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An Advanced Voice Recording and Control System with Fault-Tolerance for High Reliability and Stability

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Abstract: Big issues of the conventional voice recording and control systems are that the reliability of voice recording data is very low. So, now a days the entire systems are duplicated redundantly to solve these problems. But it is economically inefficient. On the other hand, because of the cost issues, only the servers among the whole system can be redundant in the form of main/secondary system structure. This structure is also very inefficient in terms of efficiency since most failures occur on the voice recording module. Therefore, in this study, we design and implement an advanced voice recording and controls system with fault-tolerant characteristics for high reliability and stability. To do this, the proposed system is developed by a voice recording and control module with fault tolerance characteristics which has an analog voice recording board with 8 channels and hot-swappable for wired and wireless calls. Even though, a failure occurs in one of parts of the circuit board module, the developed voice recording and control module does that the other part of the module outputs the recording files. So, stability and economy of the voice recording and control system can be achieved. Due to ongoing global disaster or safety issues as the importance of the voice recording and control system will be expanded, the proposed system will contribute to improve the reliability and stability of the system.

Key words: Voice recording failure, fault-tolerant voice recording module, parallel processing, wired/wireless call, disaster safety system

INTRODUCTION

Control systems are essential for national disaster and safety such as earthquake, tsunami, collapse of buildings, nuclear accident, aviation control, maritime control and national defense. Among the control systems, voice recording and control system is an element indispensable for the entire system (Denning, 1976; Dubrova, 2013; Menychtas and Konstanteli, 2012; Goode, 2002; Karapantazis and Pavlidou, 2009; Wang *et al*., 2005; Ahson and Ilyas, 2009). But, one of the biggest problems of the conventional voice recording and control systems is that it does not guarantee the reliability and stability such as loss of voice data due to the system failure (Dubrova, 2013; Menychtas and Konstanteli, 2012).

So, as a solution to this problem as shown in Fig. 1 the entire system is to be built in two sets and operated in duplicate. This redundant configuration method is economically inefficient. On the other hand, in order to reduce costs due to these cost issues as shown in Fig. 2 only the servers among the whole system can be redundant in the form of main/auxiliary server structure. This structure is also very unreliable and inefficient and since most failures occur on the voice recording module.

In this study, we design and implement a voice recording and control system with fault-tolerant properties to ensure high reliability and stability. To do this, the proposed system consists of a pair of voice recording and control modules with fault tolerance characteristics which has the analog voice recording circuit boards with 8 channels and hot-swappable for wired and wireless calls. Even if a failure occurs in one part of the circuit board modules, the developed voice recording and control module does that the other part of the module outputs the recording files.

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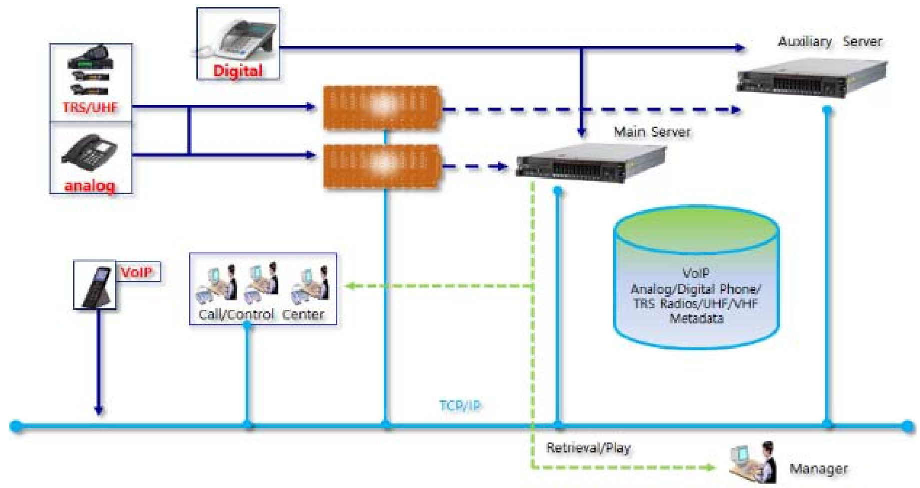

