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ITJ

ISSN 1812-5638

INFORMATION TECHNOLOGY JOURNAL

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Information Technology Journal 11 (6): 686-698, 2012
ISSN 1812-5638 / DOI: 10.3923/itj.2012.686.698

A Development of a Web-based Remote Monitoring System in the Noise and Thermal of an Enclosed Air Compressor Room

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Abstract: Industrial noise occurring within an enclosed machine room can be harmful to workers. Additionally, because of inefficient ventilation systems, equipment will breakdown. In order to protect worker's hearing and to ensure that machines run safely, the development of a remote system to monitor noise and temperature levels in a machine room is necessary. Here, an air compressor room will be introduced. The web-based remote system for monitoring noise and temperature levels of a machine room will be established by using the embedded JavaScript, the HTML, the web control unit and the ADAM4118. The noise and temperature data in the machine room will be fed online to the remote PC via the web-based remote system. The user of the remote PC will monitor the status of the noise and temperature online. Both the warning light and video alarm at the remote's PC interface will be triggered when noise and temperature go beyond the preset thresholds. Moreover, the detected noise and temperature will be continuously recorded onto the web control unit. The historical data will be retrieved by the user when analysis of the historical event is required. The experimental results reveal that the noise and temperature of the machine room will be obtained and shown online on the interface of the remote PC.

Key words: Remote control, web-based monitoring, noise, temperature, web control unit

INTRODUCTION

As pointed out by the Occupational Safety and Health Act (OSHA), high noise levels can be harmful to workers and can lead to psychological and physiological ailments (Alnawafleh and Nizhibitsky, 2004; Ratnasingam *et al*., 2010; Mirhossaini and Pourzamani, 2008). Because of a reverberant sound propagating within an enclosed building, a noise monitoring system installed within an enclosed machine room becomes vital (Cheremisinoff and Cheremisinoff, 1977; Alley *et al*., 1989). To avoid noise exposure and to efficiently monitor the room's noise level, a remote noise monitoring system installed between the machine room and the control room is necessary. In the past decade noise monitoring stations using both modem and fibre-optical communications have been established in open fields such as industrial zones, parks and roads (van den Berg, 2005; Filipponi *et al*., 2008; Livshitz *et al*., 2004; Leong and Laortanakul, 2003). However, the assessment of an indoor noise monitoring system used for entrance control has been neglected. Moreover, to prevent the breakdown of a machine caused by an inefficient ventilation system, thermo monitoring within an enclosed machine room is compulsory (Li *et al*., 2002). In previous works Chiu (2010a, b) monitored the temperature online in both greenhouses and multi-functional aquariums using a PC-based control system constructed with a VB interface, a sever PC and a client PC via the RS232/RS485 protocol. Other researches also utilized the PC-based control system in individual fields (Lai *et al*., 2010; Liandong *et al*., 2004; Yu *et al*., 2007; Amien and Lin, 2007; Yu *et al*., 2008). However, the sever PC located inside the room is cumbersome.

In order to reduce the working volume at the sever PC, a compact web control unit is considered. Moreover, to improve the VB interface at the client PC, an interface using a web page embedded with JavaScript (Lou *et al*., 2003; Huang and Tseng, 2002; Mahdavi *et al*., 2008) is adopted. In this paper, a web-based temperature and sound monitoring system for an enclosed air compressor room shown in Fig. 1 is introduced. Here, the web-based interface is established using a web page embedded with

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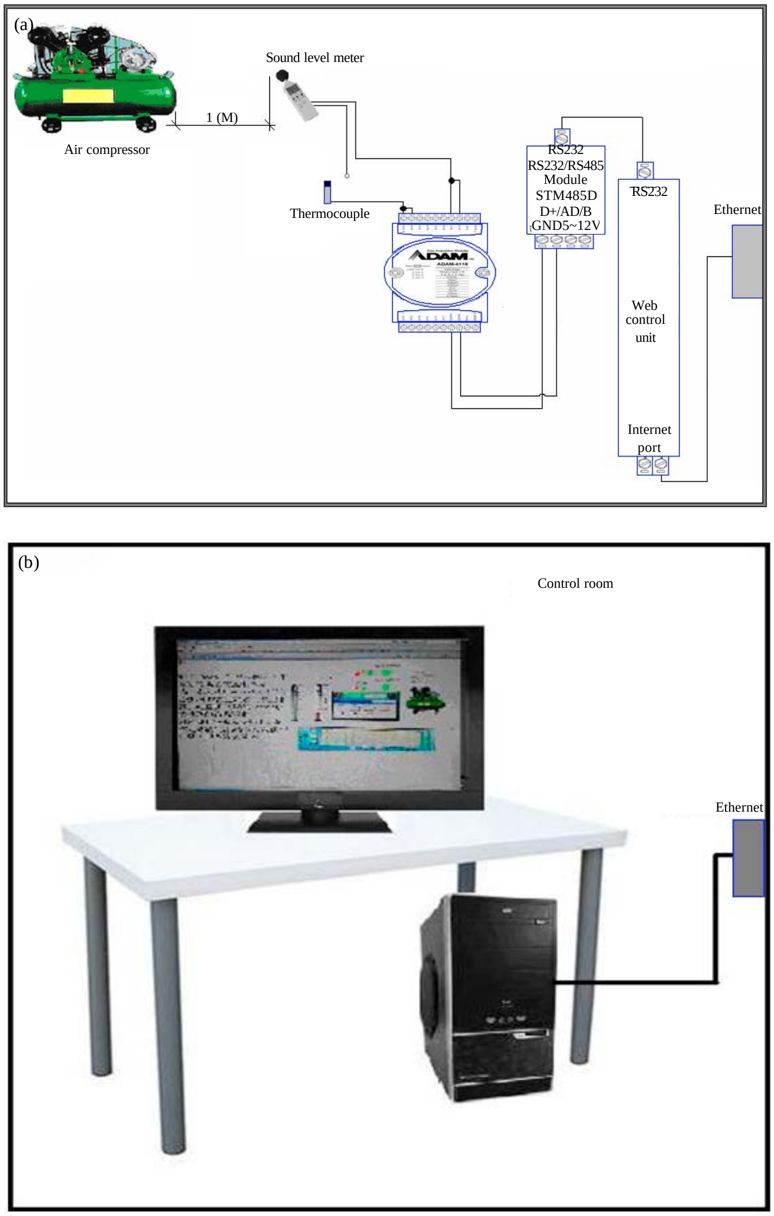


