ISBN 2320-2602

International Journal of Advances in Computer Science and Technology (IJACST), Vol.5 , No.3, Pages : 19-23 (2016)
Special Issue of ICDCB 2016 – Held during April 14-15, 2016 in Kuala Lumpur, Malaysia
http://warse.org/IJACST/static/pdf/Issue/icdcb2016sp04.pdf

Framework of Fast Medical Data Transmission

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Abstract: Nowadays, PACS system in hospitals have been upgraded to 3D and 4D images. PACS (Picture Archiving and Communication system (PACS) is a medical imaging technology which provides storage and access to images from multiple modalities. Images from echocardiography, and magnetic resonance imaging (MRI) are among the big data to be transferred through the network. Thus, the large size of data has used a lot of time to transmit through the network. To solve the problem, in our research, we proposed a new framework named "Exponential-and-Uniform-based (*ExpoNUni*) to improve the transmission time and maintain the quality of the data. Our "*ExpoNUni*" Framework has performed a better result compared to the framework embedded with techniques such as Fibonacci-based Splitting with V^1_{min} Technique and Uniform-based Splitting Technique.

***Keywords*:** Video Storage, Grid Computing, Grid Storage, Data Transmission, Video Splitter.

1. Introduction

In hospitals, PACS System are integrated with multiple modalities such as the machine for MRI, echocardiography and computerized axial tomography scan (CAT scan). The medical images and video will be transferred to a network for the doctors to diagnose by viewing the images or videos. Among these data, echocardiography is a kind of video and videos has become an important medium for the area of communications and entertainment [1]. To enhance the video clarity and quality, nowadays, the video has been improved from the two dimensions (2D) video images into three dimensional (3D) or four dimensional (4D) video images. However, the improvement of this dimension also increased the size of the video data. Thus, among those data, video is the only one data that takes up a lot of space and time during the transmission and storage session.

To reduce the transmission time and the usage of storage space, a number of researchers are doing the research on solving the size of video. There are two common techniques used by the researchers to reduce the video size during the transmission and storage session, which are the compression technique and the splitting technique. For video compression techniques, there are some common compression techniques were used in these recent years, such as Motion Estimation Technique, Motion Compensation Technique and JPEG2000 Technique. There are some research been done on these three compression techniques, such as in the papers of [2, 3, 4, 5, 6, 7, 8]. However, from our studies, we found that video compression technique can reduce the size of the data, but it cannot maintain the original quality of the video images.

In papers of [9], [10], they are focusing on the video splitting technique. They introduced some splitting techniques in their paper, such as the Uniform-based Splitting Technique, Fibonacci-based Splitting Technique, and Fibonacci-based Splitting with V^1_{min} technique. By studying the video splitting techniques, we found that unlike the video compression techniques, video splitting techniques not only can reduce the data transmission time, they also can maintain the quality of the video images.

Besides the issue of the delay in transmission and storage for storing the massive amount of video data, the management of those massive video data also becomes an issues for this recent years [11, 12, 13]. The European Data Grid Project [14] is one of the biggest projects that also worked on the mass data storage management. The project developed to permit the secure access of massive amounts of data in a universal global name space, to move and replicate data at high speed from one geographical site to another, and to manage the synchronization of remote data copies [14].

In paper [13], presented that many fields such as the news broadcasting (news, shows, series, etc.), advertising, and medical applications, all requires large video storage to store large amount of video data. Thus, in our research area, besides introducing a new video splitting technique, we also proposed a new Grid-based Video Storage framework that can be used in many fields. Our new video splitting technique, which is the Exponential-and-Uniform-based Splitting Technique, will be applied into this Grid-based Video Storage framework. Moreover, to test our framework, we are building the framework under the real grid environment, which is running on Academic Grid Malaysia. Massive amount of video data are stored in the storage of Academic Grid Malaysia.

2. Academic Grid Malaysia

The proposed Grid-based Video Storage Framework runs on

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the Academic Grid Malaysia Environment. Academic Grid Malaysia is an architecture that combines all the heterogeneous and shared network connection resource to solve the large-scale of scientific, execute technical or business data or tasks. These heterogeneous shared resources are including the devices of disk drives, mass storage, and other utilities. Due to the reason of public collaborations across many companies and networks, generally the size of the grid computing is large and growing.

Academic Grid Malaysia is also called as A-Grid, a learning and discovery grid. It aims to let the academic staffs, research officers or assistants, and postgraduate students work on the grid facilities. More than three Terabytes of storage spaces are available to the grid users for storing their data inside the Academic Grid Storage. The members of the Academic Grid Malaysia are including the Biruni Grid of Universiti Putra Malaysia, the Crystal Grid of University Malaysia, and the Grid of Universiti Teknologi Malaysia.

