On-demand learning system using 4K video source

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ABSTRACT

There are various kinds of learning systems in the world and quite a lot of them are using video sources. Also, those video sources have many kinds according to the content of learning and aim. In this paper, I’d like to describe the usability of learning systems by using a super high definition video source focusing on making handling of video source using super high resolution. Furthermore, the future progress and present problems would be considered by proposing an on-demand learning system using a super high definition video source. The super high resolution here means 4K (4096x2160 dots).

Keywords: multimedia for education, 4K video workflow

1. INTRODUCTION

Recently, we have seen a change in the teaching methods within the universities. The systems that are provided, not only for regular classes on a time table, but also systems that are used in various ways using the class video sources which were in use by past classes. The cause of this change seems to be for the diversification of students’ life styles and one of the other main reasons is the permeation of information technology devices are progressing greatly.

The system, that is recording the past classes as a video source and providing them to students according their requests, needs to be provided in the best way according to their present circumstances.

First, the items below would be used as the available instruments providing the class video sources.

Then, I’d like to examine the characteristics of each instrument and how to provide a learning system.

- mobile phone
- PDA (iPod touch or iPhone)
- PDA (Pocket PC)
- Note PC
- Desktop PC
- HDTV
- 4K Projection system

Next, I’d like to consider the content by taking existing learning systems which run on PC platforms as some examples.

As a system goal, I approach the establishment of the learning system using a 4K super high definition video source, and examine the efficiency, and report the underlying problems for meeting the satisfaction of our system goals.
2. 4K RESOLUTION

In the first place, the resolutions of several types of equipment are shown on the chart in below. The 4K super high resolution means as pixel size of 4096x2160(dots) in this paper and is also used as the Hollywood movie standard. Our 4K is simply two times resolution of 2K 2048x1080(dots) in all directions which make up a total number of dots that are four times. In the case of 2K it has a bit different vertical resolution from the full HD 1920x1080(dots) of HDTV and is properly acknowledged. Incidentally, the NTSC standard is 720x480(dots).

Comparing of size for 4K resolution is shows in Fig.1.

3. ABOUT PRACTICABLE TERMINAL

Here, I’d like to describe the best way for providing for and their advantageous effects by each items using the class video sources.

3.1 Mobile Phone

The establishment of the possibility of a learning system is speculated as to the various functions of the regular mobile phone. Unfortunately, it seems that it’s difficult to work out because it is hard to get the video source in terms of on-demand. In the future, this feature will be realized by retrieving video sources from a packet communication network provided by each mobile phone company.

3.2 PDA (iPod touch or iPhone)

The PDA (Personal Digital Assistant) is an individual hand-held terminal and its distinction is it’s handy size, portability and it has a specialized arrangement of built-in functions, although its functions are limited compared to the Note PC etc.

Here, the iPod touch procured from Apple Inc. and the general PDA are separately described.

The iPod (iPhone) has schemes, which enable it to view many contents used in mobile electronic communications. The scheme is called Pod Cast and is recommended by Apple Inc... This formula enables the user to see as appropriate by saving the video source, which he wants to refer to by a mobile player like iPod from the server in advance. This provides a kind of store of broadcast programs.
In recent iPod display specifications for the iPod nano 320x240 (dots), iPod classic 320x240 (dots), iPod touch 480x320 (dots), and iPhone 480x320 (dots) students can get a class atmosphere and content from sounds from the provided video source. However, they cannot confirm the contents of the documents from the image, and so some other kind of technique is required to be discovered.

3.3 PDA (Pocket PC)
There are a variety of multipurpose OS’s available for the Pocket PC but all these have common point in that they are designed for operating lightweight tasks as much as possible by limiting their functionality. One of the reasons for this is limitations on CPU performance due to available space, amount of memory, and power consumption.

The majority of Pocket PC’s available on the market uses the Windows Mobile OS. The Windows Media Player is provided for playing video sources as a standard feature and it can easily play the moving image as large as the display size.

The general display size on Pocket PC is 640x480(dots). It can show finer video than the iPod and as a general video source can provide the class the atmosphere and contents of the sound. However, the content of the presentation documents in the class cannot be properly recognized from the video image and so, some solution needs to be considered.

3.4 Note PC
The performance of Note PC computers have became much better than previous versions. It makes it possible to show a movie image without any trouble. There are still some limitations compared to the desktop PC and these are in relation to the CPU performance due to the limited space, amount of memory, and the power consumption just as noted in the previous discussion of the PDA.

In consideration of the portability issues, the network relies on a wireless LAN connection, but the usable network spectrum of a wireless network is theoretically only 54Mbps, with an average, true, network connection of 20Mbps using IEEE 802.11g or IEEE 802.11a. The display size also has a limitation of 1280x1024(dots) or A4 size, which is a concern for maximum portability.

3.5 Desktop PC
In case of the desktop PC, there is no limitation for CPU speed and memory capacity which is different from that of the Note PC. It connects to a 30-inch high resolution display providing a large and effective display for the surroundings and enable us to show both the video screen and the control screen efficiently for the learning system applied.

