ShareBook: An Application of Cross-Platform E-Book Viewer with Vector Graphic

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Abstract - Many handheld devices have been developed in the mobile industry. Most mobile devices in the market are carried Android operating system. Android also supports many other hardware components that increase mobile devices functionality. The operating system can be used for multimedia, touch screen, number of types of sensors and 2D/3D graphics. Due to open source license, many manufactures integrate their own production to Android system. Hence, this paper proposed a ShareBook software based on Android system. ShareBook integrates new types of sensor such as touch sensor, bending sensor and gyroscope to develop a flexible display platform with Android operating system. These sensors change user's operation in general smart mobile devices with Android. Flexible displays bring great difference in interaction behavior between system software and end user. However, there are some other problems in traditional E-Book application. Size of screen on mobile devices is the first problem. Hardware manufactures produce 4-5 inches display on their mobile phone production, the display size is at most 10.1 inches on pad production. Some people hardly read contents on small size screen. So, ShareBook can easily transfer e-book viewer to larger size display such as TV or LCD display when user can reach the larger size display in their environment. Second problem is application's performance efficiency. ShareBook integrates vector graphic library into Android and optimizes the performance of vector graphic library by Renderscript and GPGPU. ShareBook also combines cloud platform resource for image file transformation and storage resource extension.

Keywords: Vector graphic, e-book, cloud, android apps.

1 Introduction

Smart mobile devices become the center of people's personal life and more ubiquitous. Android system occupies a considerable share of the market of smart handheld device. Android is a Linux-based operating system and is maintained as open source project by Google. Many programmers and manufactures are entering in to the system development due to open source. So, there are many applications and hardware devices which are developed based on Android operating system.

Today's advanced mobile devices are well integrated with the Internet and have far more functionality than mobile phones of the past. Some peoples use handheld devices to be personal multimedia device for playing music and movie through Internet. Some other people read books on mobile device. Hence, many software developers design applications of multimedia player and E-Book reader.

E-book became a popular application nowadays because of e-learning and paperless promotion. However, some open issues still need to improve for better user experience.

- *Small size display*: Many handheld devices equip with 4-5 inches display or at most 10.1 inches screen. However, user cannot change to large screen to view the content, if there are some larger display platforms around user current place. Users need to re-install the application and contents on larger display platform, if they want to switch to bigger display for comfortable viewing.
- Performance efficiency: E-Book applications spend a lot of time to process path calculation and drawing, if E-Book application is developed based on vector graphic library. Vector graphic library has a major strength for E-Book application. Vector graphic library avoid image distortion when user scales up the size of contents or images on E-Book application.
- Resource limitation: Users usually have many e-book contents and electronic comic books in their mobile devices. It is very inconvenient for user to manage their e-book content in small storage device. It occupies a large part of storage space in their device. Besides of storage limitation, processing image transformation is also a heavy load work on mobile device. Due to battery life, mobile devices try not to do a task with long processing time. Therefore, cloud platform help E-Book applications to solve the resource limitation problem.

In this paper, we develop ShareBook software on Android system. ShareBook combines new types of sensor with flexible display to create innovative mode of user interaction. ShareBook can easily switch the content view to larger display which is near to user. Larger size of display is more comfortable than small screen and user also can control the larger size of display by flexible display. Performance of ShareBook is also optimized by using GPGPU to improve vector graphic library and integrates with cloud computing resource.

The rest of this paper is organized as follows. Section II shows relate works of E-Book applications, vector graphic library, embedded GPGPU and cloud image file transformation processing. Section III presents our system architecture in the cloud service. In Section IV, we present our system execution result and benchmark. The brief conclusion is presented in Section V.

2 Related work

E-book application has been widely studied by research group and industry manufacture in recently. Some previous studies probe E-Book's applications [1, 2], security [3, 4], platform and standardization [5]. According to [5], we know that there are many different e-book file formats and each file format is not compatible with another e-book file format. Therefore, it is a important issue of uniform format for ebook application. Vector drawings can enlarge to any size without any loss in quality. Then, vector graphic is a free file format and it is also readable for any handheld devices and computers. So that, we can convert e-book file to xml descriptor of vector graphic. There are many libraries to support vector graphic reader in embedded platform [6] [7]. We integrate OpenVG [6] library with Android system and we also optimize it on our embedded platform.

In [8], they proposed some algorithms for converting file to vector graph format. They only deploy client server architecture to execute their algorithm. However, converting file format produce a huge workload when user need to transfer large amount of files. Our solution is a parallel implementation of the Autotrace that uses multi-VM and it achieves near-linear speedup on cloud computing platform.

Another advantage of cloud environment is the huge storage space [9]. We store our e-book file in cloud storage. After authorization, users can access their contents. If users are publishers, they can authorize their file to reader.

