FOREX Publication
Open Access | Rapid and quality publishing

International Journal of
Electrical and Electronics Research (IJEER)
Review Article | Volume 10, Issue 2 | Pages 218-224 | e-ISSN: 2347-470X

A Study on Edge Board for Blur Image Judgment and Cluster Image Behavior Analysis: AI-Based Image Processing System Research

Hee-Chul Kim[1]
[1]*Professor, Department of Computer Engineering, Gwangju University, South Korea*

***Correspondence:** Hee-Chul Kim; Email: jaziri@daum.net

ABSTRACT- The purpose of this study is to solve the problem that the control center cannot cope with the situation properly due to the difficulty of analyzing the behavior in the case of cluster images or the occurrence of unclear images due to weather conditions and fine dust. Edge board development is necessary for cases in which the image sharpness check and overlap image check are inaccurate. In addition, evaluation techniques such as PSNR (; Peak Signal-to-Noise Ratio) and SSIM (; Structural Similarity Index) are used for the corresponding images to evaluate the degree of image improvement of the model with a validation dataset for each fixed image. After evaluating the model's inference speed in terms of FPS (; Frame Per Second), verification is performed for each stored model for each training, and the improvement rate of the image is calculated to evaluate which model is the most optimal for each weather condition. Development of modular edge board for CCTV (; Closed Circuit Television) linked event processing and ICPoIP (; Image Check Processing over IP) system for hybrid-based image classification, video improvement solution and superimposed image shape analysis by linking with the video control system Develop solutions for image processing systems to advance the performance of the image processing system.

Keywords: Edge board, Image processing, Superposition, Video monitoring system, Enhancement, Convolutional Neural Networks.

ARTICLE INFORMATION
Author(s): Hee-Chul Kim;
Received: 11/04/2022; **Accepted**: 19/05/2022; **Published**: 10/06/2022;
e-ISSN: 2347-470X;
Paper Id: IJEER22TK408;
Citation: 10.37391/IJEER.100229
Webpage-link:
https://ijeer.forexjournal.co.in/archive/volume-10/ijeer-100229.html

Publisher's Note: FOREX Publication stays neutral with regard to Jurisdictional claims in Published maps and institutional affiliations.

1. INTRODUCTION

In the image processing system, CCTV is installed and operated to collect images of the control target area through image information in repeated congestion situations, unexpected situations, and special situations. It is difficult for the control center to deal with the situation properly due to the occurrence of unclear images due to weather conditions and fine dust, or the difficulty in analyzing the behavior of group images.

This is inevitably less effective in the case of control through passive CCTV, where the control personnel monitors images with the naked eye. In the case of the Boston terror attack, a homemade bomb was made and a bag was left in a place where a crowd was gathered, and then exploded. In the case of "Won-choon Oh" in Korea, CCTV caught a scene of the winner wandering around the scene, but the abnormal behavior was not noticed in advance.

In order to overcome the limitations of passive CCTV control systems, intelligent surveillance systems that help prevent crimes and incidents by detecting and analyzing CCTV images in advance are being studied. There is still a limit to solving problems such as shaking, transmission noise, and image blur caused by weather conditions that occur in the actual field.

Current event detection technologies are mainly object-oriented methods that determine whether a set rule is violated while tracking an object after finding an object in an image. Because there is a loT of overlap between objects in an environment in which crowds move, it is difficult to obtain accurate information on individual objects, so it is difficult to apply the existing image analysis technology [1].

Recently, an intelligent selection control (AI) system has been introduced. The current selection control system of the central cloud method needs to introduce a very expensive server system to handle the huge load that occurs during image analysis. The number of CCTV channels that can be processed simultaneously is also limited to about 32 to 64 channels, and in case of network system failure, the installation site video cannot be received, so a security gap is inevitable [2].

2. THEORETICAL BACKGROUND

2.1 Modular Edge Board Research

By developing a board capable of judging image quality and mounting solutions through the development of AI Edge device equipment, the main processor module is developed for internal system management, CCTV image reception, and connection with central control. It uses open-source hardware

FOREX Publication
Open Access | Rapid and quality publishing
International Journal of Electrical and Electronics Research (IJEER)
Review Article | Volume 10, Issue 2 | Pages 218-224 | e-ISSN: 2347-470X

to realize reasonable manufacturing cost.