Fig. 1(a-b): Remote/near ports for the sound and thermal monitoring system within an air compressor room. (a) Air compressor room equipped with a sound level meter, a thermocouple and web control unit and (b) Remote PC (client PC)

JavaScript. A compact web control unit installed inside the air compressor room is linked with a sound level meter (Fig. 2) and a k-type thermocouple. The current and historical temperature and sound data will be remotely monitored. Therefore, the security of the system and the status of the worker's hearing can be assured.

A WEB-BASED SOUND AND TEMPERATURE MONITORING SYSTEM

An automation system used in industrial, agricultural and aquatic environments to reduce manpower is customary. As indicated in Fig. 1, to protect the hearing

Fig. 2: A multi-function sound-level-meter installed within an air compressor room

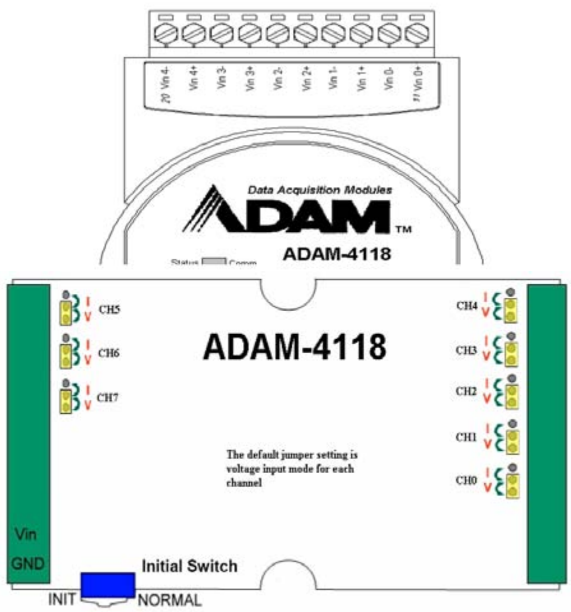


Fig. 3: An ADAM4118 module with eight channels

of workers and avoid overheating within the air compressor, a web-based interface is established using a web page embedded with Javascript. Here, an ADAM4118 module shown in Fig. 3 is inputted with analogue signals emitted from the sound level meter and the thermocouple. Because there is a serious decay of the signal for a RS232 protocol traveling over a long distance (fifteen meters), a new protocol (RS485) with a steady signal transmission is recommended. Therefore, the ADAM4118 that transforms analogue signals to digital signals will be used to forward the signals to the web control unit via the RS232/RS485 module. Also, the web control unit connected to the Ethernet will save the digital data and forward the data to the web page. The real-time data transmitted to the web page will be updated online. Moreover, a default setting of the web control unit will save the digital data in a Comma Separated Value (CSV) format every ten minutes.

As indicated in Fig. 4, the analogue signals received from the sound level meter and the thermocouple are transformed to digital signals by the AD converter within the ADAM4118 module. The digital data will be transmitted to the web control unit controller using a