There are 4 layers inside the Academic Grid, which are the Network Layer, Resources Layer, Middleware Layer, and Application and Serviceware Layer. In the Network layer, it is the layer that contains the switches or routers. For the Resources Layer, is related to the storage, sensor, supercomputer and other resource. A Middleware Layer commonly involving the Grid Information Service and also the security services. Lastly, for the Application and Service Ware Layer, it is normally a layer that provides the services to the end users. Figure 1 shows the infrastructure of Academic Grid Malaysia.

Grid Computing is also been used in many fields, such as the scientific field [15], mathematical field or even the academic field. In the commercial enterprises, grid computing has been used for drug diagnostics applications [16], protein folding applications [17], financial modeling applications [18], earthquake simulation applications [15, 19, 20, 21, 22], climate or weather modeling applications [23, 24], medical videos and images applications [25, 26, 27, 28, 29, 30, 31] and other applications.

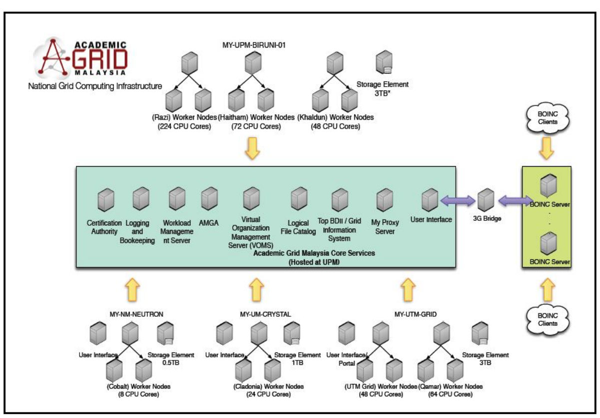

Figure 1. Infrastructure of Academic Grid Malaysia

3. Framework of Grid-based Video Storage

The proposed Grid-based Video Storage framework is using the distributed database in the grid environment to store the users' large video data. There are some important components in our framework, such as the video splitter to split the video data before transmitting through the network, Virtual Organization Management System for authenticating the users' identity, Grid Information Service System for checking the status of each Grid Storage Node. Figure 2 shows the integration on PACS system with the framework whereas Figure 3 shows the components involve for the Grid-based Video Storage Framework.

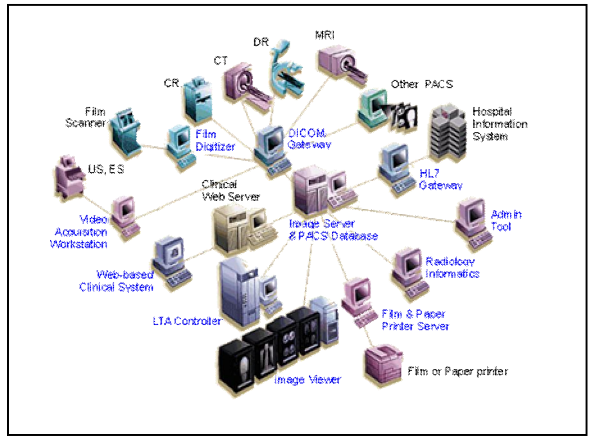

Figure 2. PACS system integration

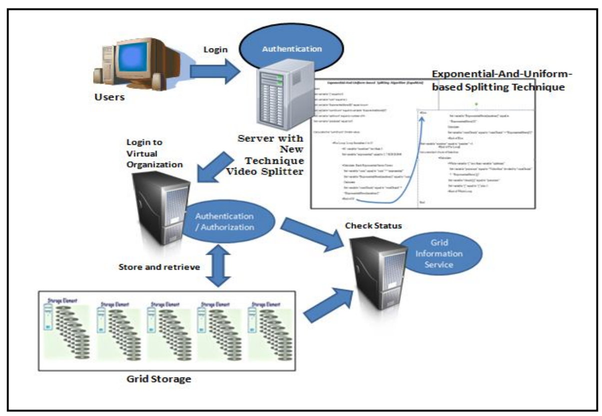

Figure 3. Framework of Grid-Based Video Storage

As what we have discussed in the Introduction Section, besides the storage problem, the delay of data transmission is also another issue. Thus, to reduce the delay of data transmission, we have applied the new video splitting technique, which is called the Exponential-and-Uniform-based Splitting Technique that will be embedded as a video splitter of the framework. Figure 4 shows the location of the video splitter. By using the video splitter, the video data can be split into smaller video chunks. Thus, these smaller chunks of video data can be easily transmitted through the network and store in the Grid Storage.

