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System Integration for the Operation of Unmanned Audio Center based on AoIP

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Abstract

Recently, the development of the information communication industry has made many changes in the industrial acoustic industry. Especially, it has a great influence on the change of system and equipment of acoustic system. Analog equipment is changing to digital equipment, and integrated control equipment makes it easier to operate and manage the sound system. However, the integrated control system currently on the market is only controllable for some devices. In this paper, we propose a new AoIP - based system configuration method, which enables the operation status monitoring, unmanned operation and self - diagnosis of equipment. As a result of the study, it is confirmed that the proposed system can be operated, monitored, and self - diagnosed at remote sites. It is expected that an AoIP- based sound system will be the industry standard in the future.

Key words: *AoIP, DANTE, AV System Integration, SR system*

1. Introduction

The high-quality sound system continues to evolve along with the ubiquitous era. In particular, public spaces such as public institutions, large expositions, international conferences, and seminar venues require high-quality sound systems. The sound system will be installed according to the purpose of use. However, it costs a lot to operate and maintain it. Therefore, an integrated control system for simple operation is required in the market. In this paper, we propose a new AoIP based system configuration method. It aims to make non-experts easy to operate and manage, and to minimize operating expenses through unmanned operation and self-diagnosis of acoustic system [1-2]. In Chapter 2, we analyze the integrated control system technology introduced in the market. In Chapter 3, we describe the network-based acoustic system configuration. In Chapter 4, the unmanned operation of the acoustic system and the implementation of the self - diagnosis technology are explained. In Chapter 5, conclusions and future technical developments are presented.

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2. Aoip and System Integration Technology for Sound System

2.1 AoIP Technology

Acoustic system is composed by connecting each device using Microphone Shield Cable (MSC) or UTP Cable. It is common to connect using MSC, but the configuration method using UTP cable based on AoIP is increasing recently. Compared with MSC, UTP cable system configuration is suggested as the most suitable method for acoustic system configuration because there is no line interference and signal loss due to long distance transmission [3-4]. AoIP is a technology to send and receive 44.1khz CD sound quality based on IP network in uncompressed real time. AoIP technology is different from VoIP technology. AoIP transmits high quality voice, but VoIP is not used for SR systems because of the quality of the phone call quality. AoIP can build a system using an existing network without configuring a separate network. Prior to the introduction of AoIP, CobraNet technology developed by Cirrus Logic in the United States was used for remote sound transmission. CobraNet is a transport technology based on 2 layer of 7 layers, a network model of the International Organization for Standardization (ISO). Although it is used for public address broadcasting and remote sound transmission of large-scale commercial facilities, there is a problem in that it is necessary to pay royalties for ADC or DAC and to purchase and use interface equipment. In recent years, DANTE, Australia's Audinate company, has a high market share. DANTE uses standard Internet protocols (TCP / IP, UDP / IP) and can transmit 24 bit 48kHz, 512x512 channels from Gigabit [5-6].

Table 1. AoIP Technology [4]

Technology	*Launch date*	*Synchronization scheme*	*Protocol*
Live-Wire	2004	IEEE1588-(Developing)	RTP
DANTE	2006	IEEE1588-2002	UDP
Q-LAN	2009	IEEE1588-2002	UDP
RAVENNA	Developing	IEEE1588-2002	RTP

2.2 Sound System Integration Technology

The sound system is installed and operated according to the purpose or its use. Operation and management of equipment should be done with expert's knowledge of each device, which means to be accompanied by a lot of cost to operate the equipment. The Integrated control of sound equipment began to appear on the market in the late 1990s in order to solve all of these problems [7].

