

STREET MOVIE STORING AND ARCHIVING SYSTEM

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ABSTRACT

Design of storing and archiving system is proposed which enables to store and archive various kind of scenes of human lives as movies with open accessibility through internet.

For this, at first, necessary storage capacity was derived in the case of multiple video cameras set along the main streets to take moving pictures. Secondly, optimum construction of the storage system is made clear to maximize the throughput of simultaneous write and read operations. Third, storage system construction consisting of fast, medium and low speed storage devices and their hierarchical management system are made clear.

1. INTRODUCTION

These days, economical growth in every country makes human kinds' living styles and living environment change so much. Also, ICT enables systems to collect and store various kinds of information automatically and to upload them in websites with open accessibility to people worldwide. For example, Google collects more than several peta bytes of new information and forms huge database. The information collected covers all kinds of data such as documents, books, photographs and moving pictures. These owe much to the progress of ICT.

It is very important to store and archive changing scenery surrounding human kinds.

This paper aims to clarify a system design which fits best to store and archive moving pictures of living spaces and environments of human lives with open accessibility through internet.

In real, under the condition of setting cameras along roads for moving picture taking, following system design items should be made clear.

- (1) Relationship between a necessary storage capacity and moving picture quality.
- (2) Hierarchical storage system design for huge amount of data storing and archiving.
- (3) Relationship between the one I/O data size of read and write and data transfer rate in a disk storage.

There are very few research reports[1] which give answers to the design above.

So, this research has been done as described in the following chapters.

2. EXTRACTION OF STUDY TASKS

To design a street movie storing and archiving system, following tasks should be studied.

- (1) To clarify the relationship between the video quality, video coding method and storage capacity requirement.
- (2) To clarify the storage capacity requirement for storing videos along major roads in cities and countries in Japan.
- (3) To clarify the design of ultra-large storage and archive.
- (4) To clarify the performance of the ultra-large capacity storage.

3. SYSTEM DESIGN

3.1. System constitution design

Figure 1 shows the system constitution for street video storing and archiving.

- (1) Cameras are set along the roads and connected to a network.
- (2) Hierarchical storage systems are formed and connected to a network.
- (3) Controller is set to manage cameras and storage systems through a network.
- (4) Videos can be retrieved on-line by PCs through internet.

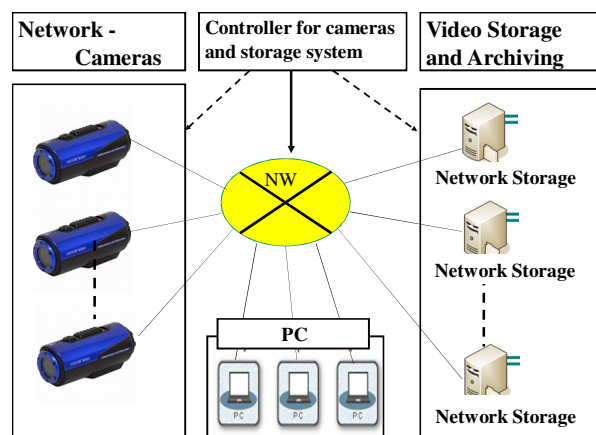


Figure 1 System constitution

3.2. Capacity design for street video storage

3.2.1. Data capacity for one camera

Data capacity requirement depends on the number of pixels of a video camera and video coding methods such as MPEG1, MPEG2 and H264 etc. Table 1 shows a calculated data capacity requirement for 1 day video storage where 4 representative types of cameras are chosen.

From table 1, it is understood that so large capacity of about 10 to 130 Giga bytes are required to store videos for 1 day.

Table 1. Video data capacity requirement for various kinds of video quality and video coding method.