Besides cloud integration, ShareBook using embedded GPGPU to increase the performance of application. The embedded GPGPU is based on ARM Mali architecture. The Mali series of graphics processing units (GPUs) are semiconductor intellectual property cores produced by ARM Holdings. Mali-T604 supports Android Renderscript library. Renderscript [11] is a low-level API for intensive computation using heterogeneous computing. It allows developers to maximize the performance of their applications at the cost of writing a greater amount of more complex code. Some researches use it to optimize 3D graphics library [12]

and multimedia development [13]. In ShareBook, Renderscript is used to optimize the performance of vector graphic library in Android system.

3 System architecture

As shown in Figure 1, there are three parts of our system: flexible display with vector graphic E-Book in end user, cloud platform for e-book file format transformation and content storage. Final part of system is near field communication. The near filed communication transfers data with smart TV or LCD displays which is equipped with NFC or Wi-Fi module.



Fig. 1. System architecture

3.1 Flexible display with multiple sensor devices

The felxible display is still a propototype that simulate by bending sensor and plastic display. Our felxible display palform is integrated with friendlyarm mini 210 and combines with some new types of sensors into flexible display plaform. Sensors include touch sensor, bending sensor and gyroscope. Each sensor brings an innovative mode of user interaction in E-Book application. Touch sensor is placed on the back of flexible display. Touch sensor can recognize user's gesture and make the gesture to be a unique private key to login cloud platform for processing. Touch sensor in ShareBook is microchip mTouch platform. Figure 2 shows the concept of touch verification.



Fig. 2. Interaction mode of backboard touch sensor

Bending sensor let switching page be straightforward. User switches the page by bending different position sensor in flexible display. Figure 3 shows the concept of page switching in flexible display. User also can zoom in/out the view on flexible display through gyroscope.





Fig. 4. Interaction mode of gyroscope

3.2 Optimize vector graphic library

ShareBook is developed based on vector graphic library. The vector graphic library fallows OpenVG standard for library implementation. OpenVG separates the procedures of drawing vector graphic to seven steps. We optimize the vector graphic library in step four on Android system by Renderscript. Triangulation is the main process in rasterization step. The time complexity is O(n3) in original algorithm. Renderscript reduce the significant time complexity of triangulation. Figure 5 shows modification flow of vector graphic library in ShareBook.



Fig. 5. Modification flow of vector graphic library with Renderscript

3.3 Cloud platform environment

This research work converts wide variety of image format to vector graphic descriptor in order to support more and more file format. However, file transformation procedure is a heavy workload process in embedded platform. For that reason, our solution takes advantage of cloud computing in order to enhance our computing power.

We deploy the Autotrace [5] code in cloud. Autotrace is software of file transformation. And we build up a domination machine to dispatch converting task to back end cloud platform. We parallelize the file format conversion task in group of images method. Our solution splits all images which are in e-book file to different group and the system assigns these group tasks to different computing virtual machine in cloud. We present our cloud solution in figure 6.



Fig. 6. Cloud parallel method

Users manage their contents through our web interface. Users can do some operation on management website, such as: uploading contents, downloading their contents and sharing their contents with copyright. We also put all contents which are uploaded by same user in single cloud storage. The placement method can increase data locality.

3.4 View switching

Flexible display equips a Bluetooth and Wi-Fi module. Hence, flexible display can connect to Internet or peer to peer network via network module. ShareBook design a matching mechanism for determines whether the view is switching to other display platform. First, ShareBook will send a packet to ask the size of display which can reach by near filed paring. The view is switched to other display platform, if the size of display is larger than flexible display platform. And user can control the larger display platform on flexible display platform via network communication.

4 System result

Flexible display equOur demo environment is described as follows: smart phone, pad and embedded development platform (FriendlyARM mini210), and private cloud computing platform. We show our execution result in figure 7 and performance result in figure 8.ipes a bluetooth and Wi-Fi module. Hence, flexible display can connect to Interenet or peer to peer network via netwrok module. ShareBook design a matching mechanism for determing whether the view is switching to other display platform. First, ShareBook will send a packet to ask the size of display which can reach by near filed paring. The veiw is swithed to other display platform, if the size of display is larger than flexible display platform. And user can control the larger display platform on flexible display platform via network communication.



Fig. 7. Execution screen on FriendlyARM mini210

Figure 7 is the result of our system execution on embedded platform. Then, figure 8 presents our performance speedup. Our solution uses multi-VM and achieves nearlinear speedup on cloud computing platforms.



Figure 9 shows the performance speedup by optimization algorithm and we believe that ShareBook can get better performance after integrating Renderscript.



Fig. 9. Performance of file transformation

5 Conclusion

In this paper, we present an E-Book application, called ShareBook, which consider three factors that affect the user experience of display size, performance and resource limitation. The basic development tool of ShareBook is vector graphic library and we optimize the vector graphic library by replacing original triangulation algorithm with monotone triangulation and polygon partitioning. We also integrate new types of sensors into a flexible display. Every sensor brings an innovative mode of user interaction in E-Book application. Finally, ShareBook is also verified the cross-platform display function on flexible display and LCD monitor. In the future, ShareBook will be a popular application system.

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