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4. Exponential-and-Uniform-based (*ExpoNUni*) Video Splitting Technique

There are three important process inside the grid-based video storage framework, which is the video upload process, video splitting and storage process and the video download process.

Video splitting process is one of the most important components of our Grid-based Video Storage Framework. On our Grid-based Video Storage Framework, our new Exponential-and-Uniform-based Splitting Technique will be embedded in the framework and used to split the video into various sizes of smaller chunks. Figure 4 shows the flowchart of the splitting process. In the process, Equation (1) is used to calculate the best number of splitter.

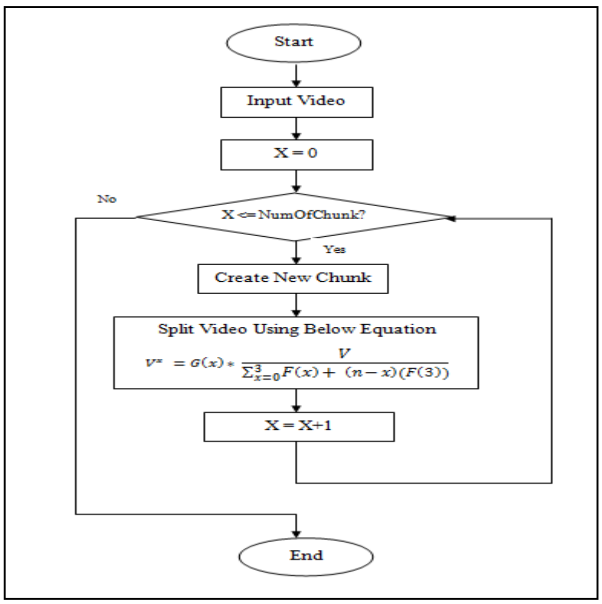

Figure 4. Flowchart of Splitting Process

5. Experiment Setup

We have developed and test our Grid-based Video Storage Framework in the real grid environment, which is running in the Academic Grid Malaysia Environment. The framework was implemented for hospital UiTM and HUKM where the study was to test the video download delay time in the real grid environment and still maintain the quality of video on a workable framework. A web portal was developed. All the interfaces of the web portal are developed by using the PHP language; while for the video splitter, it is developed by using the C programming language. All the users need to login at our web portal first before the Grid-based Video Storage Service is executed.

As illustrated in Figure 5, we developed an interface for doctors to upload the patient's echocardiography data into the grid storage according to their patient ID or identity card number. All the echocardiography data will be split and stored in the Academic Grid Storage under the folder of that patient ID, following by the Upload Date or Visit Date.

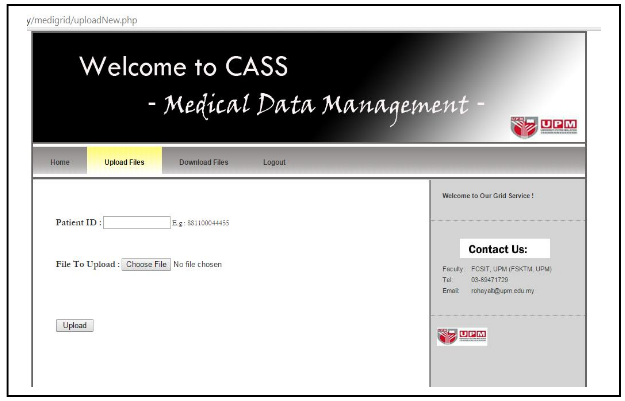

Figure 5. Medical Data Upload Interface

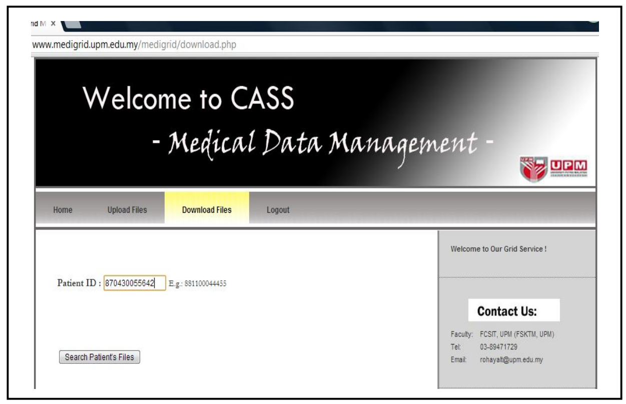

Figure 6. Example Interface for Searching the Patients' Data in Academic Grid Storage