Resolution in pixel (Alias)	Coding System	Coding Speed 30frame/s (Mbps)	Video Data Capacity Required for 1day	
			1 camera (Giga Byte)	Cameras set along all roads (Exa Byte)
360x240 (QVGA)	Mpeg1	1.5	16.2	2.062
640x480(VGA) 720x480(SD)	Mpeg2	6	64.8	8.248
1440x1080 (HD)	H.264	1~9 (Note)	10.8~ 97.2	1.374~ 12.372
1920x1080 (Full HD, 2K)	H.264	1.5~12 (Note)	16.2~ 129.6	2.062~ 16.496

Note: Coding-speed depends on the picture quality

3.2.2. Data capacity for multiple cameras set along the roads

Here, data capacity requirement is estimated in the case that video cameras are set along the roads as shown figure 2 where cameras with 90 angles of view are set with the duration of distance L.

According to the Ministry of Land, Infrastructure, Transport and Tourism of Japan [2], total length of roads is about 1,217,127.8 Km including 1,023,962.4 Km of city, town and village roads.

When cameras set 10 meters apart from each other along the total length of roads of 1,217,127.8 Km, data capacity requirement for 1 day video is calculated about 1.37 to 16.5 Exabytes as shown in Table 1.

Data capacity of 10 Exabytes seems not to be realized only by HDDs (Hard Disk Storage) because of manufacturing capability limit.

So, storage system with extraordinary capacity and long-term archive is essential. The solution for this is to combine various kinds of large capacity storage media such as HDDs and Blue-Ray disks.

3.3. Hierarchical storage system design

Here, hierarchical storage system (HSS)[3] is designed so as to realize an extraordinary capacity storage system with long-term archive.

Requirement for HSS is as follows.

- (1) Fast access and heaper cost is preferable.

- (2) Some of the storage media in HSS should be removable to realize unlimited capacity of archiving.
- (3) Files stored in HSS can be accessed just the same way as that for HDD.

According to the requirements above, HSS is designed as shown in figure 2. In figure 2,

Primary Storage: HDDs.

Secondary storage: Jukebox-type optical disk storage in which plural Blue-ray disks are stored.

Archive storage: Jukebox-type optical disk storage in which plural Blue-ray disks are stored.

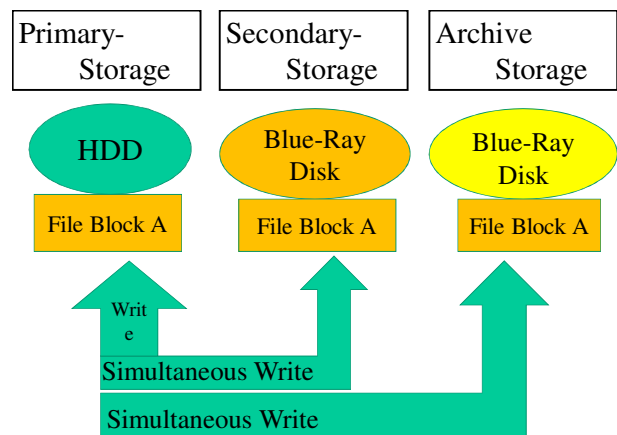


Figure 2. Hierarchical storage system with archivability

One file block in figure 2 consists of plural and continuous sectors as shown in figure 3.

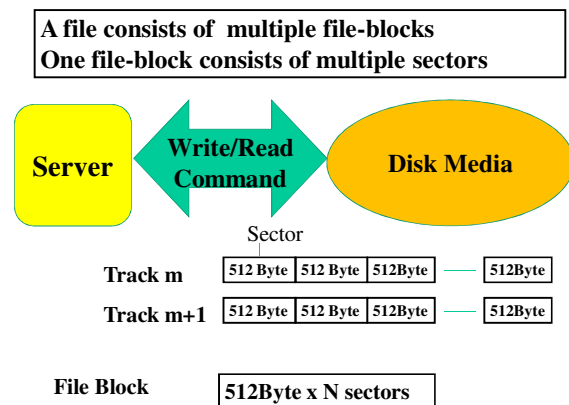


Figure 3. File block and sectors

In this HSS, file I/O is done as shown in the following.