In addition, process extension technology is implemented to overcome the computational power limit of open-source hardware. Unmanned operation, system power management technology to minimize failure, and expandable structure to further improve computational power are adopted [3].

Designate 3rd-party hardware and software-SDK applicable to software, hardware compatibility standard, and use technology sharing internet site.

2.2 Overlaid Image Behavior Analysis

It can be viewed as a pre-processing function to solve the difficulty of image reading according to the field situation and an object detection function to detect a necessary object in the image.

For the object tracking function that obtains information such as the movement path and speed of the detected object, an abnormal behavior detection function using the obtained trajectory and speed information is designed and implemented.

By testing this in a real environment, it is verified that it is effective in detecting crime signs. It provides an operation service for centrally managing the CCTV system in the field. CCTV management [4], AI-based image quality improvement, and cluster image shape analysis are performed as the main functions of the CCTV operation service.

2.3 ICPoIP Development

It is necessary to solve the problem of the number of channels that can be processed per server, which is a problem in recent server-based methods. This solves problems such as edge-based method device computing power and limitations in application of high-level image analysis techniques. As a hybrid-based image classification method combining only the advantages of the two methods, the ICPoIP system is developed as shown in *figure 1*.

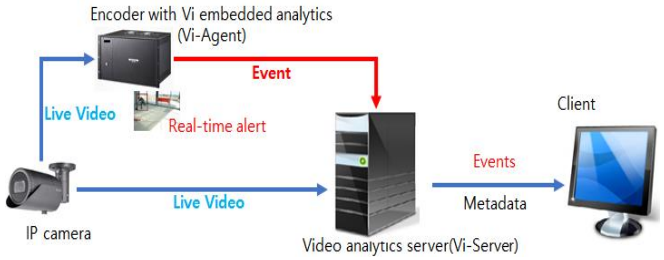


Figure 1: ICPoIP structure

In the structure of ICPoIP, the camera consists of a mode for transmitting image information and a mode for transmitting image feature information, and the mode change is controlled by the server. In the mode for transmitting characteristic information, the characteristic data transmitted by the camera to the server is image information of a specific area where the event occurred.
It has various shapes such as the shape, size, speed, direction, color, brightness, and superimposed image behavior of the detected object. The server sets the characteristic information to be transmitted from the camera and the transmission mode of the camera [5]. The event is detected using the characteristic information transmitted from the camera. When the server detects an event, the camera changes from the transmission mode to the video transmission mode.

Through this, the manager performs the verification of the event. In general, the server-based method can accommodate 4 to 16 cameras, whereas in the structure of ICPoIP, one server can accommodate 200 cameras. Hybrid-based methods such as ICPoIP improve blurred images related to fog, fine dust, and heavy rain in the image enhancement module.

Using the image improvement module and the superimposed image behavior analysis module, the vehicle stop and repeated congestion are analyzed in non-congested situations for traffic volume, speed, and unexpected situations by lane. By distributing the feature extraction and event detection functions from these images to the camera and the server, it is possible to increase the camera capacity of the server and overcome the limitations of the camera computation capability.

2.4 Edge Board Development

The hardware design conforming to AI image processing uses Quad-Core Cortex-A72 (ARMv8) 64bit. Figure 2 uses EDGE board to design extended main process circuit for event processing [6], H/W design considering the circuit design, surge and moisture resistance by using the system power 120W class AC/DC converter as a system recovery H/W design according to status monitoring and internal power supply and abnormal symptoms.

The circuit design of the external RJ45 (1Gbps) input design and the internal 5-channel expandable Router Chip application field is designed with a heat sink and heat sink according to CPU signal processing. Controls RS485, GPIO, Ethernet, watch-Dog with system H/W design that can monitor system status and respond to internal power and abnormal symptoms [7].