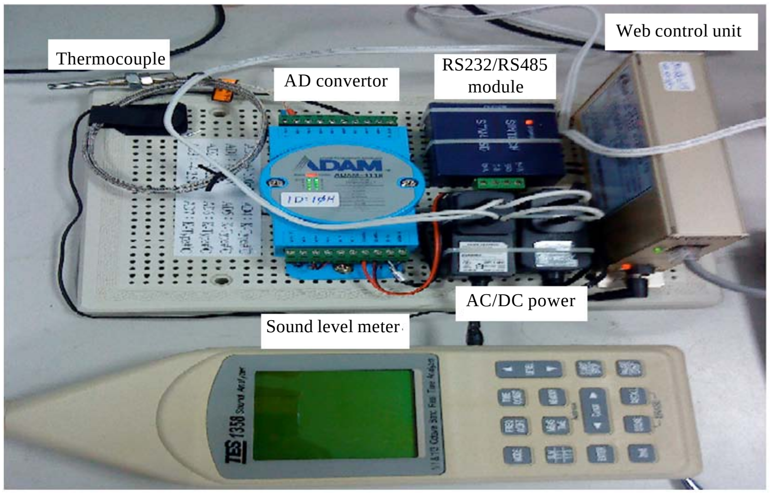


Fig. 4: Hardware for a web-base monitoring system

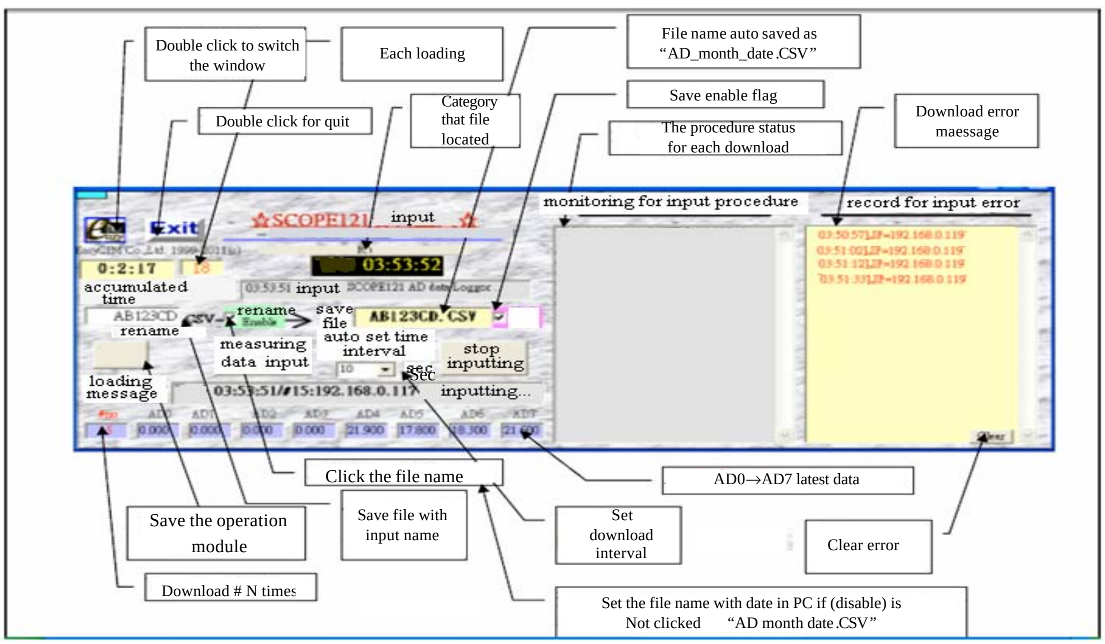


Fig. 5: The setting for the web page driver

RS485 protocol. Also, the data will be continuously saved on the web control unit in a CSV format. The related temperature and noise level will be dynamically monitored and displayed in the remote PC using a web page embedded with JavaScript. As indicated in Fig. 3, there are eight channels that are available to use sensors.

The web control unit can trigger the web page, demonstrate the profile elements and download the signal data via the File Transfer Protocol (FTP). The remote PC can be linked with the web control unit when both the PC and the web control unit have the same IP address. The setting for the web page driver is depicted in Fig. 5. The digital data of the sound and temperature will be periodically recorded on the web control unit with a default file-saving name from 1 to 31 (REC01.CSV to REC31.CSV 31). As

