

# Study on a Hazardous Environment Monitoring and Control using Virtual Instrumentation

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**Abstract** This paper proposes a hazardous environment monitoring and control for monitoring information concerning safety and security, utilizing Wireless Sensor Network (WSN) technology. The proposed hazardous environment monitoring and control collects industrial environmental safety and security information from both inside and outside industry environment through WSN-based sensors, collects image information through vision system, and collects location information through wireless radio modules. This collected information is converted into a database through the Virtual Environment Monitoring Server consisting of a sensor manager, image information manager and wireless radio manager. The sensor manager manages information collected from the WSN sensors, the image information manager manages image information collected from vision system and the wireless radio manager processes the location information of the hazardous environment. In addition, a power supply based on solar cell and battery back-up is implemented with the central control unit so that it could also be used in environments with insufficient power infrastructure. Immediately after the occurrence of accident, the Accident Data Recorder (ADR) automatically logs the wireless sensors and vision system data for the legal verification and judicial purpose. This data can be used as a First Information Report (FIR) for accident damage investigation and estimation. And it could be expected that the usage of such a system could contribute to increasing safety and security.

**Keywords:** Accident Data Recorder (ADR), First Information Report (FIR), Virtual Instrumentation, vision system, wireless sensor network

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## 1. Introduction

In recent years, keeping pace with most of the industrialized accident that occur in hazardous environment due to which the consequences may be very serious and generally cause damage to life, property and environment. Hazardous environmental safety and security can be most important for moral, legal, and financial reasons.

All organizations have the duty to care and ensure the safety and security of the employees and the environment. This paper has also enlisted several short-term and long-term measures which if implemented by Government and other organization will help in improving safety & security of industrial & commercial environment.

Using Virtual Instrumentation (NI Lab VIEW) software and NI data acquisition (DAQ) hardware to setup a system to capture the hazardous data, recording and transmitting the accident information in real time for data logging at a remote location.

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Lab VIEW is an integral part of virtual instrumentation software because it provides an easy-to-use application development environment designed specifically with the needs of engineers and scientists in mind. Lab VIEW offers powerful features that make is easy to connect to a wide variety of hardware and other software. One of the most powerful features that lab VIEW offers engineers and a scientist is its graphical programming environment. With Lab VIEW, one can design custom virtual instruments by creating a graphical user interface on the computer screen through which one Operate the instrumentation program Control selected hardware Analyze acquired data Display.

## 2. System Configuration

The system's block diagram, which clearly includes three basic scenarios:

## 2.1. Measurement Station

The hazardous location where the hazardous parameter measurement process is performed is called a measurement station. It contains sensors, the signal conditioning circuits, a data-acquisition board, and a computer running a communications program, called measurement server.

The measurement station is the location where the Hazardous parameters are measured and sent to the control centre. It consists of the following stages (see Figure 1):

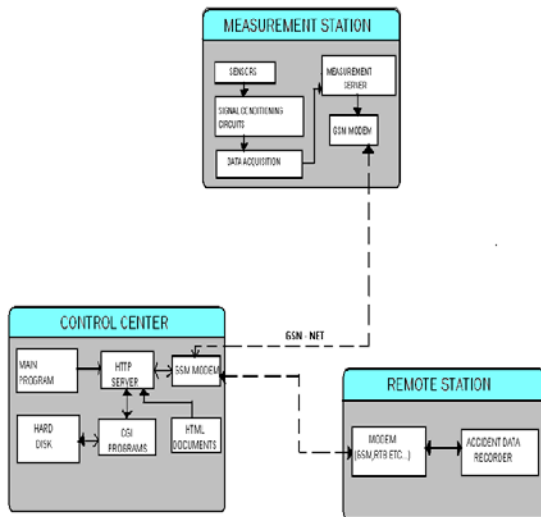


Figure 1. Block diagram of system configuration

### 2.1.1. Sensors

The wireless sensor network (WSN) platform delivers battery-powered nodes that offer industrial certifications, reliable networking protocols, and optional outdoor enclosures for long-term, stand-alone deployments. With the Lab VIEW WSN Module, you can integrate Lab VIEW code directly into the nodes to add algorithms and intelligence.

### 2.1.2. Signal Conditioning Circuits

It consists of five electronic circuits (one for each measured parameter), which adapt the output signal of each sensor to be easily processed by the rest of the system. Software temperature correction is used, reducing the cost and dimensions of circuitry.

### 2.1.3. Data Acquisition

The NI Wi-Fi data acquisition (DAQ) devices use IEEE 802.11 to stream continuous waveform data over a wireless network. Because IEEE 802.11 uses over-the-air RF signals as its physical transmission medium, it offers unique security challenges beyond those of a wired system. NI Wi-Fi DAQ supports the highest commercially available security, IEEE 802.11i, for effective protection of wireless data transmissions, a Wi-Fi network must have a strong encryption algorithm (cipher) and some form of key management.