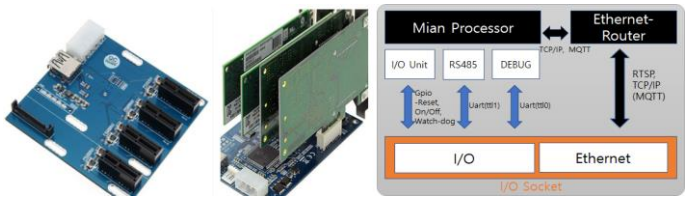


Figure 2: Event Module Extension Socket Structure

3. RESULTS

3.1 Operating System Development

It manages the setting and operation status of CCTV, and updates the image improvement algorithm model for AI-based service functions. The competitiveness of this developed technology is verified through image improvement and comparative verification based on the existing hand-crafted

FOREX Publication
Open Access | Rapid and quality publishing
International Journal of Electrical and Electronics Research (IJEER)
Review Article | Volume 10, Issue 2 | Pages 218-224 | e-ISSN: 2347-470X

feature. Through comparison with CNN, which is an artificial intelligence-based image improvement method, the efficiency of algorithms is improved by minimizing the size of learning data and computation time [8], such as verifying the competitiveness of this developed technology.

The output video of CCTV supports the improvement of the performance of the improvement technology by improving the learning model relationship between the obstacles caused by the illuminance of environmental changes, fine dust, fog, and swarming objects. In the image processing related system, TSP Receiver, H.26X Encoding image analysis, and communication device interworking system are established in the interworking device for blurry and superimposed images [9].

Various device diagnosis and test functions are added inside the IoT device to transfer control/status data between the device and the edge system. The developed algorithm and model verification system are established in order to advance the selection condition module through SDK-related edge protocol development and image preprocessing [10].

3.2 AI-based Video Control System

Through judgment according to the sharpness of the CCTV image or the case of the swarm image, an image improvement and behavior analysis command for the swarm image sent to the control center is generated. It controls load distribution related to image analysis of the control center through pre-processing of object image data through module operation. To design and manufacture an image improvement device equipped with development technology, design and manufacture an expansion board type PCI socket) circuit for the development of image preprocessing Edge Sub Board H/W. For system status monitoring, internal power supply and H/W system design that can respond to abnormal symptoms, reset circuit control and H/W WATCH-DOG circuit are designed using Gpio port [11]-[12]. U-boot ver 2020.01-rc4 is used for image preprocessing Edge Sub Board system boot loader design and F/W porting. For OS Porting (Linux) and optimization, kernel ver 5.4.44 is used. For device driver porting and optimization, uart, RS485, ethernet, graphic-drive, flash-drive, file-system, and GPIO-drive are used. For image preprocessing RTSP protocol porting (Client) and software optimization, FFmpeg, OpenCV, libVLC, etc. were configured and designed as shown in *figure 3*.

Table 1: Shows some of the related programs [13]