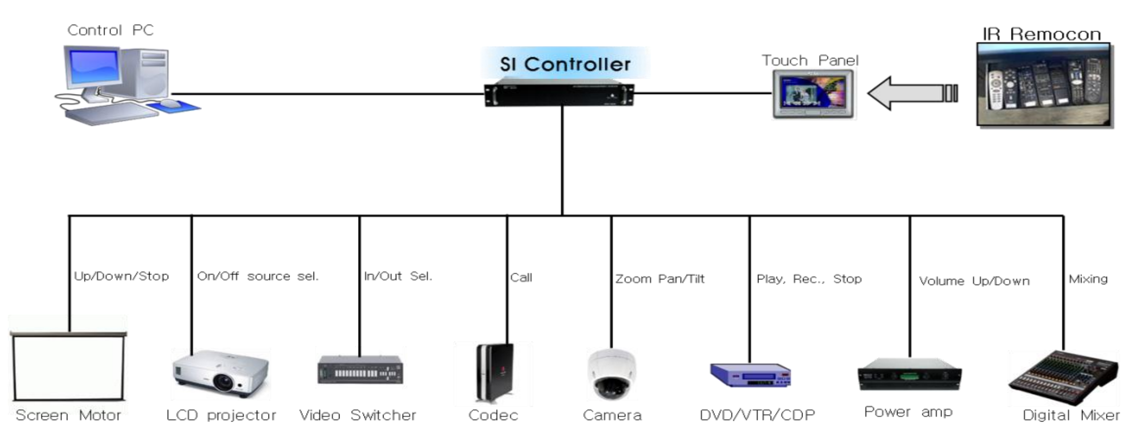
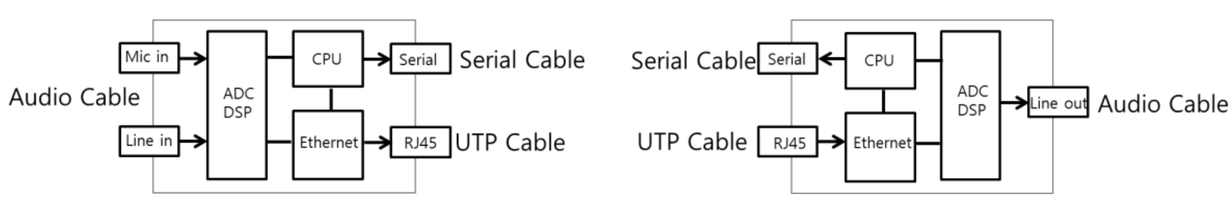


Figure 1. System Integration diagram

Figure 1 shows the components of the current integrated control system. Each device communicates through TCP or UDP communication or through the serial port. Most device controls are controlled using the protocol provided by the manufacturer, but some products (DMX512, Camera, etc.) are also controlled using standard protocols. Currently, various integrated control companies are competing in the acoustic market including famous brands such as AMX, Crestron, and Extron. Although each brand may have its own characteristics, it can be controlled only for devices capable of serial communication and devices capable of controlling by relay contact. Even analog and digital products can not control products that do not support external communication. For this reason, integrated control systems presently on the market can not be self-diagnosed and unmanned.

3. Analysis Of Sound System Diagram

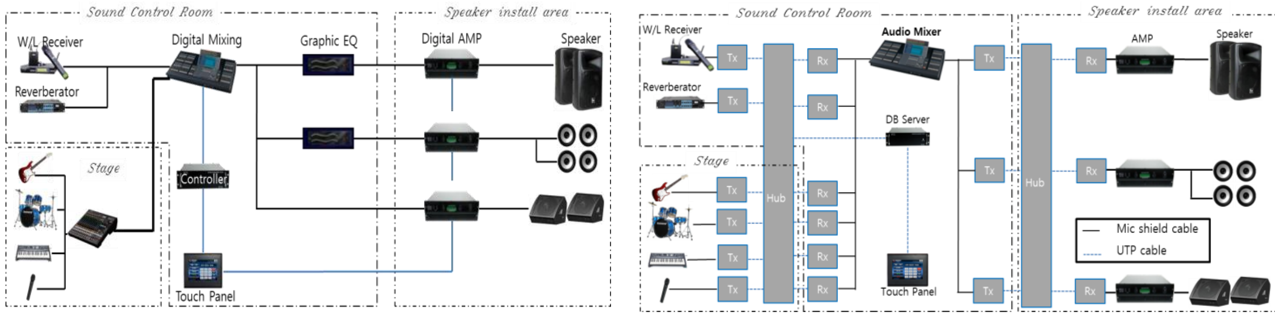
The acoustic system can be constructed in various ways depending on the characteristics of the building, such as reverberation time. The construction of the sound system has two main objectives. First, it transmits the distortion-free sound to the listener through the speaker. Second, it minimizes the cost of operation and management. In a sound system, a device having different functions is connected by a cable to form a system. In general, MSC is used for connecting acoustic equipment, but UTP cable may be used for some sections in recent years. Transmitting acoustic signals using the MSC may cause line loss or interference depending on the distance. However, transmission based on UTP cable has no loss or interference. The acoustic system configuration based on the UTP cable is possible when transmitting each device signal to the network. Currently, the system configuration method of point-to-point concept among network-based systems does not appear on the market. In this paper, we construct a sound system based on point-to-point to enable system control of all equipment. For this purpose, On-site Audio Center (OAC) was installed in each equipment to enable equipment control. OAC is made lightweight and compact, allowing it to be installed in a distributed sound system. In particular, OAC enables the transmission of uncompressed, real-time sound signals, and a DSP function that can adjust the audio signal, so that it can be set and adjusted appropriately for the construction environment after installing the sound system [8].