(1) Video data writing

- a. Data are divided into plural file-blocks and each of the file blocs is written in primary storage of HDDs, secondary storage and archiving storage.
- b. When HDDs become full, files with low access frequency are deleted to create recordable file-

- blocks. Then, data are written on HDDs as shown above.
- When secondary storages become full, files recorded on them with low access frequency are deleted to create recordable file-blocks.
 - When archiving storage become full, some blue-ray disks are removed from the juke-box and new blue-ray disks are mounted on the juke-box to create recordable file-blocks.
 - In a dedicated area of HDDs, control information is recorded which indicates the storage in which each of the recorded files exist.
 - In some area of each of the blue-ray disks, some information is recorded which indicates the allocation of files recorded on the disk.

(2) Video data reading

Data reading from HSS is done as in the following.

- When a file is accessed through internet, HSS at first accesses the control information recorded area of HDDs and comes to know the specific storage and access path to the file.
- Then, HSS reads and transfers the required file.

As is clear from above explanation on the design of HSS, it realizes cheap storage system, fast accessibility to the files and unlimited capacity for archiving.

4. HSS THROUGH-PUT ESTIMATION

As described in section 3.3, HDDs are used as the primary storage of the HSS. So, HDD through-put is estimated which is reasonable to show that of HSS.

HDD is the most commonly used storage in many computer systems.

4 key factors which determine through-put of HDD are the seek time, the rotational delay, the sustained data transfer rate and data size of one write or read command to HDD.

Required time T_d to write (read) of D of data size is calculated as follows.

$$T_d = T_{skav} + T_{rtav} + D/V_{sdtr} \quad (1)$$

Where

T_{skav} (s) : Average Seek time

T_{rtav} (s) : Average Rotational Delay

V_{sdtr} (MB/s) : Sustained data transfer rate

D (MB) : Write /Read Data Amount per 1 operation

T_d (s) : Required Time for Write/Read of D

P_{th} (MB/s): D/T_d (Through-put)

$T_d \approx T_{skav} + T_{rtav}$ (2) (for $D/V_{sdtr} \lll T_{skav} + T_{rtav}$)

$T_d \approx D/V_{sdtr}$ (3) (for $D/V_{sdtr} \ggg T_{skav} + T_{rtav}$)

Followings are understood from equations of (2) and (3),

- In case of small data size of write/read, required time for write/read is determined by the average seek time and average rotational delay.

- In case of large data size, required time for write/read is determined by the sustained data transfer rate.

In table 2, T_d and P_{th} are calculated by changing the write (read) data size per I/O operation for high speed HDD and medium speed HDD.

Followings are found from table 2.

- The through-put of HDD becomes higher as write /read data size per one I/O become large.
- Under random access condition, about 1/2 through-put of 200MB/s of the sustained data transfer rate can be achieved when using high speed HDD with 8.2 ms of average seek time and 4.17ms of rotational delay.

Table 2. Required time for data write/read and the through-put of HDD

One Write/ Read Size HDD D (MB) Spec.	0.5	1	2	3
HDD1: High Speed Tskav:8.2ms Trtav:4.17ms Vsdtr(Outer): 205MB/S	Td= 14.8ms Pth= 33.8MB/s	Td= 17.2ms Pth= 58.1MB/s	Td= 22.1ms Pth= 90.5MB/s	Td= 27.0ms Pth= 111MB/s
HDD2: Mid. Speed Tskav:8.2ms Trtav:4.17ms Vsdtr(outer): 85MB/S	Td= 18.25ms Pth= 27.4MB/s	Td= 24.27ms Pth= 41.6MB/s	Td= 35.89ms Pth= 55.7MB/s	Td= 47.66ms Pth= 62.9MB/s

4. CONCLUSION

Design of street movie storing and archiving system was studied. Through this study, followings are made clear.

- Relationship between movie quality of video camera, data coding method and total data capacity requirement were derived.
- Total capacity requirement for storing videos taken by the video cameras set along all city and country roads in Japan.
- Hierarchical storage system were designed to store and archive huge data for the street videos which consist of HDDs and Brue-lay disk juke-boxes.
- The through put of the newly designed hierarchical storage system were made clear.

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