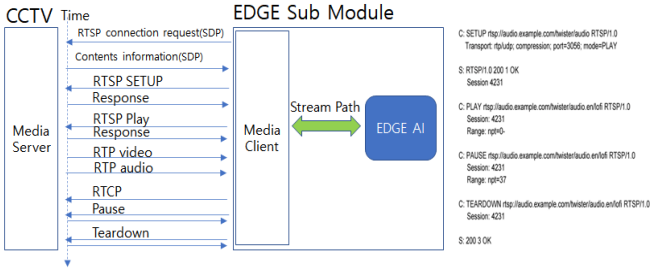


Figure 3: EDGE Sub Module RTSP Client Soft Ware

Programs related to *Table 1*

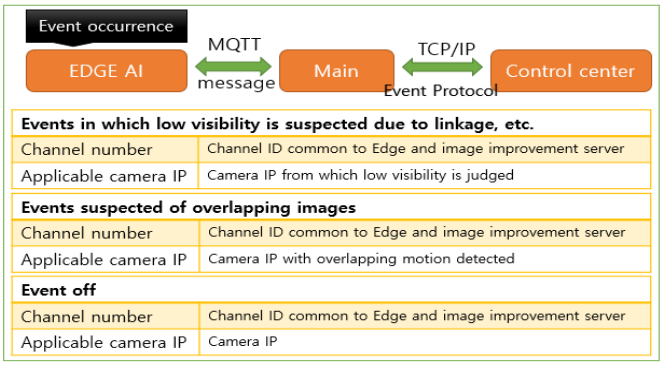
```
# CONFIGURATION
# For using instances
if ( basename $0 | grep "activemq-instance-" > /dev/null);then
   INST="`basename $0|sed 's/^activemq-instance-//;s/\.sh$//'`"
  ACTIVEMQ_CONFIGS="/etc/default/activemq-instance-${INST} $HOME/.activemqrc-instance-${INST}"
  echo "INFO: Using alternative activemq configuration files: $ACTIVEMQ_CONFIGS"
else
  ACTIVEMQ_CONFIGS="/etc/default/activemq $HOME/.activemqrc $ACTIVEMQ_HOME/bin/env"
Fi

# load activemq configuration
CONFIG_LOAD="no"
for ACTIVEMQ_CONFIG in $ACTIVEMQ_CONFIGS;do
  if [ -f "$ACTIVEMQ_CONFIG" ] ; then
    ( . $ACTIVEMQ_CONFIG >/dev/null 2>&1 )
    if [ "$?" != "0" ];then
      echo "ERROR: There are syntax errors in '$ACTIVEMQ_CONFIG'"
      exit 1
    else
      echo "INFO: Loading '$ACTIVEMQ_CONFIG'"
      . $ACTIVEMQ_CONFIG       CONFIG_LOAD="yes"
    break
  fi
Fi
done
```

In the Event Main Module, RJ45 (1Gbps) input design and a router chip application circuit that can be expanded to internal 5 channels is designed [14]. It has a system recovery function and design (RESET function, H/W Watch-Dog circuit control function) according to the sub-board system status monitoring and power supply and abnormal symptoms. 120W class AC/DC converter is used for system operation power. For circuit design, 4 channels of sub module, power supply of main module, and 4 channels of heat dissipation PAN power are supplied.

When designing H/W considering surge and moisture resistance, cut off power and use recovery fuse. Coding is processed for surge circuit design and PCB invasion. In Figure 4, MQTT internal communication is used when an event occurs according to the event processing (TCP/IP) software development and image preprocessing for MQTT porting and optimization.

This is received in the Main Processor and transmitted to the control center in the form of Event Flag. Creates communication protocol between EDGE Sub Module and internal control Main Module. Optimize RS485 service for control and develop control software and use it as a preliminary protocol for control of Sub Module in Main. In the development of control software for EDGE status monitoring, there are Watch-Dog and Reset functions for sub-module control in Main.



Events in which low visibility is suspected due to linkage, etc.	
Channel number	Channel ID common to Edge and image improvement server
Applicable camera IP	Camera IP from which low visibility is judged
Events suspected of overlapping images	
Channel number	Channel ID common to Edge and image improvement server
Applicable camera IP	Camera IP with overlapping motion detected
Event off	
Channel number	Channel ID common to Edge and image improvement server
Applicable camera IP	Camera IP

Figure 4: Event Flag MQTT Communication Structure according to Preprocessing

FOREX Publication
Open Access | Rapid and quality publishing
International Journal of Electrical and Electronics Research (IJEER)
Review Article | Volume 10, Issue 2 | Pages 218-224 | e-ISSN: 2347-470X

For communication structure, RS485 Service software development uses preliminary protocol for Edge Sub Module control. Developed control software for system status monitoring and internal power supply and abnormal symptoms. It controls RESET and power on/off according to the network connection status of Edge Sub Module, transmission speed and device operation status.

In developing web server software for internal system setting, each setting page such as RTSP, Port-Forwarding, MQTT, DHCP, STATIC-IP, RS485, Device-State (reset, power on/off, gpio) is provided. AI EDGE board was mounted on the module for event processing to improve performance through image preprocessing function test and software optimization. The AI image processing algorithm is mounted on the EDGE board to perform an image analysis performance test. You can see the event generation function verification test according to the event generation algorithm and the system status monitoring software function verification test [15].