3.6 HDTV
The HDTV allows us to listen and watch movie(s) supplied from our Store Server at HD quality. There are mainly two ways for audio-visual. One is by HDTV, that is, the incoming data is received into the executive IP Set-Top Box by using an IP network and changed into HDMI output, and listened and watched by HDTV.

The other is that the data is sent by the image signal on the antenna cable just like general TV broadcasting and operated by adjusting the channel as normal program broadcasting. This makes it possible to watch a 1920x1080(dots) image in each way and to confirm detailed contents of the presentation data in the class.

3.7 4K Projection System
In this system the 4K resolution projector enables us to play on a super high definition movie screen. The resolution is 4096x2160(dots) and it can perfectly take in the content of the presentation data from our learning system. The super fine image allows delivery of the images with a reality and vigor and therefore, provides an effect which makes people to be absorbed in the image, although it depends upon the screen and the place where the screen is setup.

So far, it is most popular to use the large-size screen as a way to show the 4K movie image but, recently, a 56-inch liquid crystal display has also received attention since on the market. Because the purpose of this paper is to mention about the efficiency of 4K movie image displayed on the large screen, I’d like to describe only the way to display the image on the large screen.
3.7.1 NAIST 4K Projection System

The 4K Projection System as used at the Nara Institute of Science and Technology (NAIST) has been constructed on the wall near the entrance on the 1st floor of the IT building and has a screen size of 200-inch. The reason we selected the place is that many people come and go by that location the most and we built it into the window frame directly. It has been very useful for several events and widely used for the introduction of our university and student projects and so on.

The input for this projector is operated by displaying the output of 4 HD image projectors. With regard to a special built input terminal, we can input computer output directly by a DVI-D (signal link). The Input terminal is a DVI-D but also it is possible to input HD-SDI and HDMI by inserting media converting equipment.

Additionally, it has extra function to show the extended HD image and it allows to us to watch general HD content on a 200-inch display.

It shows in Fig.2, and composition is shows in Fig.3.

4. THE USAGE OF A PRACTICABLE TERMINAL

In this paragraph, through the previous consideration, I’d like to examine whether the terminal would be used for the learning system or not. Then, they could be classified as follows by considering usage.

- PodCast
- Streaming on PC
- Web based application on PC
- On-demand TV on HDTV
- Special equipment for displaying 4K
Gathering of materials of the learning system is important to consider as using of and caring for each of the terminals, usage, data abstraction, resolution, users and so on, the list will appear below.

On demand request is controlled by a Web base application on a PC at all terminals or by using a specified application.

The Table 1 has ended up with all of the considerations above.

Table 1. The Usage of a practicable terminal

<table>
<thead>
<tr>
<th>Terminal</th>
<th>Application</th>
<th>Data</th>
<th>Size</th>
<th>Use Place</th>
<th>Adaptation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobile Phone</td>
<td>none</td>
<td>Packet</td>
<td>240x320</td>
<td>handy</td>
<td>n.g.</td>
</tr>
<tr>
<td>iPod</td>
<td>Podcast</td>
<td>FileServer</td>
<td>480x320</td>
<td>handy</td>
<td>n.g.</td>
</tr>
<tr>
<td>Pocet PC</td>
<td>Streaming</td>
<td>VideoServer</td>
<td>640x480</td>
<td>handy</td>
<td>n.g.</td>
</tr>
<tr>
<td>Note PC</td>
<td>Web Based Streaming</td>
<td>VideoServer</td>
<td>1280x1024</td>
<td>handy</td>
<td>good</td>
</tr>
<tr>
<td>Desktop PC</td>
<td>Web Based Streaming</td>
<td>VideoServer</td>
<td>unlimited</td>
<td>desk</td>
<td>good</td>
</tr>
<tr>
<td>HDTV (IP)</td>
<td>IP Set-Top Box</td>
<td>VideoServer</td>
<td>1920x1080</td>
<td>room</td>
<td>good</td>
</tr>
<tr>
<td>HDTV (cable)</td>
<td>RF (Radio Frequency)</td>
<td>VideoCable</td>
<td>1920x1080</td>
<td>room</td>
<td>good</td>
</tr>
<tr>
<td>4K screen</td>
<td>SpecialApplication</td>
<td>FileServer</td>
<td>4096x2160</td>
<td>large room</td>
<td>good</td>
</tr>
</tbody>
</table>
5. EXISTING LEARNING SYSTEMS

I’d like to consider the existing learning systems shortly.

5.1 Real Helix Server, Windows Media Server

These servers deliver contents by using the IP network streaming server on PC computer(s). Generally speaking, this way is widely used and it can be automatically played by applying contents via URL links to a Web page. Normally the largest image size is about 720x480(dots) and actual data is retrieved by streaming.

