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Design and Implementation of Video Management System

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Abstract—The hard-disk recording system commonly used conducts recoding by generating one buffer and file in each of the IP cameras and accessing hard-disk on a one-for-one basis. In this case, as the system accesses hard-disk in order to process numerous channel data at a time, and this causes a bottleneck phenomenon, increasing the number of times access to hard-disk, and reading data of hard-disk, lowering search speed of head, able to record about 40-45% of maximum writing speed and not able to record due to lowered writing speed in case of large file, and generating deserted data or downloading program. Hence, this research aims to reduce the number of times access to hard-disk and minimize a bottleneck phenomenon by applying Smart Grouping algorithm, calculating channel group unit that can display hard-disk performance at maximum in accordance with the number of connected IP cameras, and applying algorithm that can generate buffer and file in accordance with group unit, and process large data of numerous channels by controlling the size of buffer with optimal value in accordance with data capacity received by generated buffer, and pulling in recording performance of hard-disk at maximum to process data of group-based channels by applying Dynamic Buffering.

Keywords—DVR, NVR, VMS, Intelligent, Software

I. INTRODUCTION

The demand for computer-based Digital Video Recorder (DVR) system is gradually on the decrease, while the demand for DVR system in a form of Internet Protocol (IP)-based Stand-alone is on the increase. The IP-based DVR system is being expanded into home network, home security, disaster prevention, disaster monitoring system, and applied security system [1]. Surveillance cameras monitoring visitors, advertising LCD providing users with the variety of information, and diverse operation information sensors for emergency phone devices and safe operation are installed in elevators of a collective building recently built such as building, apartment, and officetel to transmit numerous multimedia data in a bi-directional, real-time manner to building-integrated control room, management office, or janitor's office. Furthermore, Network Video Recorder (NVR) system is a system exclusive for image recording, monitoring, event management, and re-production of camera or video server installed in network, which is a device replacing existing digital video recorder (DVR) with IP-exclusive storing device that compresses and saves digital images transmitted from IP camera. For these functions, NVR storage appliances, NVR recording algorithm, network-interlocked interface, multi-screen display functions, sensor interface software, and integrated control software should be implemented [2]. Up to the present, each of the subsystems such as surveillance cameras, advertising LCD, emergency phone call devices has been independently installed and operated through additional lines, and has had a difficulty in integrated control due to each different management main body. Thus, if the subsystems are integrated into a single line, providing integrated control functions in a single system, this will enhance the overall efficiency, and reduce the cost. Currently, as the majority of multi-channel surveillance systems are integrated based on IP, and should enable all kinds of information to be shared and controlled even in the outside by interlocking Internet network, research is required on ACL for network security, QoS functions for static image information, and other various IP-based functions.

Figure 1. DVR(Digital Video Recorder)

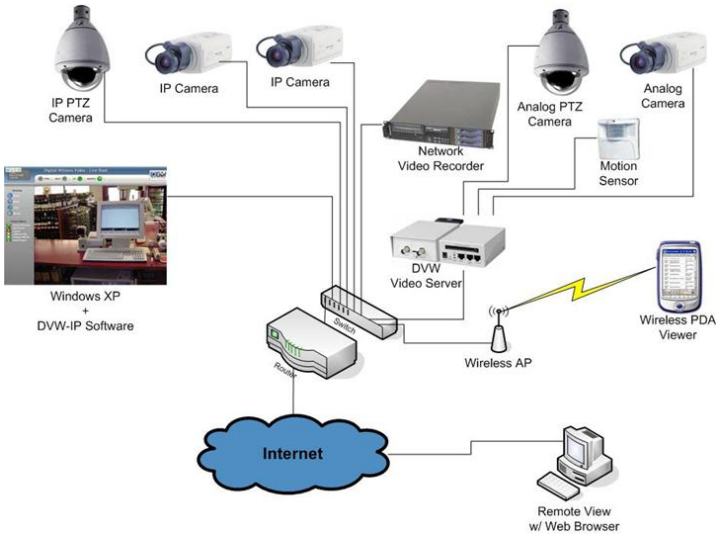

Figure 2. NVR(Network Video Recorder)