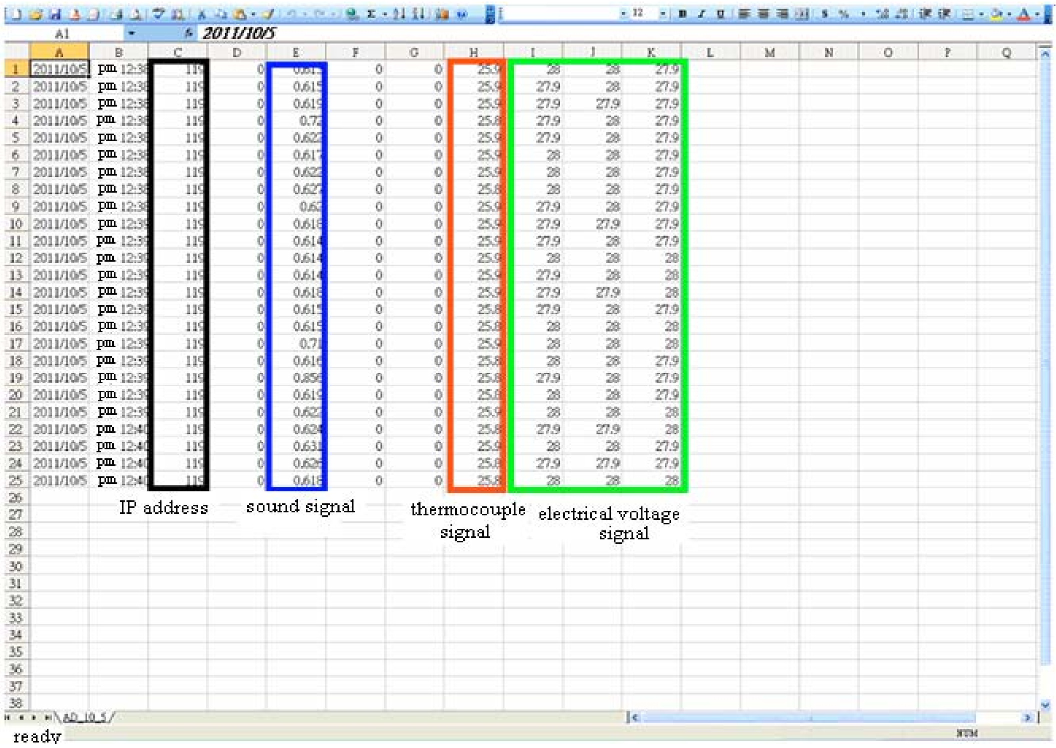


Fig. 6: The output excel file downloaded by the PC using the FTP protocol

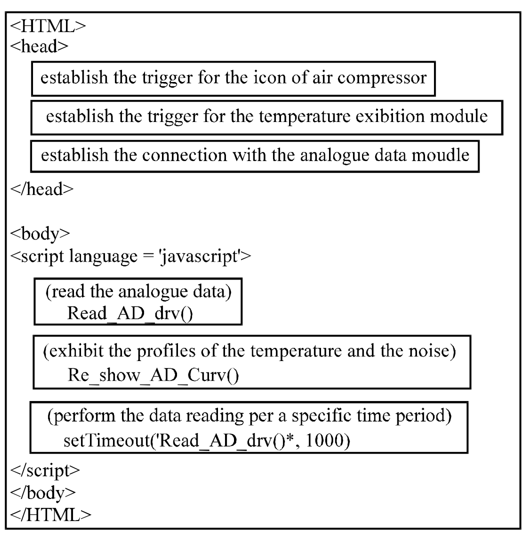


Fig. 7: The structure design of the HTML/JavaScript

indicated in Fig. 6, the data can be recalled by the FTP and shown in an excel file.

The structure design of the web page in HTML/JavaScript is shown in Fig. 7. The flow chart for the signal reading procedure within an embedded web page is depicted in Fig. 8.

As indicated in Fig. 9, the monitoring interface for sound and temperature transmitted from an air compressor

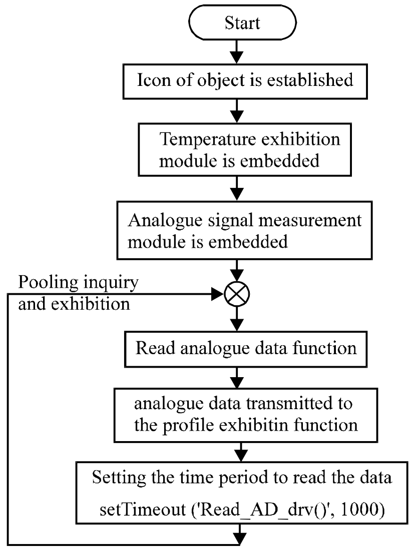


Fig. 8: Flow chart for the signal reading procedure within an embedded web page

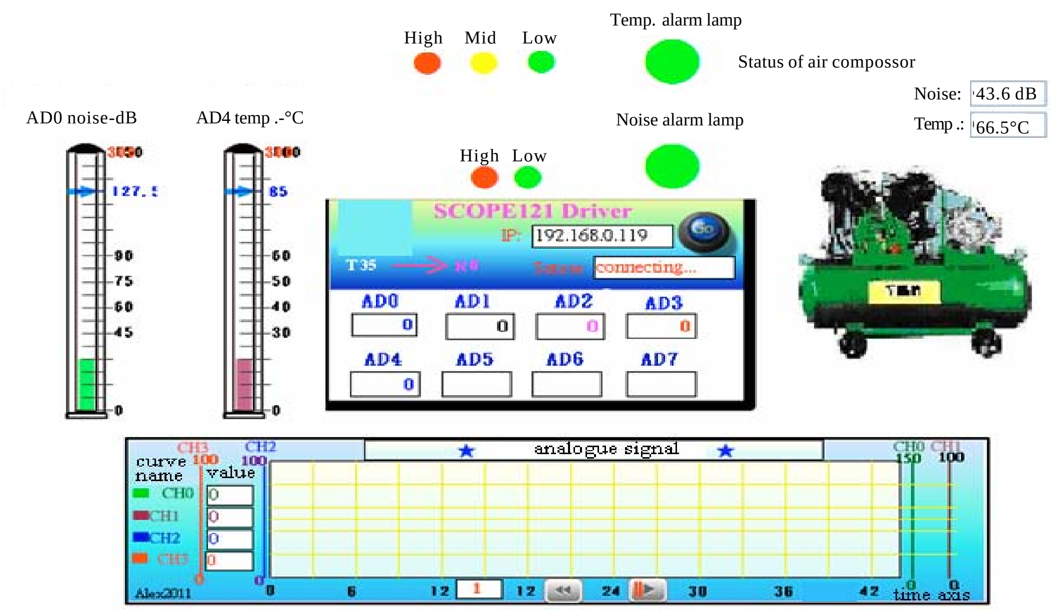


Fig. 9: The monitoring interface for sound and temperature transmitted from an air compressor room (at the beginning of the web page without being triggered)

room can be plotted using a time trend diagram. Various lights and alarms will be triggered when either the sound or the temperature is in an abnormal condition (i.e., beyond the specified limit).