### 2.1.4. Measurement Server

A server program is created to send the measurements to the control center, where the corresponding client program (called measurement client) is located. When a request arrives, the server sends the measurements to the control center, expressed in convenient units. The protocol used for communications is based on TCP / IP protocol, which is the base of Internet developments.

### 2.1.5. GSM Modem

The communications hardware can be flexibly selected: RTB modem, LAN boards, etc. A RTB modem is useful if the measurement station is located near a telephone line. Otherwise, using a LAN board or GSM modem could be the best choice. The software has been developed using the National Instruments Lab VIEW environment. That package aids the development of virtual instruments, executable within several types of computers and operating systems without changes in the source code. Any virtual instrument is completely designed graphically (via diagram blocks), using a programming language called G.

### 2.1.6. Control Center

It contains a computer, running an application called “main program”. That program basically presents the values of measured parameters using charts, needle indicators and tables, also performing other data processing, storage, and Internet-related tasks. The computer also gives support to remote access across the Internet, through the other software components integrated in the control center.

The control center is the location where the measurements are first stored, processed, and shown. The tasks are performed by a virtual instrument called “main program”. In a second scenario, the control center gives support to remote access across the Internet, using other software components installed on the computer.

### 2.1.7. Alarm Notification

When one or more measured variables take anomalous values, the main program attracts the attention of the user with sounds and on-screen warning.

### 2.1.8. Measurement and Alarm Storage

The measured values are stored on user-selected historical files, allowing future processing of data with other analysis software. These files are also used for the dynamic on-line generation of HTML reports, visible through a Web browser. Historical files with alarm events are also generated and used in Web reports.

Automatic transfer of daily reports to a remote machine: Automatic alarm notification via e-mail: When an alarm warning is triggered, the main program sends an e-mail message to a list of recipients. The body contains information about the event (rest of measurements, date, and time, list of anomalous variables, etc.).

### 2.1.9. CGI Programs

These are server-side applications, enabled to communicate with the HTTP server through environment variables. When one of those programs ends, the result is returned to the client, in the form of an HTML document.

The system includes two CGI programs, dedicated to the Web report generation and remote user validation.

The computer installed in the control center must be connected to the Internet in order to allow the access of remote stations. Once again, the communications hardware can be flexibly selected. The selection depends on several factors (LAN and proxy server availability, telephone line accessibility, etc.).

## 2.2. Remote Stations

Each of them only consists of a computer, which has a Web browser installed. The Web browser provides the user-interface needed to obtain real time information about the water state. Setting up a remote station is an easy and inexpensive task. It only requires a Web browser (e.g. Netscape Navi-gator) installed on a computer, which must be correctly connected to the Internet. A typical implementation is a mobile station, based on a laptop computer and a GSM modem. The remote user connection starts by typing the control center's URL in the Web browser. Then, an authentication page is shown, requesting a valid login and password.

Real time monitoring of the main program's panels: The control center's panels can be tracked in real time using the Web browser. A variety of panels can be monitored: individual and global charts, indicators, alarms, etc.

In the remote station multichannel PC-based data loggers provide multiple channels of temperature, Gas leakage, pressure, Smoke and fire measurements. They are available in several different form factors and include data-logging software. They can also be programmed with custom functionality using NI Lab VIEW software.

Wireless data loggers extend measurement capabilities to applications where cables are inconvenient or impractical. Wireless technology can dramatically reduce costs by eliminating cables and installation time.

## 3. System Implementation

An important part of the system is represented by software development. Software development is based on:

- Data acquisition and conditioning;
- Data storage and retrieval;
- Remote access by web application;
- Simulation models.

The implementation of this software package is conceived as follows:

### 3.1. Hazardous Workstation DAQ and Conditioning System

The hazardous workstation DAQ and conditioning system is implemented by DAQ board and a software application developed in industrial environment. The application sends the data to a database or to the web application if an experimenter requests that. Data flow diagram of this module.

### 3.2. Data Storage and Retrieval

The discontinuous availability of primary emerging source data for experiments requires data storage. By

using data storage module the data can be studied on various periods of time. The main data source is the DAQ module and the beneficiaries are the database and web application.

### 3.3. Remote Access by Web Application

The access to the virtual laboratory is allowed with username and password identification. Once the user is logged-in, it can perform a new experiment or an existing one. In case of a new experiment, the hazardous workstation users have to make a system reservation. The actual modules don't allow a simultaneous access for more users. In the future, it is intended a development of a system which allows parallel experiments by multiplexing user access using a faster DAQ architecture.