Figure 3. VMS (Video Management System)

II. RELATED RESEARCH

CCTV and DVR technology creating the mainstream of video security is a field which has experienced rapid growth since 2000. With advancement in IT technology, video surveillance system,

which enabled managers to transmit video information obtained from CCTV cameras installed in specific space to the control center by using exclusive cable transmission line and conduct direct surveillance through monitor, has developed from the VCR storage device-based analogue era to the digital era using DVR-based video compression and digital transmission technology. Recently, intelligent video surveillance technology has been evolved that is integrated with automatic video analysis, recognition technology, and IP-based network using broadband communication network and open protocol [2].

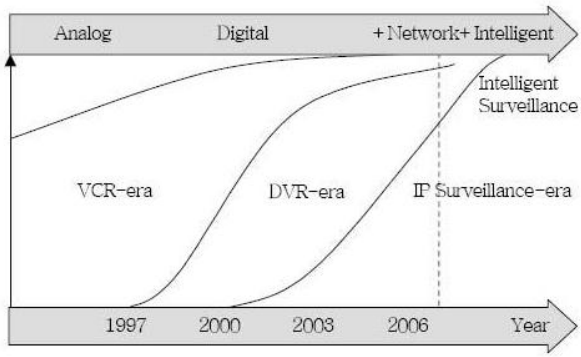

Figure 4. Evolution of Video Surveillance Technology

Basically, video security system is composed with CCTV camera for video shooting, display device to show video, transmission network to connect camera with display device, and storage media to save video. CCTV camera has been developed from black & white Charged Couple Device (CCD) into mega-pixel high-resolution digital IP camera, and as CCTV camera is installed in PTZ control system, it can perform functions such as image magnification, object or region detection, enabling a person to watch display remotely by using PTZ controller at the control center.

Figure 5. PTZ Control Device

DVR has become the mainstream in the field of video storage media since it was first successfully commercialized by a company in South Korea in 1997, and DVR compresses and save videos obtained from numerous CCTV cameras with 16 channels or above on average. As standards are used to compress videos, MPEC-4 method is being converted into the H.264 standard with high compression performance and flexibility. As the reliability of product is one of the most important factors due to the characteristics of security equipment, DVR should be operating without error for 24 hours 365 days. Further, it is common to provide search functions by time, date, camera, and event. For the time being, DVR is being developed into service combined with mobile and DVR

using smartphone and GPS through PC-based Stand-alone solutions. Further, transmission network is evolving from early coaxial cable into Ethernet-based transmission network. IP camera starts from static image obtained from simple compression technology, such as MPEC or JPEC, to which simple streaming technology is added. Currently, in this field, D1-level resolution 720*480 or 720*576 and IP camera adopting MPEC-4 technology have become the mainstream. Hence, for simultaneously operable in low-speed network, dual streaming technology is much adopted that implements MPEC and JPEC functions simultaneously, and RTSP/RTP (Real Time Streaming Protocol/Real-Time Transport Protocol) and HTTP Streaming technology are mainly used for network transmission technology.