RESULTS AND DISCUSSION

Results: A prototype of the web-based remote sound and temperature monitoring system is established and shown in Fig. 10. The wire connections of the module in the near port of web-based sound and temperature monitoring system are depicted in Fig. 11. On the basis of the Occupational Safety and Health Act (OSHA), the threshold of the sound level is preset at 85 dB. The safety temperature of the air compressor room is preset at 26°C and below. The danger level for temperature in the air compressor room is preset at 30°C and above. The algorithm of sound and temperature in JavaScript is

Fig. 10: A prototype in the remote port of the web-based sound and temperature monitoring system

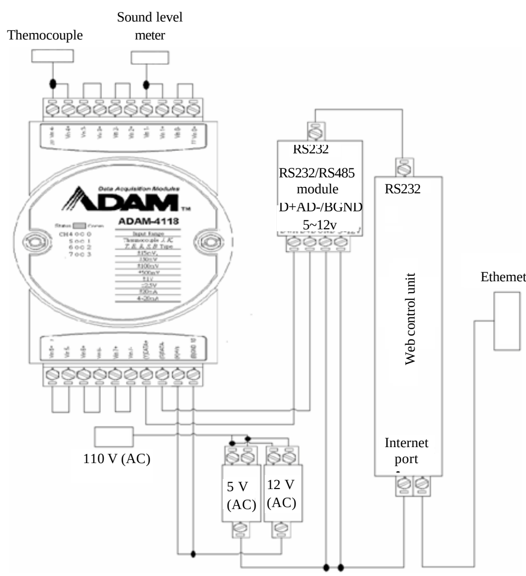


Fig. 11: The wire connections of the module in the near port of the web-based sound and temperature monitoring system

shown in Fig. 12. Here, the sound signal's green light will light up when the sound level is 85 dB and below. The sound signal's red light will light up and its alarm will be triggered when the sound level is 85 dB and above. Similarly, the temperature's green light will light up when the temperature is 26°C and below. Also, the temperature's yellow light will light up and its warning alarm will be triggered when the temperature is within 26-30°C. Moreover, the temperature's red light will light up and its emergent alarm will be triggered when the temperature is 30°C and above. The plan for the light and alarm of the sound and temperature monitoring system is shown in Table 1.

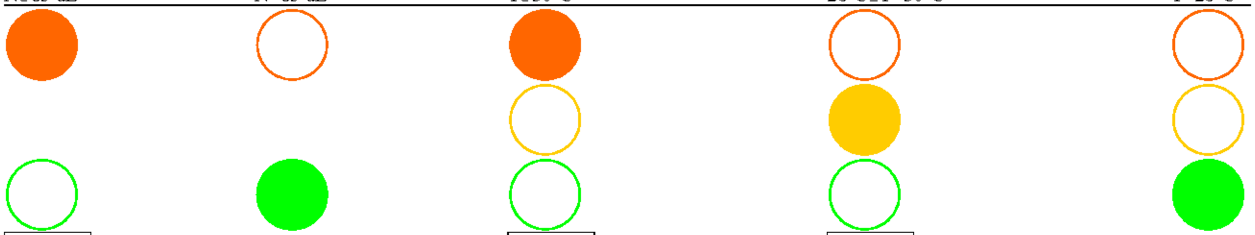
Discussion: Six kinds of case studies used to verify the monitoring performance are investigated and shown below:

- **Case I:** $N \leq 85$ dB and $T \leq 26°C$

The resulting monitoring interface is shown in Fig. 13. As indicated in Fig. 13, the current sound level and temperature are 80.3 dB and 23.2°C, respectively. Therefore, both the status of the sound and temperature are in the green light. They are in a safe condition.

- **Case II:** 85 $dB < N$ and $T \leq 26°C$

Table 1: The plan for the light and alarm of the sound and temperature monitoring system

Noise level (N)		Temperature (T)		
N≥85 dB	N<85 dB	T≥30°C	26°C≤T<30°C	T<26°C
				
Alarm		Alarm	Alarm	

```
function Read_AD_drv()
{
//
AD_CH0=document.AD_LIB.GetVariable("AD0");
AD_CH1=document.AD_LIB.GetVariable("AD1");
AD_CH2=document.AD_LIB.GetVariable("AD2");
AD_CH3=document.AD_LIB.GetVariable("AD3");
AD_CH4=document.AD_LIB.GetVariable("AD4");
AD_CH5=document.AD_LIB.GetVariable("AD5");
AD_CH6=document.AD_LIB.GetVariable("AD6");
AD_CH7=document.AD_LIB.GetVariable("AD7");

AD_V1=parseInt(AD_CH1*1000)/10;
AD_V4=parseInt(AD_CH4*10)/10;
AD_V10 = AD_V1; //

D_vol.value=AD_V1+'dB';
D_amp.value=AD_V4+'C';

if (AD_V4>=30 & AD_V1>=85)
  {
  document.all['LED'].style.color='#FF0000';
  document.all['LCD'].style.color='#FF0000';
  mySND.src ='ding.wav';
  }
else if (AD_V4>=30 & AD_V1<85)
  {
  document.all['LED'].style.color='#FF0000';
  document.all['LCD'].style.color='#00FF00';
  mySND.src ='ding.wav';
  }
else if (AD_V4>=26 & AD_V1>=85)
  {
  document.all['LED'].style.color='#FFFF00';
  document.all['LCD'].style.color='#FF0000';
  mySND.src ='ringout.wav';
  }
else if (AD_V4>=26 & AD_V1<85)
  {
  document.all['LED'].style.color='#FFFF00';
  document.all['LCD'].style.color='#00FF00';
  mySND.src ='ringout.wav';
  }
else if(AD_V4<26 & AD_V1>=85)
  {
  document.all['LED'].style.color='#00FF00';
  document.all['LCD'].style.color='#FF0000';
  }
else
  {
  document.all['LED'].style.color='#00FF00';
  document.all['LCD'].style.color='#00FF00';
  }
```

