Mobile intelligent image monitoring system based on SDN convergence mobile Ad-hoc that can be self-powered

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ABSTRACT

This study is about a mobile intelligent image monitoring system that can self-supply and is based on SDN convergence mobile Ad-hoc. It includes a self-powered module and forms a mobile Ad-hoc -based network, but the mobile Ad-hoc-based network consists of a mobile intelligent image monitoring device that performs redundancy control by converging software-defined networking (SDN).

KEYWORDS

Self-powered, Software-defined networking(SDN), Mobile image monitoring, Ad-hoc, AI object recognition

1 INTRODUCTION

The image monitoring system developed so far is a third generation system, and the fourth generation system has been developed since 2020. It changed from low-definition to high-definition, and in the solution part, it changed from simple to intelligent. In addition, it is under development with detection such as networking of CCTV cameras, 3D implementation, thermal image detection functions, and 4K UHD ultra-high resolution. In particular, with the introduction of deep learning technology using video big data, pedestrian detection, tracking, and situation recognition performance have been significantly improved. As equipment and technologies are complex and diversified, dependence on infrastructure, such as faster network speeds and reliable power supplies, is further enhanced [1-3].

Therefore, new requirements for image monitoring systems should be supported. Requirements for video surveillance support in areas with limited underlying infrastructure such as power and communication are increasing. When changing the monitoring position, it should be supported to freely move and expand the imaging device without changing the physical environment such as a camera cable [4-5].

This study studied a mobile intelligent image monitoring system that can self-supply and is based on SDN convergence mobile Ad-hoc. It includes a self-powered module and forms a mobile ad hoc-based network, but the mobile ad hoc-based network includes a mobile intelligent image monitoring device that performs redundancy control by converging software-defined networking (SDN) [6-7].

2 RELATED WORKS

2.1 Mobile image monitoring device

A self-power supply module was developed to ensure mobility in the image monitoring device. As shown in Fig. 1(a), the self-power supply module consists of a solar panel, a storage battery, and a power supply module. The self-power supply module is designed to store and use power in the storage battery through the power supply module while solar power is available as a standalone system. The image monitoring device consists of a gateway-based device that connects to a public network and a terminal image monitoring device that connects to a private network of mobile Ad-hoc. In addition, the image monitoring apparatus considered the phase of the camera and the transmission image format so that the image monitoring apparatus can capture a general image and recognize an object. The gateway video monitoring device consists of an LTE module and a WiFi module to connect video stream data transmitted from Ad-Hoc's private network to the Internet network through an LTE router modem and transmit it to a microcloud node or a user's mobile device. The terminal imaging device duplicated the WiFi module into two, automatically connected to a surviving Ad-Hoc node when an emergency occurred, and transmitted image stream data. The self-storage medium of the imaging device stored the image for a certain period of time.

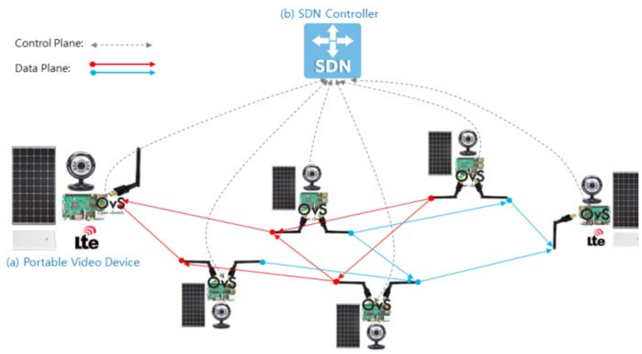

Figure 1: Mobile image monitoring device system: (a) Portable Video Device (b) SDN Controller

2.2 SDN-based mobile Ad-Hoc network redundancy control module software

In order to duplex the network using an SDN controller, all imaging devices must be connected to the network by default. To this end, all Wi-Fi ports on the device were connected to a private network using a mobile Ad-hoc routing protocol, and network address translation (NAT) was used for gateway devices to connect the private network to the Internet network. Many commonly used mobile Ad-hoc routing protocols include OLSR, Babel, DSDV, DREAM, and BATMAN, and among these protocols, the most suitable protocol for this study was tested and selected for development. Network ports were also developed to support routing algorithms and control plans to connect to the Open vSwitch (OVS) to control the data plane according to the control plane of the SDN controller. That is, SDN-based control module software was developed to redundantly reduce the mobile network on the side of the image monitoring device.

3 RESULTS AND DISCUSSION

3.1 Edge-Cloud hardware and software supporting real-time image object recognition deep learning

Edge cloud hardware consists of small servers with built-in GPUs as shown in Fig. 2(a), and edge cloud software developed SDN controller modules, video stream storage modules, real-time object recognition modules, and recognition object alarm modules into independent server modules as shown in Fig. 2(b). By modularizing and containerizing the software to be developed, the server resources of the edge cloud node could be shared and used, and the server resources could be developed flexibly. The SDN controller module was developed as Java, Python, C, etc. to control OVS of the image monitoring device by selecting the most suitable controller for this study among SDN controllers such as ONOS, OpenDaylight, and Ryu. The video stream storage module recognizes the object of the image by storing the image transmitted from the image monitoring device and transmitting it to the real-time object recognition module at the same time. In order to recognize objects in real time, the real-time object recognition module was developed to allow CNN's network to extract features at once, create boundary boxes, and classify classes. To this end, the redundant object box was enhanced using the grid method and the NMS (non-maximum suppression) algorithm, and only one boundary box was extracted. The recognition object alarm module has been developed to inform the user of the recognized object using a message API.