In the process of performing the edge board integration test, the AI sub board is mounted on the main module to enhance the performance through image preprocessing function test and software optimization. AI image processing algorithm is mounted on the sub board and installed on the main module to perform multi-channel image analysis performance test. The event generation function verification test according to the event generation algorithm verifies the system status monitoring software function.

3.3 Development of condition setting program for Event Processing

Network Camera related function development includes Proxy Server, RTSP Receiver, Frame Sync, etc. The video preprocessor sets and extracts a region of interest (ROI), resizes it (Video Resize), splits a frame (Frame Split), and uses video processing commands to improve the image, analyze the shape of a group image, and generate a passing flag.

In *Figure 5*, smoothing, histogram equalization, and expansion or contraction morphology are used as image preprocessing techniques for the captured image. In addition, pre-processing such as low-pass filtering, Gaussian filtering, and median value filtering is performed on the night image.

For the daytime image, the input image is processed according to a histogram algorithm, an edge algorithm, a labeling algorithm, etc. without preprocessing. The histogram algorithm allocates the lowest bit value that occurs frequently [16]. As the size of the frequency decreases, a larger bit value is allocated to analyze the image value.

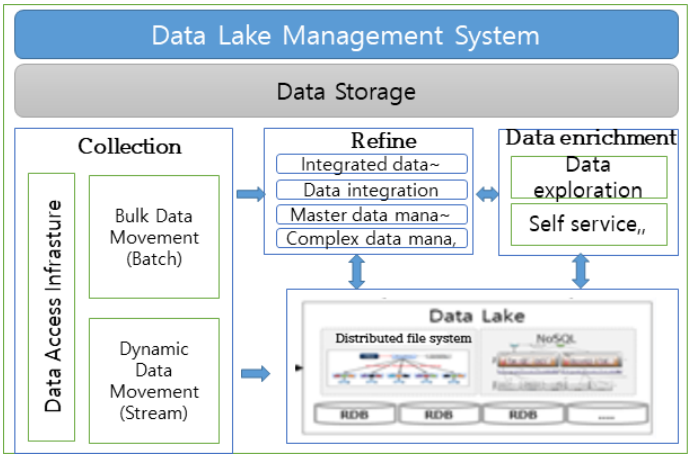


Figure 5: Web Server Structure

3.4 Cluster Image Behavior Analysis

Video improvement through AI-based CCTV video analysis or judging whether to analyze group video uses instruction information and the original video of CCTV acquisition. We develop a solution that analyzes the AI analysis management system in the center to understand the situation of the control area. The resolution of the input image and output image is set to Full-HD image (1920x1080), and the performance of the algorithm developed for the resolution is evaluated as follows.

For the corresponding images, the degree of image improvement of the model is evaluated with a verification dataset for each fixed image through an evaluation technique such as PSNR/SSIM. After evaluating the model's inference speed from the FPS point of view, validation is performed for each stored model for each learning, and the image improvement rate is calculated to evaluate which model is the most optimal for each weather condition, and PSNR and SSIM are used. To collect video data by background or subject, port data such as distance and road are collected. In addition, classification and criteria for group image behavior are selected, and a data set centered on weather (fog, fine dust, heavy rain, etc.) information is constructed.

Figure 6 shows the development of technology for video improvement, analysis of video quality of CCTV, and technology related to improvement. It collects analysis and testing data, builds learning data, and manages the setting of a specific zone in the video transmitted from CCTV. Real-time blur image improvement algorithm development and algorithm implementation and testing. Behavior analysis of group images transmitted from CCTV, improvement of raw video of CCTV, or behavior analysis of group images is carried out.