(a) (b)

Figure 2. OAC Block diagram
(a) Transmitting device (b) Receiving device

Figure 2 shows the OAC configuration. OAC is configured as a system by connecting the input and output of audio equipment separately. In Figure 2 (a), the microphone and line signals can be input to the transmitter. After the input signal is processed by the ADC, it is possible to control the reverberation effect through the gain level and the reverberation for the acoustic signal in the DSP. The adjusted signal is sent to the Ethernet by the CPU so that high-quality sound signals can be transmitted in real time over the network. The transmitted sound data is received through the receiver in Fig. 2 (b). The received data is sent from the CPU to the DSP. DSP allows Graphic EQ and Time Delay. The DSP data is converted to an analog signal through the DAC and then sent to the receiver [9].



(a) (b)

Figure 3. Sound system block diagram
(a) Sound system diagram based MSC (b) Sound system diagram based UTP cable

Figure 3 (a) shows the acoustic system configuration by MSC, and (b) shows the UTP cable configuration. Figure 3 (a) shows that all equipment is connected to each device by MSC and transmits signals. Except for the section for connecting the power amplifier and speaker, each unit is connected using MSC. Each equipment is connected to the audio mixer located in the broadcasting room. Each acoustic equipment on the stage should be wired to the broadcasting room using the MSC. As shown in Figure 3 (b), each device is wired with an OAC-based UTP cable, except for power amplifiers and speakers. The equipment is connected by very simple structure wiring. Each device is connected to the OAC, and the OAC is connected to the peripheral hub, so that all the devices are connected. The UTP cable can be wired only from the stage to the broadcasting room with one line, which can reduce the construction cost compared to the wiring method using the MSC. In addition, they are not affected by the reduction of sound quality due to the loss of the line and interference by external electrical characteristics [10].

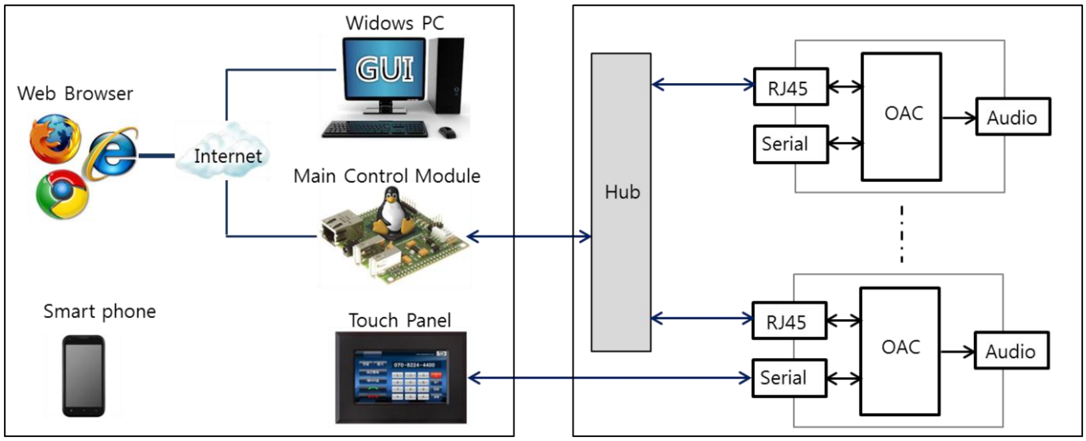
Table 2. MSC and UTP cable installation comparison

List	*MSC*	*UTP cable*	*Remark*
Cable quantity(M)	1700	260	
Cable unit price(won)	4500(p,876. Canare)	440(p,877. LS Cable)	2017.4 Distribution price
Man-power (Communication cable worker)	0.26/10M	0.15/10M	2017 Standard laboring rate

Table 2 shows the input resources when using MSC and UTP cable based on multi-purpose auditorium system of 35M width, 20M width and 6M height. For multi-purpose auditoriums, MSC requires 1700M of cable resources, and UTP cable requires 260M of cable resources. The cable price and the manpower input for the installation are shown in Table 2. Cable unit price was based on the 2017.4 distribution price in April 2017, and man-power data was based on the 2017 standard laboring rate.