Fig. 12: The algorithm of the sound and temperature in JavaScript

The resulting monitoring interface is shown in Fig. 14. As indicated in Fig. 14, the current sound level and temperature are 95.1 dB and 25.4°C, respectively. Therefore, sound and temperature are in the red and green light. Simultaneously, the sound alarm in the remote PC will be triggered.

- **Case III:** N≤85 dB and 26°C<T≤30°C

The resulting monitoring interface is shown in Fig. 15. As indicated in Fig. 15, the current sound level and temperature are 67.5 dB and 27.1°C, respectively. Therefore, sound and temperature are in

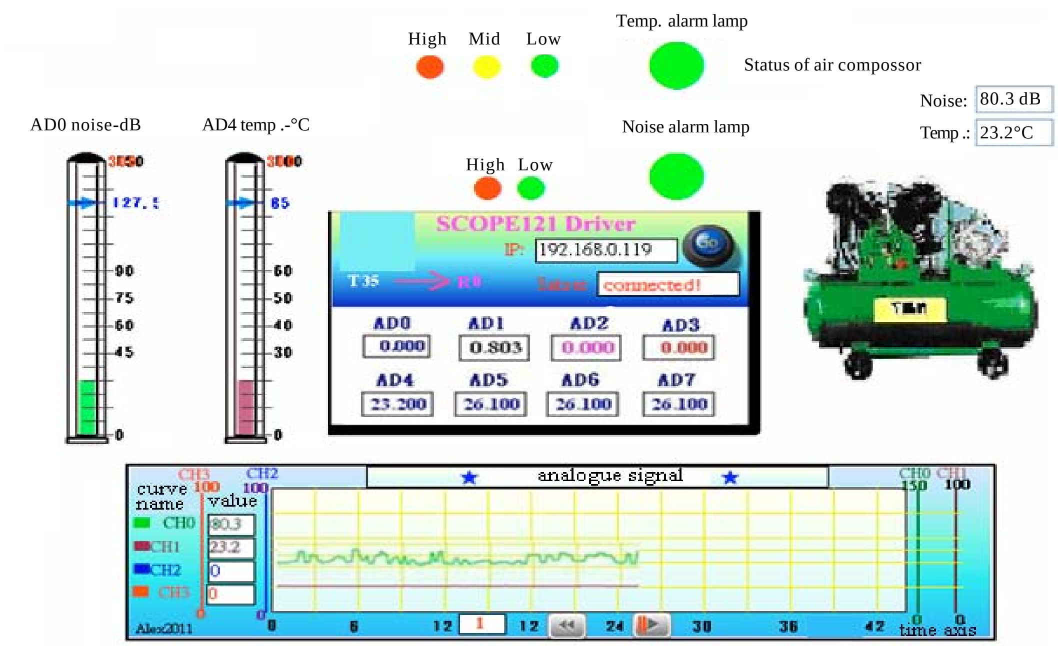


Fig. 13: Remote monitoring interface (Case I)