FOREX Publication
Open Access | Rapid and quality publishing
International Journal of Electrical and Electronics Research (IJEER)
Review Article | Volume 10, Issue 2 | Pages 218-224 | e-ISSN: 2347-470X

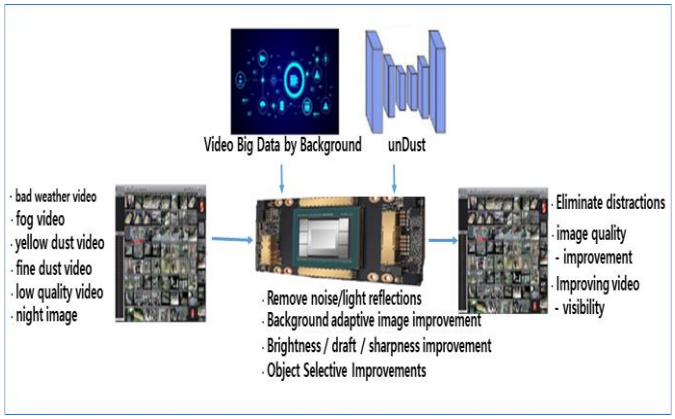


Figure 6: Data Analysis and Processing System

4. REVIEW RESULTS

4.1 Image Analysis and Performance Improvement

AI-based image analysis is performed on the collected images, and the image improvement algorithm model is continuously advanced. To evaluate the degree of object-centered improvement, it is verified through an Inception-based CNN (Convolutional Neural Networks) classifier to check whether the actual image is improved. Inception score is used as an evaluation method for this, and the image improvement rate is calculated and verified from a fixed image. In this case, the number of video frames processed per second (FPS) is used.

Set the resolution of the input image and output image to Full-HD level image (1920 x 1080), and evaluate the performance of the developed algorithm for the resolution. For the corresponding images, the degree of image improvement of the model is evaluated with a validation dataset for each fixed image through an evaluation technique such as PSNR/SSIM. After evaluating the inference speed of the model in terms of FPS, verification is performed for each stored model for each learning, and the improvement rate of the image is calculated to evaluate which model is the most optimal for each weather condition. In this case, PSNR and SSIM are used.

The unit system in the center is linked with the video control system. It transmits a message that determines whether to improve the image generated through AI image analysis or analyze the group image behavior along with the CCTV image to the control system. The video stored in the CCTV management system is provided to the video control system as shown in *Figure 7* for the center operator's situation analysis.

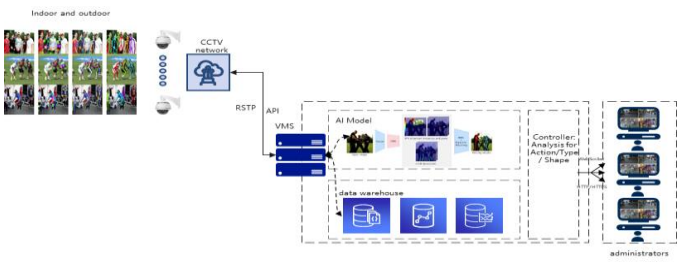


Figure 7: Video Control System

4.2 Image Quality Improvement and Cluster Image Behavior Analysis

The determination of whether to improve the image or analyze the group image through AI-based CCTV image analysis is instruction information and CCTV image security. We develop a solution that analyzes the original video in the AI analysis management system in the center to understand the situation in the control area. The resolution of the input image and output image is set to Full-HD image (1920x1080), and the performance of the algorithm developed for the resolution is evaluated as follows. For the corresponding images, the degree of image improvement of the model is evaluated with a verification dataset for each fixed image through an evaluation technique such as PSNR/SSIM.

After evaluating the model's inference speed in terms of FPS, validation is performed for each stored model for each training. To evaluate which model is most optimal for each weather condition, the image improvement rate is calculated, and PSNR and SSIM are used. For video data collection by background or subject, distance, road, port data collection, cluster image behavior classification and criteria are selected, and weather (fog, fine dust, heavy rain, etc.) information-centered data set is constructed.

The development of image improvement technology improved the image quality of CCTV images. It collects analysis and testing data, builds learning data, and manages the setting of a specific zone in the video transmitted from CCTV. Real-time blur image improvement algorithm development and algorithm implementation and testing. Behavior analysis of swarm video transmitted from CCTV, improvement of raw video of CCTV, or behavior analysis of swarm video is carried out.

4.3 Image Data Analysis Module Development

Learning data collection and database construction refer to images of situations with and without weather changes (sea fog, fine dust, bad weather, snow, rain, etc.) for fixed images from the camera. It is to place the object that needs control in a specific place and secure the image data of two situations, one with and without the weather change.