4. Implementation of Sound System Integration Technology

OAC can be controlled locally or remotely. Each OAC can remotely operate network settings, input signals, and monitor operation status. Thus, the acoustic system can be self-diagnosed and unmanned operation.



(a) (b)

Figure 4. System Integration diagram based on OAC
(a) Control diagram for OAC operation (b) OAC system

Figure 4 shows the system configuration for controlling the OAC-based sound system. OAC can be operated by a web browser or various operating systems. It can also be controlled using touch panel and smart phone. Network-based OAC processes input and output data in the main control module.

The processing of the transmission / reception data for OAC control is shown in Fig 5. The data input through the Ethernet is sent to the database via the Receipt procedure to check. The database confirms the promised data and sends it to the main procedure. Main procedure processes data sent from the Receipt procedure or GUI device. The data processed in the main procedure is sent to the send procedure. Then the send procedure picks up the control protocol of the corresponding OAC from the database and transmits it to the OAC through the Ethernet. These processes of all procedures are done by multi-threading and operated in the main control module embedded with Linux operating system. Each multi-threading operates according to the value of the database. The system unmanned operation and self-testing became possible.

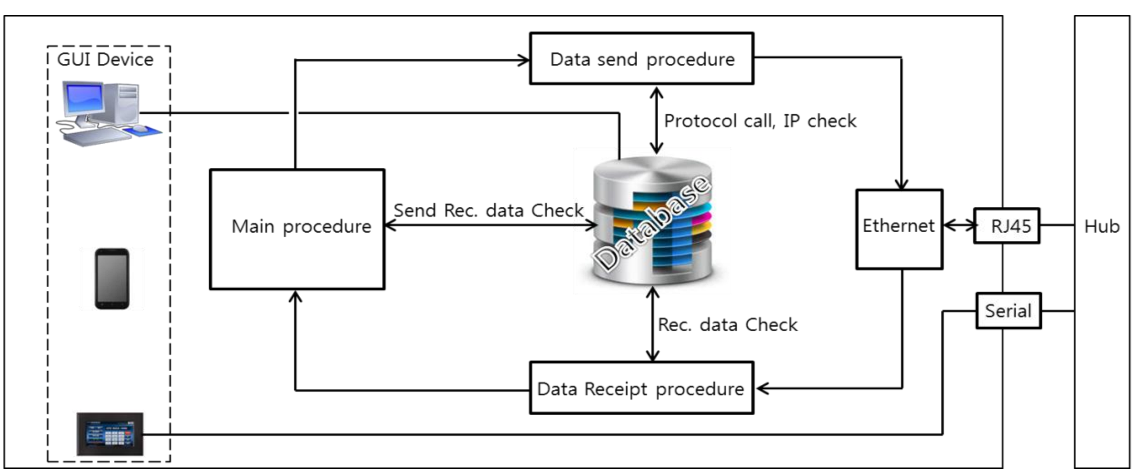
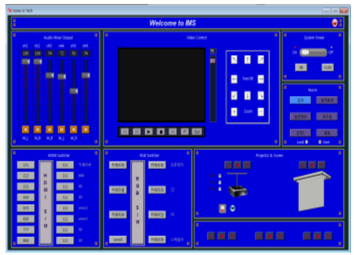
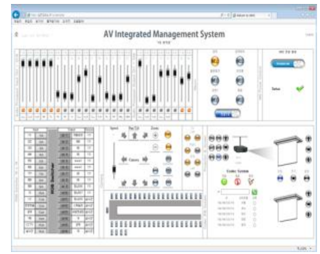


Figure 5. Program flow chart for system integration

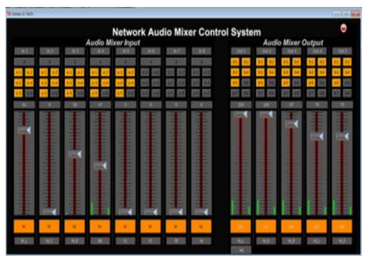
OAC can be controlled in various ways as shown in Fig 6. Fig 6 (a) shows the control in the OS-based GUI environment, and Fig 6 (b) shows the control through the web browser. Fig 6 (c) is for controlling by using the touch panel in the local area, and Fig 6 (d) shows the batch control by the Smart phone. OAC control via GUI is programmable through various cording to access the database.