Fig. 1: As-is type 1 system structure

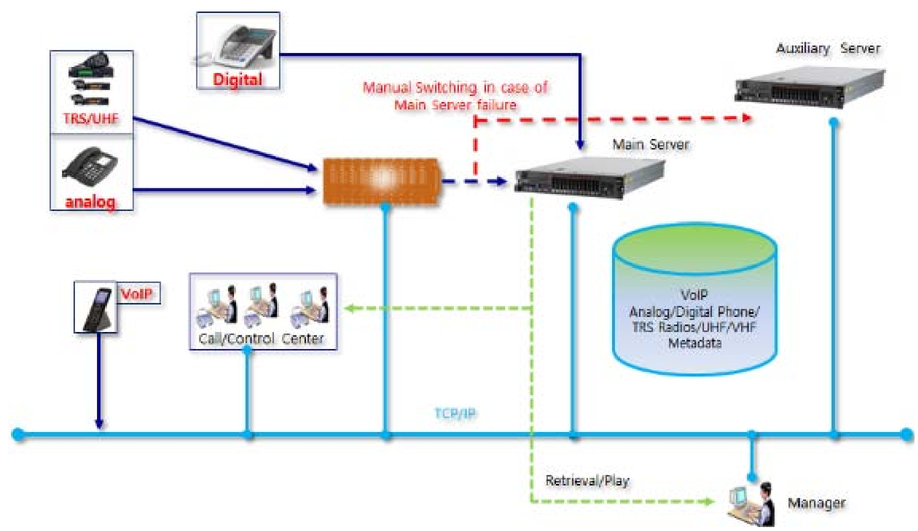

Fig. 2: As-is type 2 system structure

In particular, in order to improve the voice recording quality for wired and wireless calls such as TRS/UHF radios, analog/digital phone, VoIP phone we design and develop an engine that minimizes lost files in real time (Goode, 2002; Karapantazis and Pavlidou, 2009; Wang *et al*., 2005; Perwej and Parwej, 2012). So, the proposed system can achieve not only the reliability and stability of the voice recording and control system but also economic efficiency.

Due to ongoing global disaster or safety issues, the importance and use of the voice recording and control system will be further expanded. Therefore, the system proposed in this study is an advanced voice recording and control system with low cost and high efficiency which will contribute to the performance improvement of the control system in the future.

Design of an advanced voice recording and control system with fault-tolerance: In this study, we propose an advanced voice recording and control system with fault-tolerance for high reliability, stability and efficiency. The entire structure of the proposed system is as shown in Fig. 3.

In Fig. 3, the system includes a voice recording and control circuit board, a main server, an auxiliary server and a detection engine for voice loss file. Here, the circuit board of the proposed system processes in parallel about wired and wireless calls for fault-tolerance. To do this, we design a DSP (Digital Signal Processor) circuit module and an ethernet circuit module that can process in parallel.

