split-file formed. The aim of this technique is to enable the MMS center to identify the split files and forward them to target recipients. The size of the header of image file is 128 bytes. The algorithm is illustrated in the following steps:

\

MAX_PART_SIZE = 30000;
*MASK_HEADER_SIZE = 128*1;*
MAX_PART_SIZE_MASKED = MAX_PART_SIZE – MASK_HEADER_SIZE;
If fileSize > MAX_PART_SIZE_MASKED
numParts = fileSize / MAX_PART_SIZE_MASKED;
endSize = fileSize % MAX_PART_SIZE_MASKED;
End.

Though the implementation of the splitting technique in MMS application on the mobile phone is an easy task, the delivery process of split-files is rather complex. The split-files cannot be identified by the MMS center if suitable MMS formats are not used for the headers.

Sending the split files with headers will not cost-effective if the file size is large as normally the case with audio and video files. As an alternative, we propose a streaming framework for sending audio and video files. This method supports the mobile telemedicine system where doctor can perform diagnosis in mobile environment.

B. Proposed Architecture

We have developed a mobile telemedicine system using MMS technology to stream the audio and video file. We discuss MMS in streaming because MMS technology can be used to do streaming specially for audio and video file. Fig. 7 shows MMS framework for audio and video streaming. We use the streaming technique to send large audio and video files as an alternative for MMS.

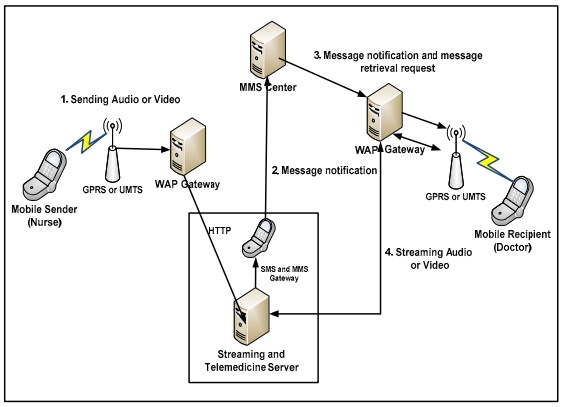


Fig. 7. Proposed MMS framework for streaming audio and video

A nurse at the patient's home can send the audio and video data to the server using HTTP protocol. The uploading application of audio and video at the client (nurse) side includes the mobile phone number of the recipient (doctor). After receiving the data, the server sends the notification message to the MMS center which forwards the message along with a retrieval request message to the recipient. From the URL link address contained in the message, the doctor gets the audio and video data by streaming from the server. Nurse can also do the same by sending a request to the telemedicine server using SMS. Fig. 8 shows the stages of request streaming from mobile client terminal to telemedicine server.

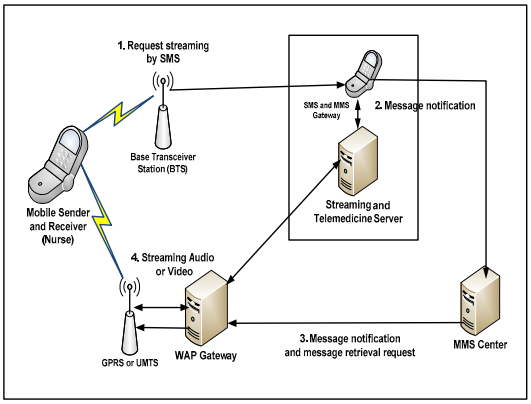


Fig. 8. Proposed MMS framework for request streaming

If the nurse needs to know the history of the patient, the server provides the tutorial or guidance for nurse in the form of audio and video files. The nurse can request the data using SMS and retrieve the data using streaming technique. This method will be helpful for the nurse to do the treatment suggested by the doctor.

C. Proposed Algorithm

The nurse at patient's home can send audio and video files to the server using HTTP protocol. The file can be transmitted to the recipient (doctor) using streaming technique. The flowchart of the algorithm for uploading and streaming audio and video files using MMS technology is shown in Fig. 9.