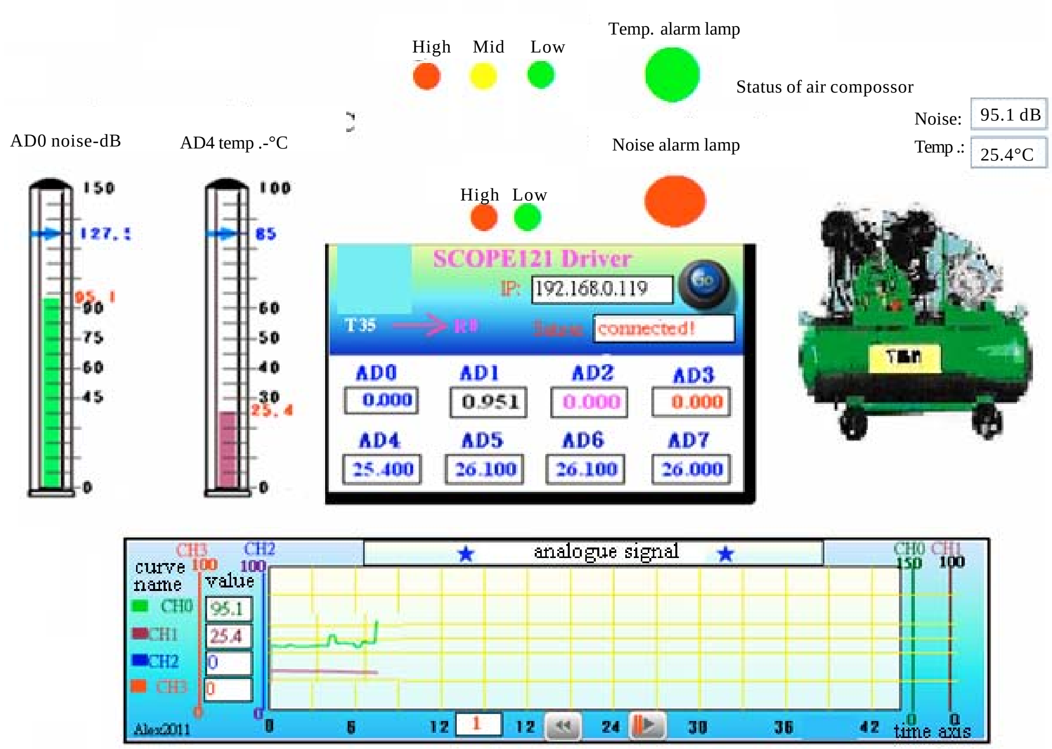


Fig. 14: Remote monitoring interface (Case II)

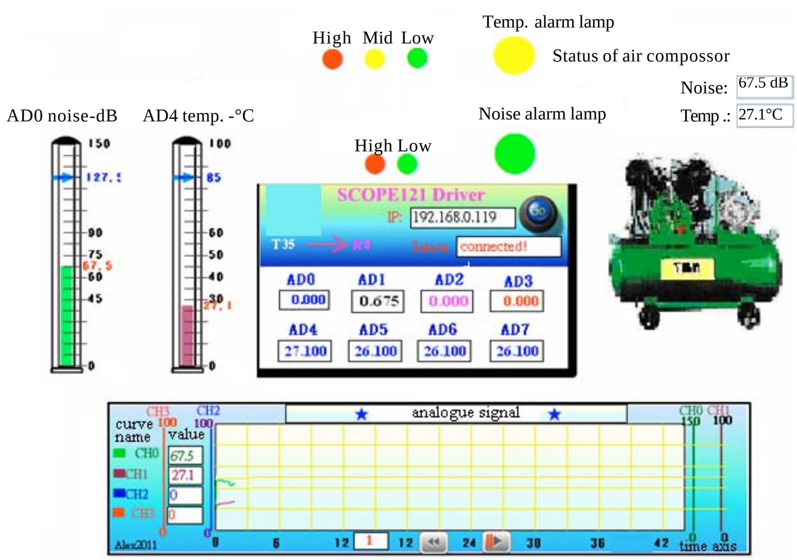


Fig. 15: Remote monitoring interface (Case III)

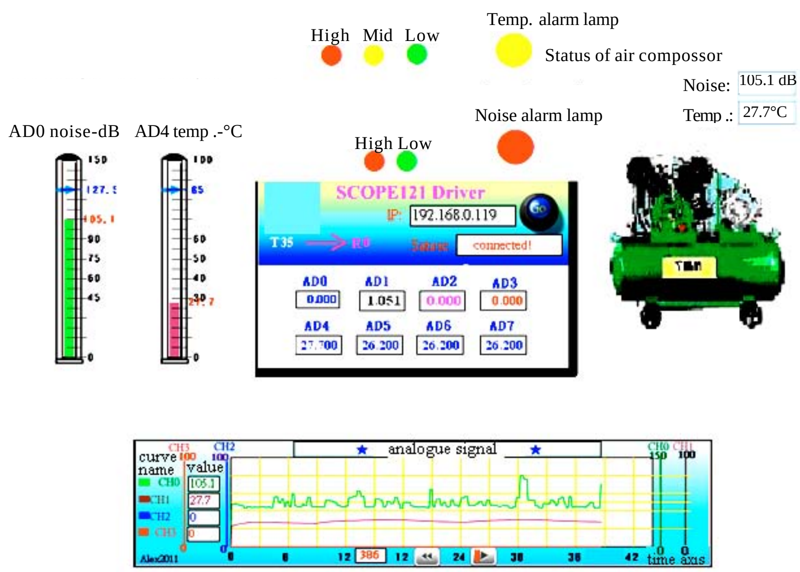


Fig. 16: Remote monitoring interface (Case IV)

the green and yellow light. Also, the temperature's pre-alarm in the remote PC will be triggered.

- **Case IV:** 85 dB<N and 26°C<T≤30°C

The resulting monitoring interface is shown in Fig. 16. As indicated in Fig. 16, current sound level and temperature are 105.1 dB and 27.7°C, respectively. Therefore, the sound and temperature are in the red and yellow light. Also, the sound alarm and the temperature's pre-alarm in the remote PC will be triggered simultaneously.