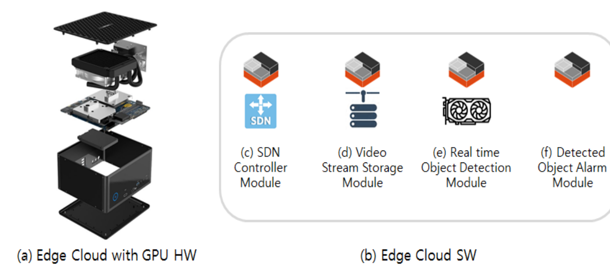

Figure 2: Design of Edge Cloud Hardware and Software : (a) Edge Cloud with GPU HW (b) Edge Cloud SW

3.2 Microcloud hardware and software for image data storage/AI object recognition

As shown in Fig. 3(a), the microcloud hardware consists of three microcloud storage cluster nodes whose product name is Abyss and an artificial intelligence microcloud node, a newly purchased server. The software developed a video storage module, a real-time object recognition multi-module, an image information integrated management module, and a multi-recognition object alarm module into an independent server module by LXD containerization as shown in (d), (e), (f), and (g) of Fig. 3(b). By modularizing and containerizing the software to be developed, the server resources of the artificial intelligence microcloud node could be pooled and used so that the server resources could be developed flexibly. Fig. 3(c) shows the microcloud storage-based artificial intelligence support framework of six intellectual property rights held by the headquarters, and will develop modules related to this study based on the technology they have. The video storage module was developed to containerize artificial intelligence microcloud nodes to support block storage 192TB of ceph-based microcloud storage. Microcloud storage used the Abyss storage system owned by the headquarters. The real-time object recognition multi-module was developed to recognize objects in real-time from multiple sources by multiplexing the real-time object recognition module in Fig. 3(e). To this end, four

GPUs were mounted on the artificial intelligence microcloud node and developed using the pathstrough technology in each containerized real-time object recognition module.

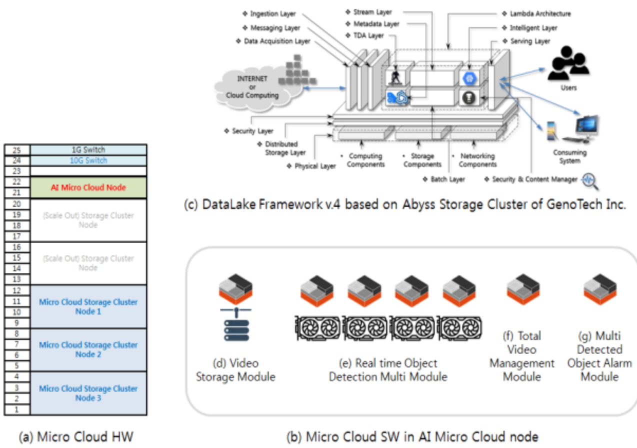

Figure 3: Microcloud Hardware and Software Configuration Diagram: (a) Micro Cloud HW, (b) Micro Cloud SW in AI Mocro Cloud node, (c) Micro Cloud SW in AI Micro Cloud node

3.3 Integrated image information management and recognition object alarm software

The integrated image information management and multi-recognition object alarm software were developed as LXD containerized modules as shown in Fig. 3b(f) and Figure 3b(g). The integrated image information management software is designed to consist of a storage server, a database server, and a web server. The storage server stores image monitoring data in the microcloud storage server using the video storage module of Fig. 4(d). Meta information of image data transmitted from each image monitoring device is stored in a database server. Among MariaDB, MySQL, Cassandra, HBase, and MongoDB, the most suitable database server was selected and used for development. The web server was developed using Apache HTTP server, nginx, node.js, etc. and java, python, php, etc. to support the integrated web user interface of image information in Fig. 4. Multiple recognition object alarm software is developed based on a messenger server, and user registration is required whenever a service user is added, and a messenger-only server is configured because the server consumes more resources as the number of messengers increases. In order to avoid this problem, it was designed to be developed using the API of the existing messenger so that you can receive an alarm service as soon as you register your contact information, such as LINE, Kakao Talk, and Facebook chat.

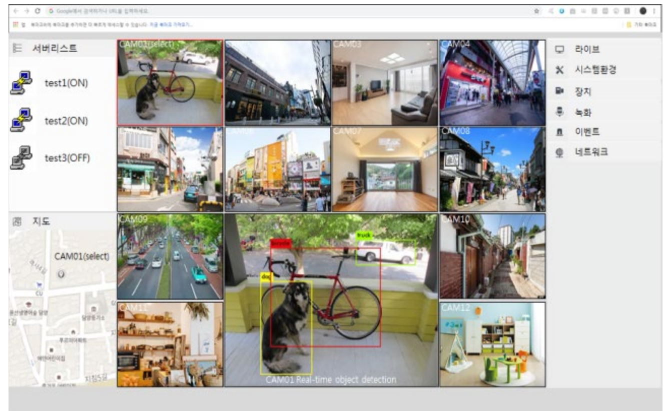

Figure 4: Anticipated Interface for Integrated Image Information Management Web UI

4 CONCLUSIONS

In summary, we have performed the mobile intelligent image monitoring system based on SDN convergence mobile Ad-hoc can support mobility, scalability, high availability, and real-time object recognition, making it easy to use even in situations where basic infrastructure such as power and communication is limited. In addition, even when the monitoring location is changed, the image monitoring device can be freely moved and expanded without changing the physical environment such as a camera cable, and the image can be continuously monitored in an emergency. In addition, there is an effect of supporting a high level of communication environment and reliable electricity supply. The mobile intelligent image monitoring system, which is self-supplied and based on SDN convergence mobile Ad-hoc, is formed in a structure that minimizes the image monitoring shadow area of the image monitoring device, thereby increasing the reliability of image monitoring.

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