(a)



(b)



(c)

(d)

Figure 6. GUI display for System integration operation
(a) OS based GUI (b) Web based GUI (c) Local touch panel GUI (d) Smart phone GUI

Figure 7 shows the process of data communication between Embedded Linux and OAC. OAC connected to each device has an IP, which allows remote access. The Linux signal procedure records the status and gain value of I / O signals through each OAC and threading in the database. OAC uses PoE power management to self-diagnose by turning the equipment on at certain times. Pink noise is generated in each OAC connected to the sound source to check signal presence and gain level. In the schedule table of the database, unmanned operation is possible by recording the operation reservation time and the usage mode.

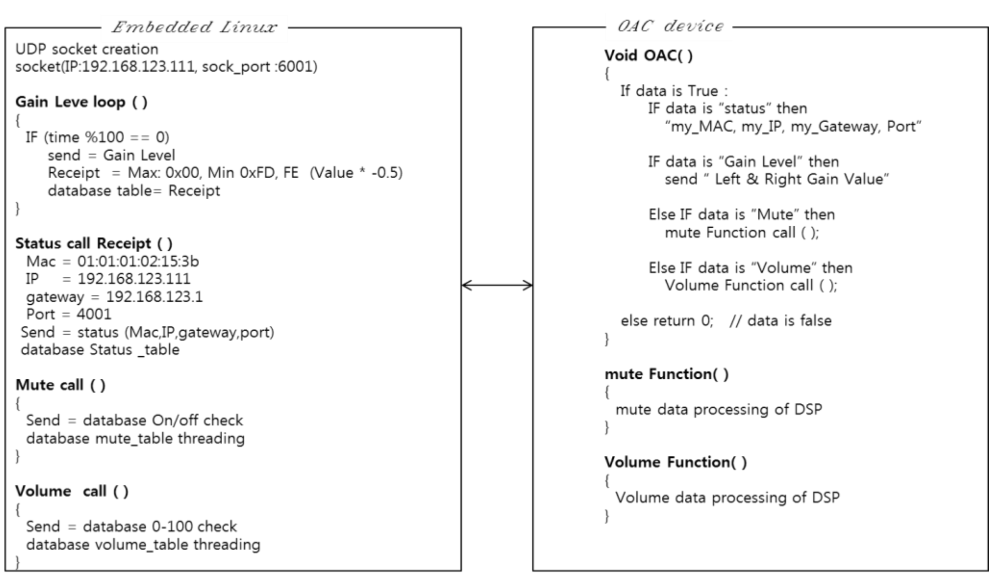


Figure 7. OAC signal remote control

A variety of integrated control systems are on the market. Table 3 shows a comparison of OAC-based integrated operations and integrated control systems currently on the market. Integrated control that is not based on OAC cannot be operated unmanned and self-diagnosed because only some devices can be controlled. On the other hand, the integrated control system based on OAC can be operated for all devices. In particular, it has reduced operating costs by enabling convenient operation for non-experts.

Table 3. OAC and non-OAC control system comparison

Feature	*OAC system integration*	*Non-OAC system integration*	*Remark*
Hardware Control	O	O	
Sound Control	O	X	
Self-testing	O	X	
Unmanned Operation	O	X	

5. Conclusion

In this paper, we propose an acoustic system that can operate unmanned and self - diagnosis through AoIP based system configuration. The proposed method is as follows. First, by replacing the MSC with a UTP cable, we were able to reduce construction costs and eliminate interference and loss due to long distance transmission. Second, all audio equipment is point-to-point connected to OAC for unattended operation and self-diagnosis. Third, it enables integrated management of sound equipment in various GUI environment. It is expected that the proposed AoIP - based acoustic system configuration method will become the standard method of future industrial acoustic system configuration.

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