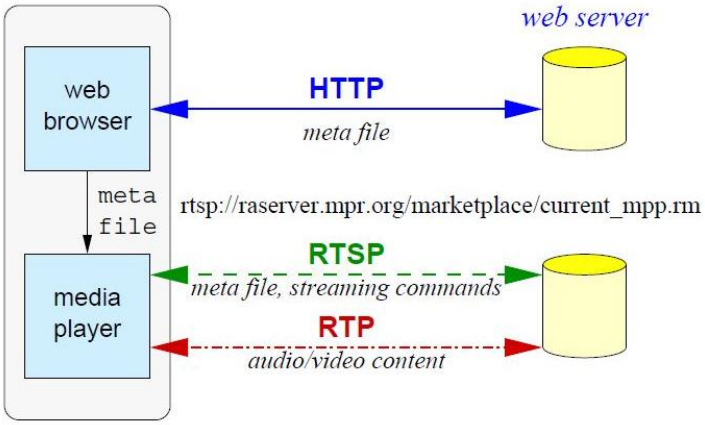

Figure 6. RTSP/RTP, HTTP Streaming

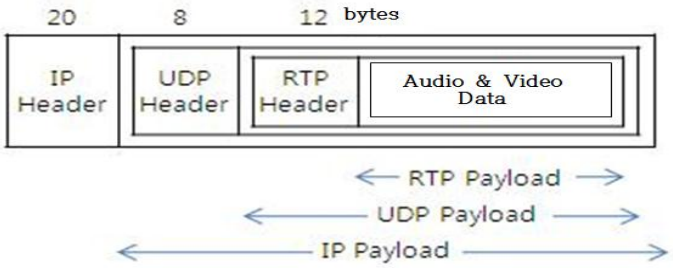

Figure 7. RTP Stack Configuration

To respond trends of the market, the importance of development of Video Codec has been debased by the companies although many specialized companies around the world develop and merchandise Video Codec. Also in price competitiveness among Codecs of these specialized companies' hardware-based Codec and high-performance Digital Signal Processor (DSP), as the initial start-up cost is almost the same as the price of main components of product, hardware-based Codec will be more used. As the H.264 technology is singled out as next-generation technology of MPEC-4 now becoming the mainstream and should bear a heavy burden of client section unlike early expectation of the H.264 technology, it does not play a major role in professional market requiring simultaneous access to multi-channels, which is being blamed for delayed adoption of the IP camera. On the other hand, as the H.264 Codec in DVR part, where extra clients are not important, comparably has a less burden of client, new product is being much adopted. Currently, notwithstanding commonly adopting CCD Image Sensor and MPEC-4 technology, the main market of the IP camera is a field of

Video Security that can rapidly process picture images, produce One Chip of each circuit block, and rapidly process adopting CMOS Image Sensor very advantageous in terms of data processing speed [3][4][5].

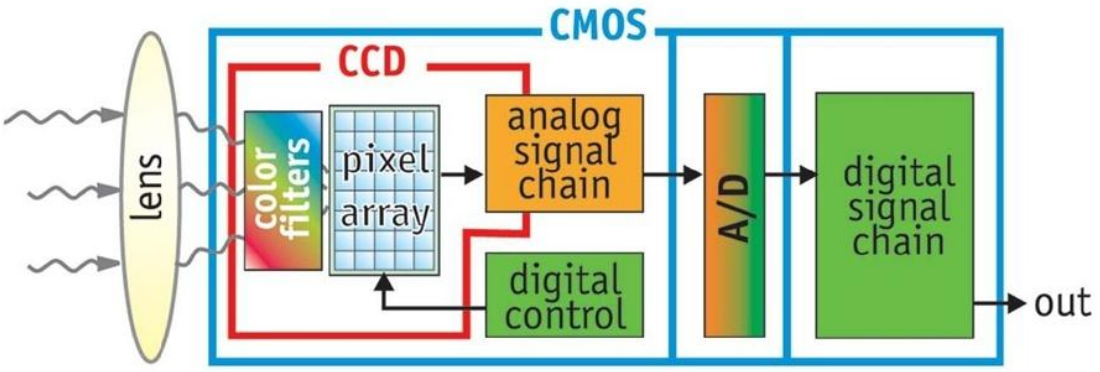

Figure 8. Difference in Chipset Structure between CMOS Image Sensor and CCD Image Sensor

III. SYSTEM DESIGN

In this chapter, we seek to explain smart grouping algorithm and dynamic buffering storage module.