- **Case V:** N≤85 dB and 30°C<T

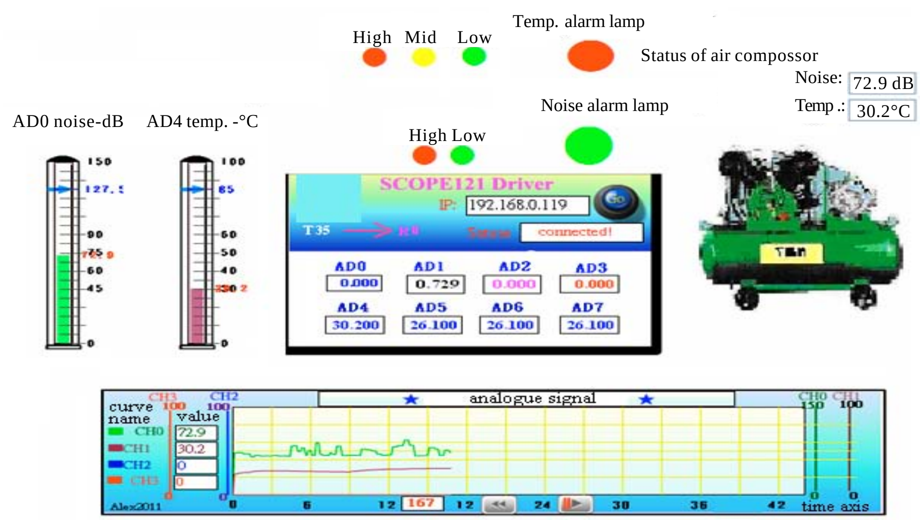


Fig. 17: Remote monitoring interface (Case V)

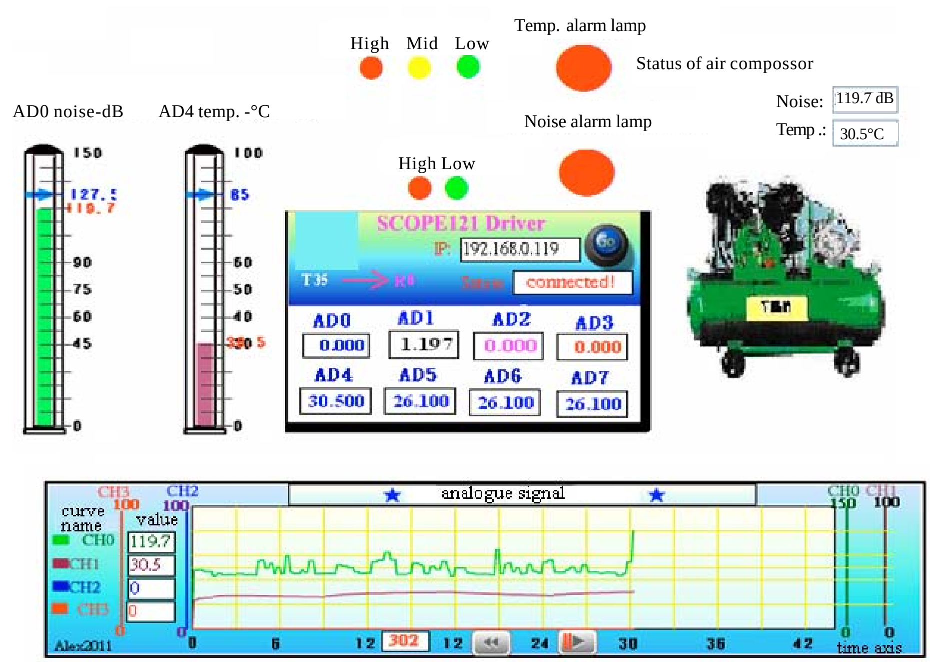


Fig. 18: Remote monitoring interface (Case VI)

The resulting monitoring interface is shown in Fig. 17. As indicated in Fig. 17, current sound level and temperature are 72.9 dB and 30.2°C, respectively. Therefore, the sound and temperature are in the green and red light. Also, the temperature's alarm in the remote PC will be triggered.

- **Case VI:** 85 dB<N and 30°C<T

The resulting monitoring interface is shown in Fig. 18. As indicated in Fig. 18, the current sound level and temperature are 119.7 dB and 30.5°C, respectively. Therefore, the sound and temperature's lights are in the red. Also, the sound and temperature's alarms in the remote PC will be triggered simultaneously.

CONCLUSION

It has been shown that a remote sound and temperature monitoring system for protecting workers' hearing and maintaining machine safety is necessary. Concerning the dynamic profiles of sound and temperature exhibited in the remote PC, a web-based remote monitoring system using an embedded JavaScript, the HTML, a web control unit and the ADAM4118 is used. The noise and temperature in a machine room will be feedback online from the near port of the web control unit to the remote PC via the Ethernet network. Here, an ADAM4118 module is inputted with analogue signals emitted from the sound level meter and the thermocouple. To avoid the decay of the signal when using a RS232 protocol in data transmission, a RS232/RS485 module used to transform a protocol from a RS232 to RS485 is adopted. Moreover, the dynamic digital data will be used by the HTML program to exhibit the data on the web page. Both the warning light and video alarm at the remote PC's interface will be triggered when the noise and temperature are beyond the preset thresholds. The historical data will be retrieved by the user when the analysis of the historical event is required.

Consequently, the experimental results reveal that the noise and temperature of the air compressor room will be efficiently monitored and exhibited online on the interface of the remote PC.

ACKNOWLEDGMENTS

The authors acknowledge the financial support of the Project (CCUT-AI-100-MA01).

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