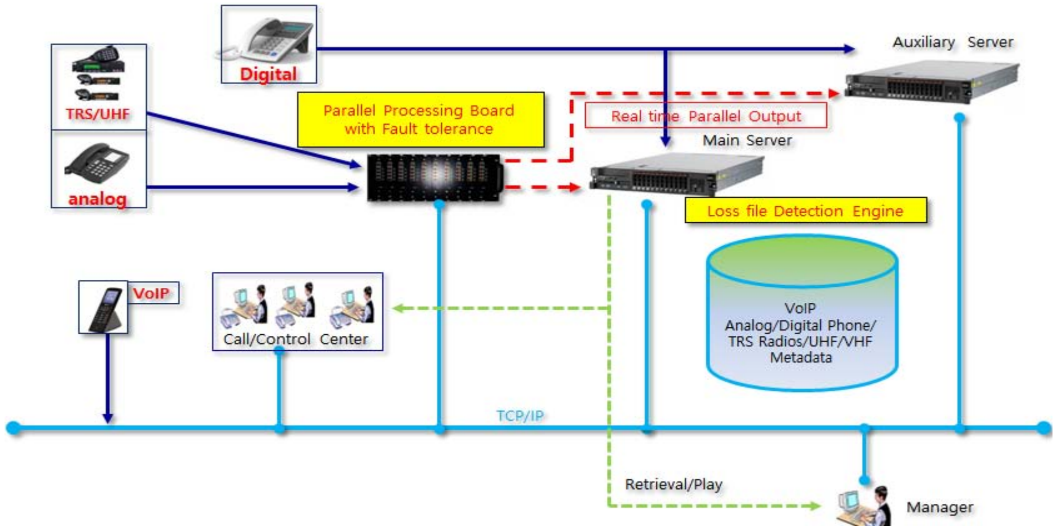

Fig. 3: The proposed voice recording and control system

MATERIALS AND METHODS

Design of a DSP circuit module: The proposed DSP circuit module is configured by a combination of three components which are a noise filter module, an AGC (Automatic Gain Control) module and a digital converter module. Thus, we should be designed for the integrated circuit module by distinguishing the characteristic of each component.

The noise filter module among the components eliminates noise through a noise filter circuit to remove and amplify of the noise the input signal. After confirming the voice signal by the voice DT circuit, the AGC module as shown in Fig. 4 keeps the output constant regardless of the strength of the voice signal received at the input port. That is the AGC circuit automatically finds and outputs the average voice level between low and high voice levels using the low/high band pass filter. And then, the digital converter module as shown in Fig. 5 converts an analog voice signal into a digital voice codec such as G723, G729 voice codec and also extracts telephone number into CID circuit embedded in DSP.

Parallel configuration of the DSP module and the Ethernet circuit module: The DSP module designed in this study consists of one pair in slots of the main board frame of the proposed entire system. A pair of modules duplicate a single voice signal received from the input port and convert the signals into two digital voice signals. Such a dual configuration is characterized in that the analog signal processing area is replicated. In general, because of the ease of implementation, replication techniques are applied to the digital circuit board. However, if the digital modules are replicated on the recording board there are many disadvantages to maintenance. When, the DSP module part is duplicated, the data input/output hardware circuit itself is configured in parallel. Therefore, it is possible to realize an uninterruptible service which is the main purpose of redundancy since you can be easily replaced when any one circuit breaks down.

And then, the digital circuit unit of the main board receives the digital signals from a pair of DSP module and generate two voice packets and store them in the built-in memory. That is the digital circuit unit generates a plurality of voice packets after it integrates a plurality of digital signals received in parallel with a decoder receiving a digital signal. In addition, the digital circuit unit transmits the generated voice packets to the Ethernet circuit module for communication.

As shown in Fig. 6 and 7, the ethernet circuit module also allows a pair of voice packets to be simultaneously transmitted in parallel to the main server and the auxiliary server. Thus, the ethernet circuit module includes an ethernet controller and two LAN transformers. The ethernet controller separates the LAN transformers and each of the LAN transformer transmits the digital voice packet to the server by TCP/IP. In this case, the number of LAN transformers is equal to the number of servers and multiple voice packets are transmitted in parallel to a plurality of servers.