3.1 Smart Grouping Algorithm and Dynamic Buffering

The hard-disk recording system commonly used conducts recoding by generating one buffer and file in each of the IP cameras and accessing hard-disk on a one-for-one basis. In this case, as the system accesses hard-disk in order to process numerous channel data at a time, and this causes a bottleneck phenomenon, increasing the number of times access to hard-disk, and reading data of hard-disk, lowering search speed of Head, able to record about 40-45% of maximum writing speed and not able to record due to lowered writing speed in case of large file, and generating deserted data, or downloading program. In response to this, this research aims to reduce the number of times access to hard-disk and minimize a bottleneck phenomenon by applying smart grouping algorithm, calculating channel group unit that can display hard-disk performance at maximum in accordance with the number of connected IP cameras, and applying algorithm that can generate buffer and file in accordance with group unit, and process large data of numerous channels by controlling the size of buffer with optimal value in accordance with data capacity received by generated buffer, and pulling in recording performance of hard-disk at maximum to process data of group-based channels by applying dynamic buffering. The picture 9 below represents storage module on a one-for-one basis, smart grouping algorithm, and dynamic buffering storage module.

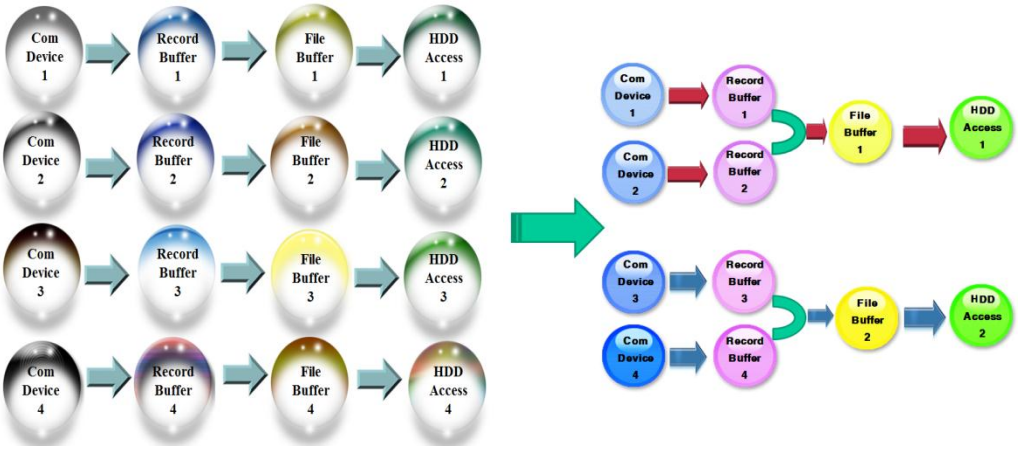

Figure 9. Storage Module for a One-for-One Basis, Smart Grouping Algorithm, and Dynamic Buffering Storage Module

3.2 VMS Performance Implementation

The number of recording channels considers each vision system as one Agent, and stands for the number of channels of VMS-integrated intelligent software, the product herein developed by each Agent; whereas the recording speed per channel considers each vision system as one Agent, and stands for recording speed per channel saved as VMS-integrated intelligent software, the product herein developed by each Agent. Further, for a total of recording speed, the recording speed is 30fps per channel. If it is 57.6Mbps (24ch∗30fps∗80Kbit) or above when 10KB/fps on average is in 720∗480 resolution, it satisfies basic requirements, but it is implemented up to 320Mbps for expandability. For screen resolution, notwithstanding VMS-integrated intelligent software, the product developed, fully supporting the resolution of vision system, the software implemented a resolution, D1-level (720∗480 Res.) or above, for a basic requirement, and the acceptable number of heterogeneous protocols is 2 vision equipments or above of each different manufacturer, which send and receive video information by interlocking with a VMS-integrated intelligent software, the product herein developed.