It detects abnormal road conditions through raw images collected through CCTV of the video analysis and management system. It is an anomaly detection model that considers the situation in the control area to detect an event in which an object separated from the background is abnormally observed differently than expected.

A gesture recognized in the recognition of human behavior related to cluster image behavior analysis is a gesture that means the movement of a body part. Data is collected by classifying it into an action defined as a combination of various gestures for one person, an action interaction occurring between two objects, and a group action occurring in a group consisting of multiple objects. In Figure 8, for the experiment to generate the weather change of the original image, it is tested by creating and securing an image in which the target objects are moving in a clear image with no weather change.

FOREX Publication
Open Access | Rapid and quality publishing
International Journal of Electrical and Electronics Research (IJEER)
Review Article | Volume 10, Issue 2 | Pages 218-224 | e-ISSN: 2347-470X

Figure 8: Human Behavior Recognition Data Set

4.4 Image Enhancement Algorithm

Figure 9 shows how to properly transform an image by emphasizing features such as contrast enhancement, edge enhancement, and pseudo coloring to improve blurry images. It calculates pixel value transformation, spatial domain transformation, frequency domain transformation, and morphology.

In order to solve problems such as image shake, noise, and blur caused by bad weather, color data is smoothed for smoothing the image so that image correction is preceded. Instead of applying the technique of black-and-white images directly to RGB color, the new color system (KCELAB) is used to maintain the brightness of the image and convert it to an independent channel form, and then post-correction to maintain the image quality.

(a) original video (b) Channel Compensation (c) Brightness maintenance conversion

Figure 9: Color Histogram Smoothing

In order to compensate for the shake occurring in CCTV, the motion image was corrected through the motion prediction, compensation and correction steps. First, a stabilized image is generated by calculating and analyzing a motion vector. The image degradation removal and minimization algorithm was developed to enable noise removal, sharpening, geometric distortion, and correction.

Automatic inspection and target recognition such as boundary /region/ relationship in cluster image behavior analysis algorithm. A threshold value called a pixel value indicates a threshold value in the histogram distribution of an image. Edge-based image segmentation is a method of segmenting regions that satisfy connectivity and homogeneity based on boundary lines.

It detects anomalies based on behavior by learning the behavioral patterns of objects occurring in the image. In this method, the behavior of people is observed through image analysis and an alarm is generated when it deviates from the normal behavior. This means that the administrator does not need to define rules, and normal behaviors are memorized through unsupervised learning of behaviors in specific places in the video, changes by time of day, and changes by day of the week, etc. If the position and movement of an object deviates from the normal behavior, it is recognized as an abnormal behavior.

To recognize the behavior of a group, we use a spatiotemporal-based analysis method and a fluid dynamics-based method. The space-time-based analysis method divides the three-dimensional space consisting of the X, Y, and time axes of an image into cubes. For each cube, feature information such as motion change was modeled, and the relationship between cubes was studied in a way to find abnormal behavior through statistical analysis.

5. CONCLUSION

The system studied in this paper proposed a solution for continuous image improvement and cluster image shape analysis through the use of artificial intelligence CCTV solution technology. As the importance of the video surveillance service through the network increases and the area to which the video surveillance system is applied increases, the degree of interest in the security of the video surveillance system has increased. As the video surveillance system evolves into the IP environment, the importance of the security function has been emphasized as the hacking technology, which has been a problem on the Internet, can be used as it is.

Invasion of privacy that may occur in the process of collecting images from unspecified people is pointed out as a more serious problem compared to other IT systems. This is an urgent need to standardize the core technologies related to intelligent video surveillance (CCTV), such as cameras, video storage devices (DVR, NVR), integrated control systems, video analysis technology, and video security technology. In order to quickly achieve the transition to a digital ecosystem triggered by COVID-19 and to overcome the economic crisis, a unified standardization strategy with the national policy direction is essential.