5.2 RICOH MPMeister

This is a commercialized product from RICOH Company, Ltd., and it indicates used presentation data and indexes in addition to streaming movie images, and it operates those three linked. It also makes display place and size change while operating the moving image and that allows us to create the picture as to the user’s intended usage.

According to its moving display specifications, a wire report from a Real Helix Server or Windows Media Server is attached partly.

It works as a school archival system in our university library at this time. This whole system is very comfortable to use as it works together with our searching system in the library.

Display image is shown Fig.4.

6. GOAL

The first goal for a store type of learning system is using a video source taken by a 4K camera that is saved as a 4K resolution in which the output power is changed according to purpose of use. For example, untouched 4K video data or resolution and format is changed. In the case of a user that has chosen the part to watch (ROI:
Region of Interest), he abstracts the useful data, ROI part, by trimming. He needs some feedback from users to provide the ROI part and to do so, he has to prepare an interface to operate a mouse or joystick. The video source is supplied to an output device after various changes. The output device for this is the 4K projection system, HDTV, Desktop PC and Note PC.

7. HOW TO USE 4K VIDEO SOURCE

7.1 4K camera

Until now, there are almost no video cameras having functions for 4K resolution. Only one commercialized camera “RED ONE” is produced by RED Digital Cinema Inc. This camera is very popular mainly in the cinema market as they have a progressive approach by marketing at a cheap price. RED ONE can store data on a hard disk drive and which can be accessed as a video source after pre-processing. The objective video source will be accomplished by changing the video format and changing and trimming the resolution during the stage of processing. There is a rumor that some Japanese companies will release these cameras in 2009.

7.1.1 Data store type

As previously mentioned RED ONE is a data store type of camera and cannot be used for live broadcasting. There seems to be no camera currently available on the market which allows for live broadcasting. Some electronic companies have developed experimental production cameras but these are not on the market.

7.1.2 Live broadcasting type

The method that is used, is an arrangement of 2x2 regular HD cameras and composite 4 HD-SDI after tweaking the zooming and direction, these are used because these are the only experimental cameras available for live broadcasting.

However, When the zooming function is used or the distance to the photographic object is made, whole cameras need re-adjustment and it cannot adapt in real time if any type of change occurs.

7.2 Transmission method

To retransmit the 4K data without compression, a 6Gbps transmission band is required. It seems to be unrealistic to acquire the transmission band stably on the internet now. However, this problem is expected to be solved within several years with improvements of the Internet hardware and IP protocol.

As it’s difficult to acquire 6Gbps transmission band in reality, I’d like to consider another way to retransmit by compression.

Additionally, TV stations and some others are searching for a way to allow 4 Full HDs to tie up so as to make the most of the old Full HD’s ability. As to network transmission, one of the ways is to consider that the data is transferred by dividing 4 files and acquiring the moving image sync before the display unit. Another way is that the moving image sync is displayed by using 4 projectors at the same time. It might be cheaper than to actually purchase new 4K equipment.

7.3 Data compression

Recently, the H.264/MPEG-4 AVC compression format of the moving image is the most popular. This format allows compression rates of almost twice as powerful as the MPEG-2 format which was previously used. In the case it compresses a 4K video, on the transmission band at data rates of about 30 Mbps and it could allow us to compress 200 times more powerful. In this transmission band case, it may enable us to deliver to the internet.

The other possible mono-compression format would be JPEG 2000. In case that 4K video is compressed in this format, a transmission band of approximately 300Mbps would be required. The biggest difference between this format and the H.264/MPEG-4 AVC format previously described above is that the compression wouldn’t work between the frames. As there is no dependency relationship between frames, the cinema market which thinks about each of frames has independent products like kile to take it. It is natural that editing work would be much easier.
It takes much time to reasonably compress data just like to uncompress data and it cannot be recommended to use it in an environment such as a real-time like a conference system, and coding system in hardware needs to be taken into consideration.

7.4 Profiling the data

Many ways to profile the data have to be under development to achieve ROI. The first achieving goal is that we fix the profiling size from a 4K moving image (two times expansion) and listen and watch as a Full HD movie image by specifying only the profiling part. The second goal is that we make the profiling size changeable (zoom) and scale up and down the profiled moving image fitting to device in use. In case that the user’s device is 4K, we need to scale up the data to 4K and in the case of the PC we need to scale down it until we reach its specified size.

To operate profiling data smoothly, a 4K moving image data needs to be handled in real-time and specially built hardware would be necessary.

8. SUMMARY

To build up the learning system by using 4K resolution, first of all, the workflow establishment to store a 4K video source of data to a server would be needed. The next step would be for the establishment of some interface to convert the format and resolution for suitable output devices.

Furthermore, a camera equipped with output like HD-SDI to build 4K live broadcasting. We have to wait for the release of a new camera which is expected to be done soon because it is extremely difficult to get this type of camera at this point.

There are many issues that need to be solved, such as the building up hardware for exclusive use. Nevertheless, the release of usable hardware is expected within the near future. We’d like to request the hardware design.

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REFERENCES