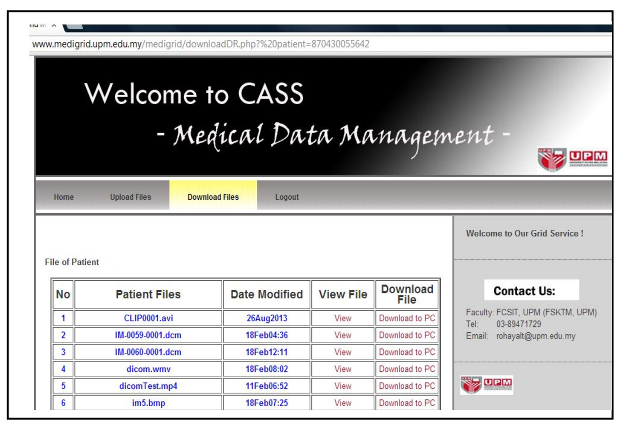

Figure 7. Example List for the Patients' Data

Interface in Figure 6 is to let the doctor search for patient's data; while in Figure 7, it shows the example list of the patient's data inside the grid storage. It provides the medical data streaming service for the medical user, which is as illustrated in Figure 8. The download service is only available for the medical users such as the doctors, while for the nurses or technicians, they can only preview the data from the streaming service and are not able to download the data from the download service. This is because to solve patient privacy issue.

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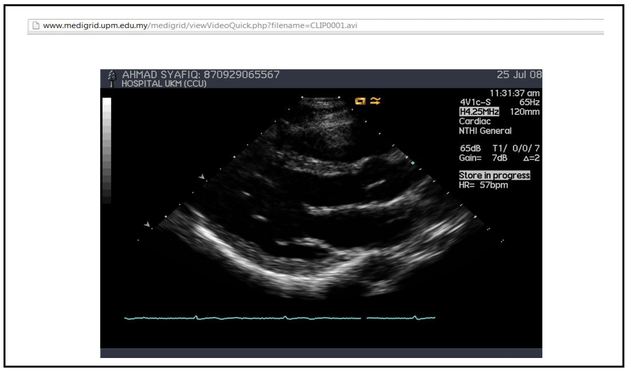

Figure 8. Echocardiography Streaming Service in the Grid-based Medical Data Storage Framework

6. Result

From this research, we have proven that the framework can be implemented for various types of area, even in the hospital. To prove that the Exponential-and-Uniform Splitting Technique is able to reduce the delay of time, we have implemented on the Academic Grid and hospitals.

Figure 9 shows results for number of 2 chunks to the number of 8 chunks, it has proven that our splitting technique has retrieved the lowest initial delay comparing with the existing splitting techniques, such as the Uniform-based Splitting Technique and the Fibonacci-based Splitting with V^1_{min} Technique.

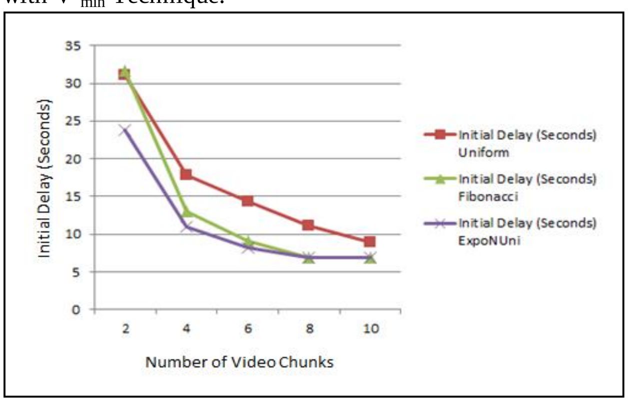

Figure 9. The Initial Delay Time with Different Number of Video Chunks.

Overall, comparing the existing framework of Fibonacci-based Splitting with V^1_{min} Technique, the framework of "*ExpoNUni*" Splitting Technique is given by an average of 11.62% lesser time for the initial delay time, while comparing the existing framework of Uniform-based Splitting Technique with our technique, our technique is in average of 26.23% of the initial delay time lesser.

7. Conclusions

Video data has become an important medium for the area of communications and entertainments such as the news broadcasting (news, shows, series, etc.), advertising, and also in medical area. However, large video data needed a large amount of the data storage. Thus, a Grid-based Video Storage Framework is introduced.

To test and verify our framework, the framework was implemented on Academic Grid Malaysia Environment and the delay time was measured. The framework has improve the existing framework such as Fibonacci-based Splitting with V^1_{min} Technique and Uniform based splitting.

Acknowledgements

We would like to thank InfoComm. Development Center (IDEC UPM), who have provided the grid infrastructure for us to run the research. We also would like to take this opportunity to thank the National University of Malaysia Medical Centre (HUKM) and Hospital UiTM Sungai Buloh Malaysia, for giving us the chance to cooperate with them in improving the performances of their medical data storage.

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