### 3.4. Simulation Models

The simulation of hazardous monitoring and control system requires complex block diagram models implemented and validated in a convenient way with Lab VIEW. The advantage of implementation is an easy way to simulate and validate existing and new models.

With technological advances, the control in hazardous parameters evolves and includes new and sophisticated methods based on different control programs and systems. In this paper we use Lab VIEW program, and wireless control to control the different systems in the hazardous domain model. The control of the hazardous industries is divided into two different types of control as shown in Lab VIEW setup.

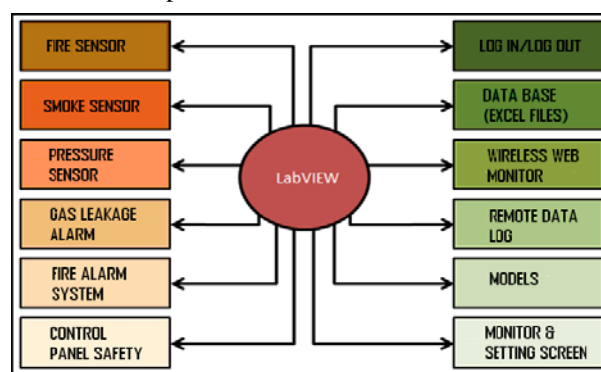


Figure 2. Lab VIEW setup

### 3.5. Lab VIEW Control

The Lab VIEW software will control the Wireless Sensor module (Fire gas leakage, Pressure and smoke sensors), fire and burglar alarm, and temperature Systems in the control panel, on the other side managing user, data base, wireless web monitoring, data logging and monitor setting.

The Lab VIEW interfacing with hazardous monitoring and control system consists of two main parts:

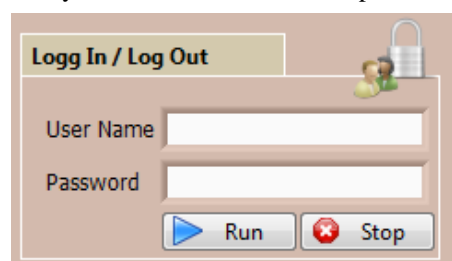


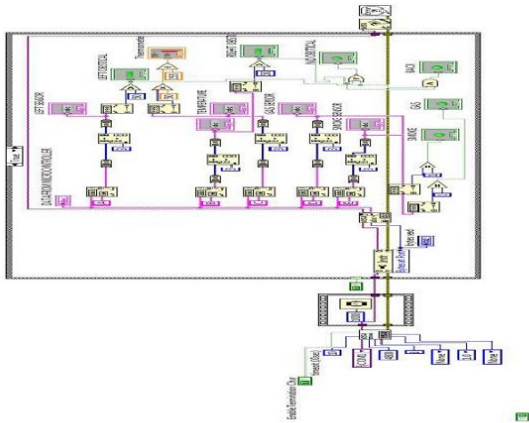
Figure 3. Log In / Log Out In Lab VIEW

### 3.5.1. Monitor Screen

Monitor screen is designed using Lab VIEW allows monitoring to all parameters of hazardous area that connected with Lab VIEW via Data Acquisition Card and It has two login; one for monitor access and the other for setting access.

### 3.5.2. Web Connection

It allows monitoring and controlling the Lab VIEW software Program via internet from anywhere in the world.



**Figure 4.** Virtual Instrumentation Software Control

One benefit of graphical system design (Lab VIEW) over other development environments is the extensive support for accessing instrumentation hardware. Drivers and abstraction layers for many different types of instruments and buses are included or are available for inclusion. These present themselves as graphical nodes. The abstraction layers offer standard software interfaces to communicate with hardware devices. The provided driver interfaces save program development time. Provides platform independent hardware access to numerous data acquisition and instrumentation devices.

Reduce system setup time, measure in minutes, synchronize and log measurements with ease, and never start from scratch with the templates and example programs. With NI hardware and software we can focus on solving problems and spend less time worrying about configuration, calibration, and debugging. Because of that we can reduce more 50% compare to other traditional method.

The following National Instruments products used our applications.

Software – Lab VIEW 8.5.

Hardware – Wireless Sensor Module and DAQ board.

## 4. Conclusion

In this research paper a virtual instrumentation based hazardous environment monitoring and control system to monitor the changes in surrounding, helping in preventing the accident of fire, gas and smoke by notifying us the accident data recorder. In this paper The results illustrate that the proposed Virtual Instrumentation based intelligent monitoring and control system provide continuous unmanned monitoring of Gas leakages, sudden changes of temperature, obstacle avoidance etc, and also “Accident Data Recorder “(ADR) will help to avoid further accident in future and this is the first digital based first information report for legal action for proceeding investigation as well as claiming the insurance.

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