Table 1. Main Performance Index

Main Performance	Unit	End Development
1. Number of Recording Channels	ch	24 or above
2. Recording Speed per Channel	fps	30 or above
3. Total Recording Speed	Mbps	320 or above
4. Screen Resolution	Res.	720∗480 or above
5. Acceptable Number of Heterogeneous Protocols	EA	2 or above
6. Mobile Web	OS	Android 2.2 Froyo or above
7. Mobile Web	OS	iOS 4.2.1 or above

3.3 Content of VMS Reproduction

3.3.1 Image Matching Manager

■ Network transmission (TCP) of event information and Database Information by using Native API of Channel

- Status Display and Alarm on Dash-Board
- Compare Viewer Development using Vision Native API

3.3.2 Access Manager

- Collection and Control on Information of Channel Status
- Function implementation for channel management function and communication with control DAEMON
- Scalable design through automatic DB information in case of network transmission (TCP) of status information and channel addition and alteration

3.3.3 Tracing Manager

- Produce DB of event by channel and control information in accordance with management policy
- Provide functions to search history through collected DB information
- Provide tracing and statistical functions on the use of system

3.3.4. Profile Manager

- Manage channel information to be managed (Location information, manufacturer, specification, etc.)
- Easily manage addition and alteration on device by providing intuitive user interface

3.3.5 Resource Manager

- Develop agent by using API provided by Native API or Vision Solution
- Network information transmission for control server DAEMON and source information

3.3.6 Application Interface Manager

- Manage input, editing, and deletion of accessed information of all the channels to be monitored with setting user circumstance function
- Manage and authenticate access authentication state (whether or not there is access, saving, control, search, etc.) with registered user id and password
- Manage DB of managed channels, and develop applied API of the integrated control center that supports simultaneous communication of video clips and voice of individual channels
- Provide multi-channel communication functions based on multi-thread
  - For simultaneous communication of multi-channels, create thread whenever demand of communication occurs
  - Quick, real-time communication of received images
- Separate Multi-Cast channel and Uni-Cast channels
  - Uni-Cast channel for process processing
  - Multi-Cast channels for alarm, notification, etc.

3.3.7 Video information Database

- Manage video information integratedly-interlocked (user information, event and alarm information, video information, location of recorded image files, etc.) and produce DB

3.3.8 Equipment Status Management

- Notify alarm by event kind
- Remote control (simultaneous back-up, control, etc.)
- Check hardware information, CPU, and memory status

3.3.9 User Interface

- Set up each device information and group
- Provide dash-board for integrated management
- Drag & Down for free screen division and integration
- Recorded, real-time image verification and bookmark, preview, and image storage functions
- Function of individualization such as user-customizable bookmark
- eMap (Environmental Monitoring & Assessment Program) that can identify location information of registered device

3.3.10 Management by Policy

- Set up and manage camera control process (schedule) in regards to event
- Perform the functions of date by product (Immediate schedule update)
- In case of exceeding capacity of recording-designated drive, implement automatic storage algorithm in a FIFO system

3.3.11 Video emitted from different environment and equipments

- Monitor through numerous PC, smartphone, and smart-pad
- Simultaneous emission in real time with recording in a different format such as MPEG-4, MPEG-2, MPEG, JPEG, and H.264
- Manage and distribute the number of video channels considering network circumstances

3.3.12 Report

- Statistical Support for Defect Ratio by Alarm Report, Line, Company, and Device

IV. CONCLUSIONS AND FUTURE WORK

As South Korea, now based on the world's highest Internet distribution, has network infrastructure enough for IT service using developed solutions, it is expected that new IT service will be created by utilizing relevant solutions without additional investment in related network infrastructure, and direct, indirect employment- and economically-induced effect derived from this will be much greater than economically-induced effect derived from IP camera manufacture and sales. This is large, real-time Video On Demand (VOD) service based on IT and Internet, expected that it will be international standards. Currently, the end users of IP camera are mostly users of Mid-to-High-end applications such as companies and government authorities. System integrator companies targeted for them serves as a crucial role, and on the other hand, the IP camera is expected to earn a great part in terms of quantity due to the convenience of use and possibility of support of various client equipments, and security companies and telecommunications service providers are expected to serve as a leading role in the market. Furthermore, high-end market will be gradually expanded around a high value-added business arising from high-resolution sensor, network, SI solution, and intelligence functions rather than Video Codec.

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