The ICT standardization strategy map linked to the future digital new deal policy should be the business base of non-face-to-face infrastructure. Maintain the brightness of the image to improve blurry images, he image was converted to an independent channel format and then the image was post-corrected to suggest a solution to the problem, improving and mitigating some performance. In the future, we derive measures to solve the problem of thermal imaging and infrared shooting it is necessary to realize digital new deals such as the establishment of data for artificial intelligence learning to standardize CCTV image processing. Not exposing everyday CCTV images In order to serve as a leading catalyst for the Korean economy, infrastructure safety and CCTV facility advancement are absolutely necessary.

International Journal of Electrical and Electronics Research (IJEER)
Review Article | Volume 10, Issue 2 | Pages 218-224 | e-ISSN: 2347-470X

6. ACKNOWLEDGMENTS

This research was supported by a research program sponsored by Gwang Ju University in the 2022 school year.

REFERENCES

[1] J. Saidov, B. Kim, J. Lee and G. Lee, "Hardware Interlocking Security System with Secure Key Update Mechanisms In IoT Environments,"J. of the Korea Institute of Electronic Communication Sciences, vol. 12, no. 4, 2017, pp. 671-678.
[2] H. A. Rowley, S. Baluja & T. Kanade. (1996). Neural network-based face detection. IEEE Transactions on Pattern Analysis and Machine Intelligence, 20(1), 23-38. DOI: 10.1109/34/65564
[3] Y. Min, "Cognitive ability measurement technology latest technology trend," Korea Institute of Science and Technology Information, 2016
[4] D.B, Parker, "The Strategic values of Information Security in Business," Computer & Security, Information Security, vol. 16, 1997, pp. 572-582.
[5] D. Dodson, M. Souppaya & K. Scarfone. (2019). Mitigating the risk of software vulnerabilities by adopting a Secure Software Development Framework (SSDF). NIST Cybe rsecurity White Paper.
[6] J. H. Bang & J. D. Ji. (2017). Certification trends and improvement direction of dom estic testing for software assurance. Review of Korea Institute of Information Security and Cryptology, 26(1), 42-4
[7] I. Cho and S. Yeom, "Long Distance Face Detection with Region of Interest Extraction," J. of Korea Institute of Intelligent Systems, vol. 28, no.3, 2018, pp. 281-286.
[8] Y. Lee, "A Semantic Dignosis and Tracking System to prevent the Spread of COVID-19 in Korea, 2020" Korea Institute of Electronic Communication Sciences, vol.15, no3, 2020, pp-611-616.
[9] M. Bor, J. Edward, and U. Roedig, "LoRa for the Internet of Things," In Proc. International Conference on Embedded Wireless Systems and Networks, Graz, Austria, Feb. 2016. pp. 361-366.
[10] K. Nam, "A Study on the Office Management Service Platform based on M2M/IoT," J. of the Korea Institute of Electronic Communication Sciences, vol. 9, no. 12, Dec. 2014, pp. 1405-1413.
[11] J. Jang, C. Choi, and D. Kim, "Design of Smart Tourism in Big Data," J. of the Korea Institute of Electronic Communication Sciences, vol. 12, no. 4, 2017, pp. 637-644.
[12] H. Lee and J. Oh, "Design and Implementation of a Small Server Room Environment Monitoring System by Using the Arduino," J. of the Korea Institute of Electronic Communication Sciences, vol. 12, no. 2, Apr. 2017, pp. 386-387.
[13] Grand View Research. (2020). Cyber Security Market Size, Share & Trends Analysis Report By Component, By Security Type, By Solution, By Service, By Deployment, By Organization, By Application, By Region, And Segment Forecasts, 2020 – 2027.
[14] S. M. Lee & S. H. Yun. (2018). A study on delay factors in apartment housing project through case study. International Next-gene ration Convergence Technology Association, 2(1), 6-14.
[15] J. I. Heo. (2020). Advanced design of smart air purifier for single-person households. Master's thesis, Graduate School, Hongik University.
[16] Y. H. Kim & S. S. Lee. (2019). Physical properties of adsorption matrix for improving indoor air quality using cork. Journal of the Architectural Institute of Korea, 39(2), 676-677.