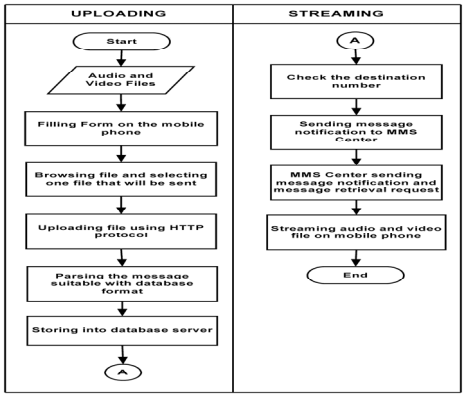


Fig. 9. The flowchart for uploading and streaming

This streaming method can be used to help the telemedicine process at the time of the doctor in outside of the hospital. The data successfully sent to the server is forwarded to the mobile phone number of the recipient (doctor). The doctor will receive the message retrieval request that contain URL link to connect with media server so that the streaming process can be done. The doctor and the nurse can communicate to follow up patient data that is successfully sent using mobile phone features, such as SMS, voice, chat and teleconference.

D. Proposed Modeling of the System

We also propose modeling the system that consist of class diagram and sequence diagram. Class diagram is model or building block that is used in a system. Class diagram shows the relationship between class and detail explanation each class with the model design of a system. Class diagram for streaming application is shown in Fig. 10.

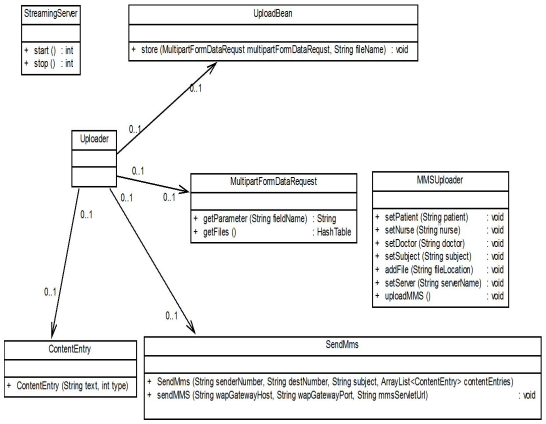


Fig. 10. Class Diagram for streaming audio and video files

The class diagram contains several classes which are used to build mobile streaming application. The use of the application is started with setting and fills the user interface as shown on MMSUploader class, and then the audio and video files are sent to server and store it into database server. The server will send the message notification and message retrieval request for carrying out streaming to the user target recipient.

We use sequence diagram to model the proposed system. The sequence diagram of streaming audio and video file is shown in Fig. 11.

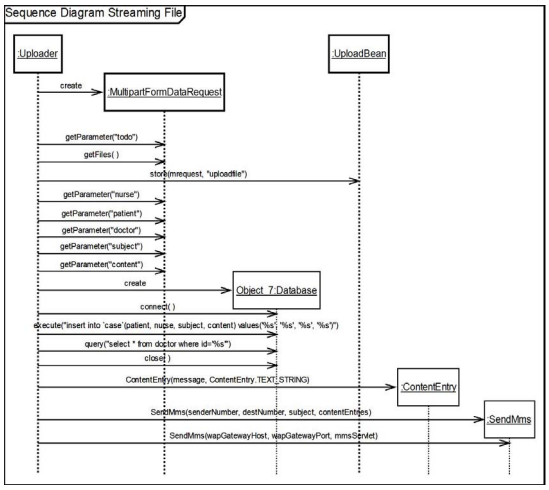


Fig. 11. Sequence diagram for uploading file on the server

IV. Simulation and Evaluation

In this section, we discuss about the simulation of the proposed framework and evaluate the performance of the system. The proposed system can be considered to be a prototype for developing practical mobile telemedicine systems.

A. Simulation

The streaming application consists of several simulation processes such as uploader application that is installed on the mobile phone, storing data into the database server, forwarding the data to mobile phone recipient and carrying out the streaming. The user interface for the uploader file application on the mobile phone is shown in Fig. 12.



Fig. 12. User interface for uploading file on the server

The user interface of the MMS application on the mobile phone on Fig. 12 requires inputs such as server address, subject, doctor, patient, nurse and audio or video file that will

be sent. Then the file is stored into the database server and forwarded to mobile phone recipient (doctor). Fig. 13 shows the stored data on the database server that is displayed using telemedicine application on the server.