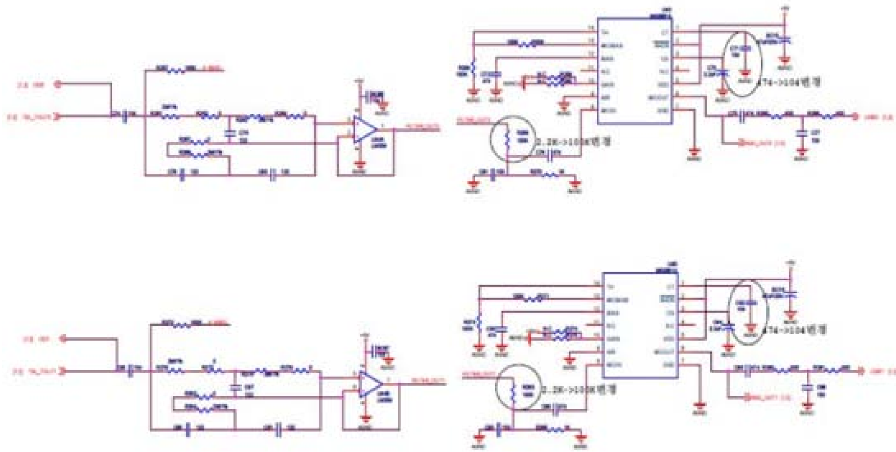

Fig. 4: An AGC circuit diagram

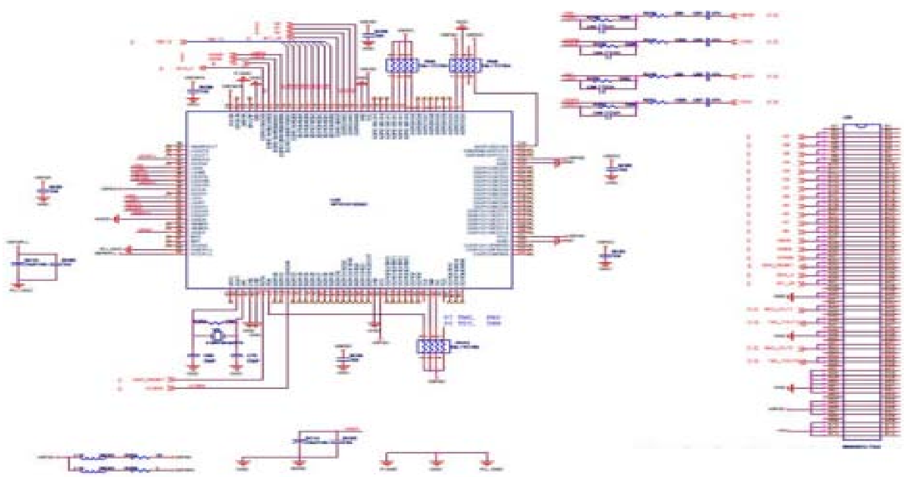

Fig. 5: A digital converter circuit diagram

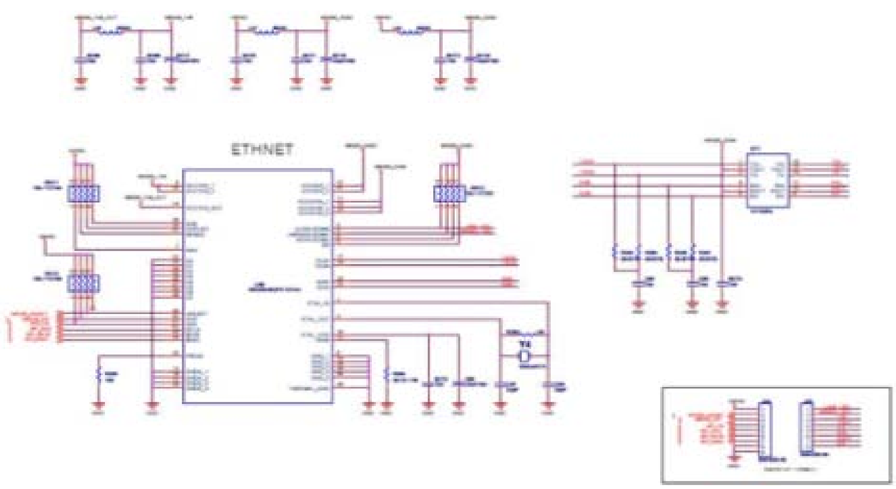

Fig. 6: An Ethernet circuit diagram

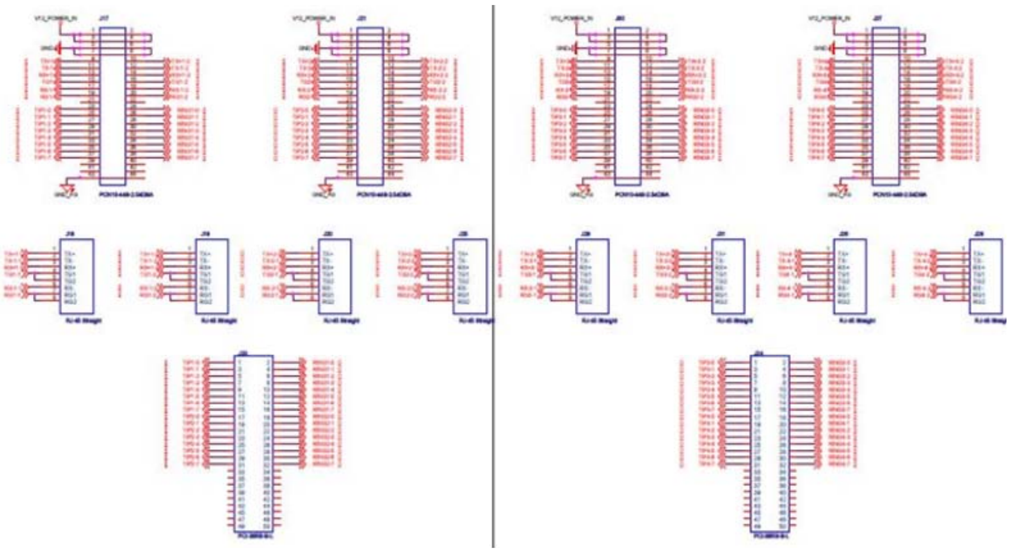

Fig. 7: A back panel diagram

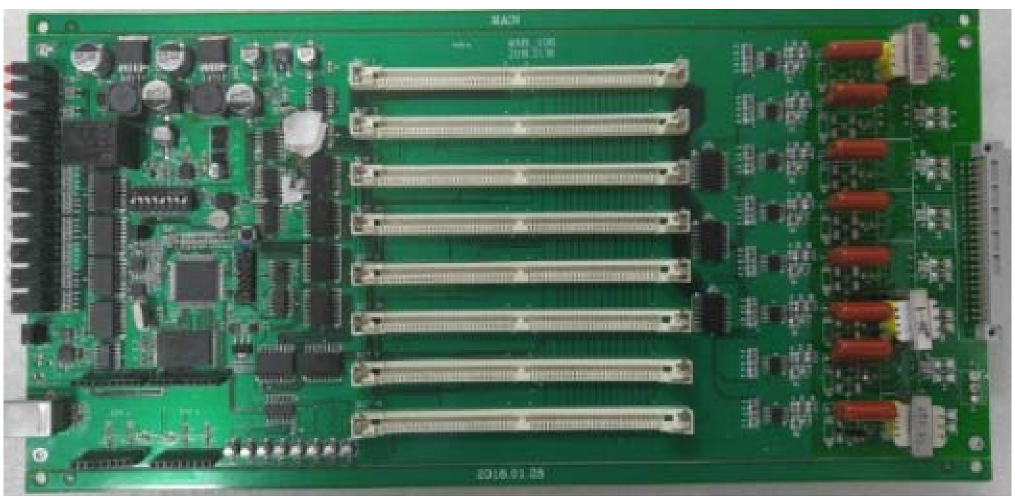

Fig. 8: The main board

Fig. 9: The DSP board

RESULTS AND DISCUSSION

To implement the proposed voice recording and control system with fault-tolerance, the developed main board is an analog voice recording board that processes in parallel which can be 8-channel integrated recording and hot swap for wired and wireless calls as shown in Fig. 8. It's MCU is 32 bit microcontroller based on EISC. One pair of the proposed DSP board in Fig. 9 and the ethernet circuit module are mounted on the slots of the main board and are hot swappable. As one example of various verifications to verify the AGC circuit module of the proposed DSP module as shown in Fig. 9, we carried out the performance tests through a number of debugging procedures. The debugging procedure of the AGC module is shown in Fig. 10.

Fig. 10: A debugging procedure of the AGC circuit module; ‘Transient amplification’ ‘Level reduction by resistance adjustment’ ‘Normal confirmation’

CONCLUSION

In this study, we designed and developed an advanced voice recording and controls system with fault-tolerant characteristics for high reliability, stability and efficiency. Because most failures of the existing systems occur on the voice recording module, the proposed system is possible to realize an uninterruptible service which is the main purpose of fault-tolerance since you can be easily replaced when any one circuit breaks down (Dubrova, 2013; Menychtas and Konstanteli, 2012).

As a result, the proposed system can achieve not only the reliability and stability of the voice recording and control for wired/wireless calls but also economic efficiency.

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