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Internet Controlled Gas-Mixing System

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Summary

In this work a gas mixing bench controlled by Internet is presented. The mixing system is controlled by a GNU/Linux server with software developed specially for this application. The control software allows the selection of gas type, mixture concentration, mixing times and valves configuration. Remote programming and monitoring can be done from any terminal connected to the Internet. The server have secure and encrypted connections for each control terminal avoiding possible external attacks.

Keywords: gas, mixing, GNU, Linux, Internet, automation
Subject category: G (sensor systems)

Introduction

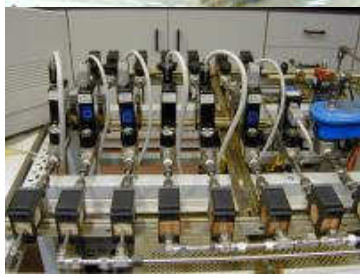
The generation of stable and reproducible gas mixtures is extremely important for the characterization and the comprehensive understanding of the conduction mechanisms of solid state gas sensors. Suitable techniques to produce low concentration mixtures of gases involve dynamic methods.

The mixing system is constituted by:

- Gas flow unit equipped with 7 mass flow controllers (MFC), valves, solenoid valves, pipelines and a sensors test chamber.
- Remote control and measurement interface.
- Server software running on a GNU/Linux operating system.
- Terminal user control software.

Gas flow unit

The gas pipelines connect the gas tubes to seven MFCs. The system has manual valves and solenoid valves to configure the different gas circuits. The gas mixing ends in a chamber for gas sensor testing and calibration.



Remote control and measurement interface

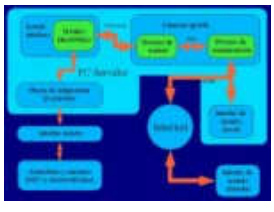
The remote interface drives the MFCs and the solenoid valves of the gas flow unit. It is connected between the server machine and the MFCs . This unit have:

- Mode selection (local or remote mode)
- Manual control for the MFCs (local mode).
- Manual control for the solenoid valves.
- Gas flow indication (front pannel LCD).
- Computer interface for remote mode.
- Independant regulated power supply for each MFC.

In remote mode, analog and digital signals from the computer (server machine) have total control over the MFCs and the solenoid valves.

Server machine

The server is a 486DX33 with 8 Mb of RAM, digital and analog I/O (Keithley DAS1600) and Ethernet network interface. The analog outputs of the DAS1600 are used to control the setpoint of seven MFCs.



The analog inputs read the gas flow of each MFC using an A/D with a resolution of 12 bits. This server is also connected to the local area network (LAN) with an Ethernet card.

A kernel module was specially designed to perform low level communication with two analog and digital I/O boards.

Kernel module

This part of the program works as a kernel module that can be plugged in the kernel space. The module can be inserted to or removed from the kernel at any time.

As it runs in the kernel space the module have access to all the low level resources found in the machine, in this particular case the module handles the I/O boards.

To communicate with the user space, where the server software is running, some special kind of files called devices are used. The server sofware excahnges information with the kernel module using the IOCTL mechanism.

The control software (client-server)

The control software was created using a client-server model. The server software runs on the server machine connected directly to the mixing bench. The client software establish communication with the server for batch programming and process monitoring.

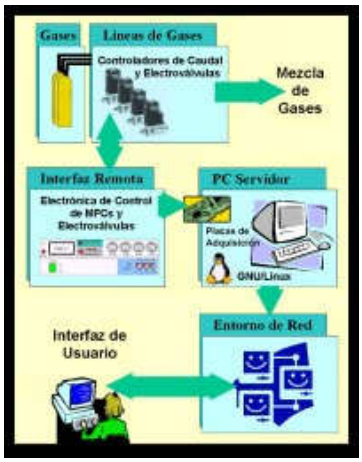
Server software

The server side uses a Debian GNU/Linux operating system and runs as a UNIX daemon started at boot time. This program executes the control process dedicated to control the remote interface, and the communication process to receive the user commands from the TCP/IP network and transfers them to the control process. Both processes communicate using pipes, the interprocess communication mechanism most commonly used in UNIX. If the communication gets stalled the control process doesn't stop and hence the programmed steps keeps working. This architecture makes the software much more robust.

User control software (client)

The client (user software) have the following features:

- Selection of gas type
- Selection of mixture concentration
- Selection of mixing times
- Solenoid valves configuration
- Colored text windows, menus and mouse facilities
- Run in UNIX systems (GNU/Linux) or in DOS compatible operating systems (Windows, OS/2, etc.).
- The client can run on any authorized host from Internet including the server machine itself.



Security

In order to increase the security of this gas mixing system a secure shell (SSH) utility was used. The SSH application validates users and establishes connections through the network. It usually uses the RSA mechanism for validation and DES

for encryption.

Conclusion

The GNU/Linux operating system has proven to be an effective tool for laboratory automation. The system developed was designed to program and monitor gas mixing from any terminal connected to Internet in a secure and reliable way.

Download

Presentation of the project at the "2das Jornadas Regionales de Software Libre" event, Montevideo, Uruguay (spanish version only):
Open Document
JPEG images: 1 2 3 4 5 6 7 8 9 10 11 12 13 14

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Laura Malatto and Liliana Fraigi in a poster session

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