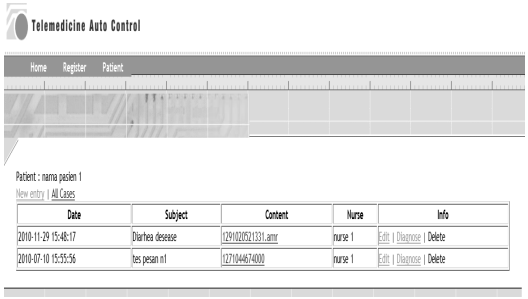


Fig. 13. The layout of telemedicine system on the server

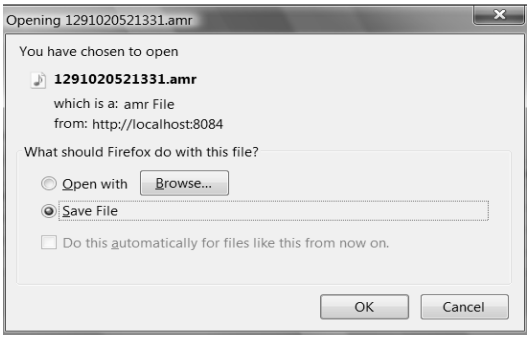


Fig.14. Opening data that successfully stored in the database server

After the data is successfully stored into database server, the server sends message notification and message retrieval request to the mobile phone recipient (doctor). The message contains URL link to carry out streaming. The doctor can also open or download files that have been successfully stored in the database server. The doctor uses the data to conduct a thorough diagnosis. The good quality of data will be very helpful to produce an accurate diagnosis. Fig. 14 shows the interface that provides a choice of whether to view or download directly from the database server.

```
String username = "mms";
String password = "mms";
String lokasiFoto = "D:\\MyWebs\\LearnTheNet\\jsp
                    \\telemedicine\\mmsdata\\images";

locationFoto = "D:\\Documents\\TELEMEDICINE\\telemedicine
                \\build\\web\\MOD\\MMS";

String fotoUrl = locationFoto + "\\" + content;
String pesan = "patient: " + patient + ", subject: " + subject +
                ", nurse: " + nurse + ". streaming:

      // for example streaming
      rtsp://telemedicine.com/streaming/" + content + ". test
      rtsp://www.astrojax.com:7070/sample_100kbit.mp4 atau

wapGatewayHost = "203.092.128.160";
String wapGatewayPortString = "9201";
wapGatewayPort = Integer.parseInt(wapGatewayPortString);
mmsServlet = "http://mms.digi.com.my/servlets/mms/";
senderNumber = "+60169481825";
subject = "Diagnose for <patient 1>";
imageMaxSize = 200000;
textMaxSize = 200000;
maxSize = 1000000;
 skip = false;
 verbose = true;
destNumber = doctor_phone;
contentEntries.add(new ContentEntry(pesan,
ContentEntry.TEXT_STRING));
SendMms mmsSend = new SendMms(senderNumber, destNumber,
subject, contentEntries);
mmsSend.setTextMaxSize(textMaxSize);
mmsSend.setImageMaxSize(imageMaxSize);
mmsSend.setMmsMaxSize(maxSize);
mmsSend.setSkip(skip);
mmsSend.setVerbose(verbose);
mmsSend.setUsername(username);
mmsSend.setPassword(password);
```

Fig. 15. Source code for sending message retrieval request to recipient

Fig. 15 shows the source code to send the URL link for streaming audio and video file to the doctor in mobile environment.

The telemedicine application is a web-based application. The telemedicine application consists of several interfaces, such as main menu, input patient data, input nurse data, input doctor data, and input diagnosis result which are used by the telediagnosis and teleconsultation processes. The interface of the telemedicine application is shown in Fig. 16.

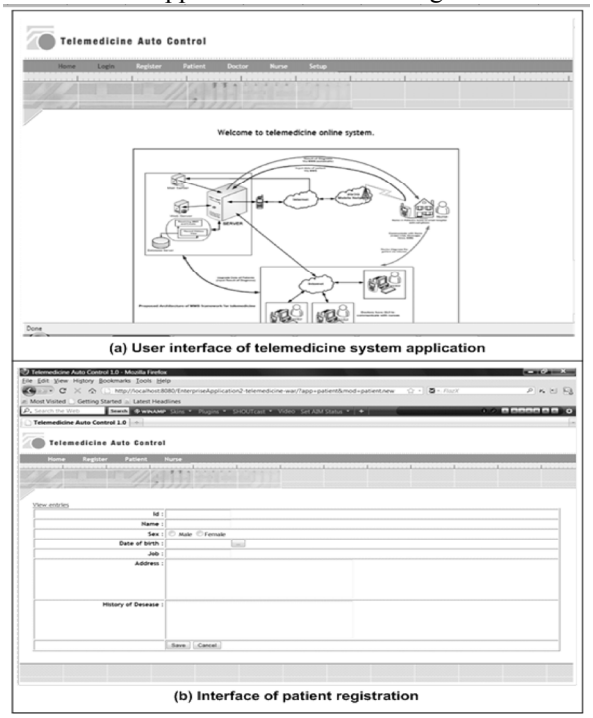


Fig. 16. Interface of the telemedicine application on the computer server

The main menu interface contains several sub-menus. The main menu is the homepage of the system, and this homepage will be automatically opened for every opening the system. Once opened, the user can log into the system with the user identification. There are several groups of users such as admin, doctor and nurse with different authorities, who have already registered in the system. Every patient who will use this system is required to register first.

B. Evaluation

The mobile streaming application is built to support a telemedicine system, without the need for the doctor to stay at the hospital. This application is built as an alternative to MMS for the nurse at patient's home to deliver large size audio and video files to the server. In developing mobile streaming application, we need mobile device that has features to play audio and video files (e.g. real player). Besides that the support of the service provider that provides streaming features plays an important role in running the application successfully.

In this work, we utilize the MMS streaming only partially because we cannot modify the system on the MMS center. We upload audio and video files using HTTP technology along with the required identifiers in accordance with the database format. Due to the use of streaming frame work, we could upload a large file to the database server. After the file is successfully stored into the database, the system gives a notification message to the recipient (doctor or nurse) to

carry out streaming using the MMS technology. We use streaming technique because the doctor can retrive the patient's data repeatedly to carry out the diagnosis process well. Video calls between the nurse at patient's home and the doctor in mobile environment can be used to get more information about the patient's condition.

The streaming process is already supported by many service providers, but not by all. This is followed by mobile phone vendors that do not add streaming feature and media player. The media player is used to play media streaming. In this research, we could upload audio and video files successfully using the simulation techniques to the database server that resides on the telemedicine server (media server), display the stored file using telemedicine system and send the MMS containing URL link to the mobile phone recipient to carry out streaming successfully.

Implementing mobile streaming application for telemedicine using MMS technology has advantages as well as some limitations. The advantage of this system is that the nurse at patient's home can send patient's data to the doctor in a mobile environment. This makes easy for the doctor to diagnose the data from anywhere. The limitation is that the doctor cannot input the diagnosis result quickly into the system using mobile phone and he needs a system to connect to the Internet.

The proposed system is expected to be able to help patients in remote areas that need medical treatment using mobile environment. Based on the proposed framework, we have implemented a mobile telemedicine prototype system using streaming application. The proposed system is still in the form of a prototype which has been developed using Java technology. The proposed mobile telemedicine system will yield the following benefits: (i) with the developed system, a patient can consult a doctor while living in a remote area, (ii) the doctor can diagnose the patient's information using a better quality of data without visiting the patient physically, (iii) the diagnostic results can be sent automatically by the system to the nurse at the patient's home through mobile phone number or email server based on the available communication system, and (iv) the system provides streaming audio and video files using MMS technology. The nurse, who is at the patient's home, can communicate and consult with the doctor for further clarification using SMS, phone, or chat facilities of GPRS/UMTS.

V. Conclusion Future Work

The developed system is a prototype, where the mobile streaming application is built to support the mobile telemedicine system using MMS technology. We have proposed the architecture, algorithm and mobile streaming application for mobile telemedicine system. The simulation results show that we can carry out streaming audio and video files on the mobile phones that have streaming features with a media player. The performance of the streaming application depends on the availability of the traffic network which is provided by the service provider.

By using the proposed mobile streaming application, the telemedicine processes become easy and flexible, where the doctor does not need to stay at the hospital as the system can be used anywhere in a mobile environment. Further research on the performance evaluation of the proposed mobile telemedicine system using MMS technology is in progress. We hope our research will provide a basis for developing an efficient and adaptive MMS framework for the internet applications.

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