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Design and Implementation of Structural Health Monitoring Based on IOT Using Lab VIEW

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Abstract:

Structural Health Monitoring (SHM) has become an essential tool for implementation of safety measures and maintainability of critical structures. In this work, we have proposed a virtual instrumentto monitor the health of a structureacross TCP/IP connection applying virtual instrumentation, LabVIEW. A web server is a program thatuses HTTP to serve the files that constitute webpage for clients, in ripostethe client requests. The server system which is an IoT freeware platform is connected to the internet so that the structure can be monitored from remote places, the client system which run on LabVIEW platform is also bridged to theaforementioned internet. An efficient hardware module is connected to the structure which can be interface to LABVIEW environment to provide the sensory information.Instead of establishing the connection to the server using broadband ISP services, we are using GPRS module so that the system has higher throughput and is also cost efficient. In this system LABVIEW software provides high precision and flexibility.

Index Terms:

LabVIEW, Microcontroller, TCP/IP, Web server, HTTP, IoT.

I. INTRODUCTION:

A lot of mechanical machines have been in use since a long time. Replacing these machines with new ones will prove to be very costly and complicated affair. Unless necessary, people will not want to opt for the replacement as it will bring the work to standstill. So it is essential to have a system in order to monitor the system. A web server in the system provides access to the other supervisors for the device through a device web page. The web technology is changing the ways how Instrumentation and Control Process is designed.

The data can be exchanged among the computers which are longer distances through the web server connected to the global Web. This feature facility provides us to transmit the data to the largerextent. For accessing the data from the remote location computers, need a web server. This will store the database of the sensory information. Engineers from the remote location using the IP address will be access the information. The user can request a particular web page from the web server. The clients through the network can access the web page and estimate the health of the structure. LabVIEW front panel is designed for user interface to display the waveforms of measured physical quantitiesusing microcontroller based circuit from serial port, that is connected to embedded board and displays the waveform on waveform chart. It has a knob for configuring the number of measurements per average to be uploaded on web server, a control for selecting the measurement type, a digital indicator to display the result, and a stop button. A graph has also been used to display the waveform.

An elaborate front panel can be created easily understood to serve as the GUI for the application. The Virtual Instrument created in LABVIEW offers more flexibility for dynamic user requirements and a range of sensory information to be acquired and also user can monitor number of sensory information from the structure or choose any function to handle the parameters to run the system automatically and avoid human interferences.This paper is arranged as follows: Section II is the related work about web server. Section III will describe thesystem architecture. Section IV we will introduce the software implementation. In Section V presents the results and discussion and Section VI is about the conclusion and future work.

II. RELATED WORK:

This workrepresents the multi-client-single-server architecture based on GPRS connectivity which can be used as a real time IoT for possible applications in structural

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health monitoring, this system describes hardware design based on a GPRS connection was designed using user datagram protocols as the communication procedure [1]. With the development of internet and the coming of the IoT era, the Virtual Instruments field and IoT is becoming the center of interest in the IT and unveilenormouspotential market. Meanwhile, the access of embedded systems into the internet has become an prime direction of the present structural health monitoring systems. Basically, SHMpermits an optimal use of the structure, a reduced downtime, and the aversionof disastrous failures, gives the constructor an enhancement in his products, changes the work organization of maintenance servicesconsiderably:

i) by trying to interchangearranged and cyclical maintenance inspection with performance-based (or health-based) maintenance (long term) or at least (short term) by decreasing the present maintenance labor, particularly by evading dismounting parts where there is no unknownflaw; ii) by radicallyreducing the human participation, and so reducing labor, downtime and human errors, and hence improving safety and reliability. These extreme changes in maintenance attitude are described in several recent papers, particularly for military air vehicles [2], for Army systems [3],for civil aircraft [4], and for civil infrastructures [5].The up gradation of safety seems to be a strong incentive, especially after some starling accidents because of: i) substandard maintenance, for instance, in the aeronautic area, the accident of Aloha Airlines [6] – or, in the civil engineering field, the failure of the Mianus River bridge; ii) mismanaged industrial process, for instance, the Injak bridge collapse.

In both the areas, the problem of aging structures was exposed and following programs were established. To pin down the significance of the problem of structural aging, the following piece of data can be brought to mind: bridge inspection during the late 1980s exposed that on the 576,000 US highway bridges, 236,000 were evaluatedas lacking by the current standards [7]. This paper designs a robust Web-based gateway for the on-site observation tool network equabled by CAN,RS-485 and other communication protocols, this is the bridge between them and the Internet, and it allows remote users to browse and manage these on-site observation equipments through browser at anytime and anywhere [3].By introducing internet in to control network, it is possible to attain remote sensing observation and controlling for equipments [4].

As compared to the endured research, this paper aims to monitor and control the environmental parameters in industries by using IOT application easily for the user. So evolving a profitable and high efficiency controller is designed in this system.

III. SYSTEM ARCHITECTURE:

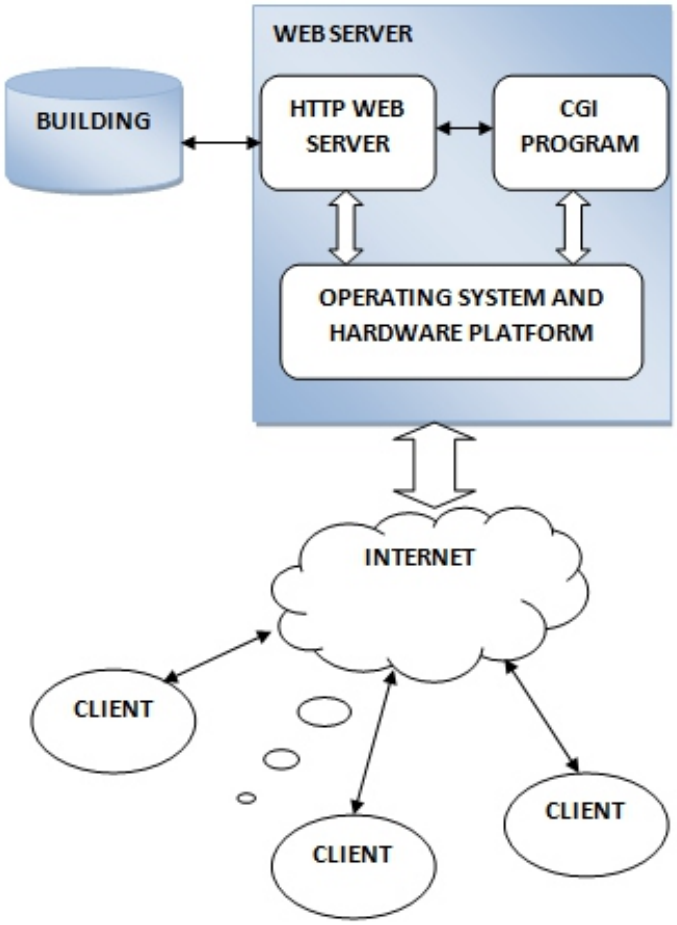

Fig 1 web server architecture

A. Web Server Architecture:

We will introduce a Web server to the field of monitoring the sensors connected to hardware platform and software system, with the help of the automated test equipment for the change in TCP/IP for the bottom communication protocol. The Fig 1 displays the abstraction of web server. The web server software system usually include application program interface, center processing module, file system, HTTP engine, configuration module, security module,. The server is the key of the central processing module, it is the control and the scheduling,

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HTTP engine perceive the HTTP protocolconfiguration, the file system access to resources, and security module implements security mechanism application interaction, the server configurationand application server interface implementation.

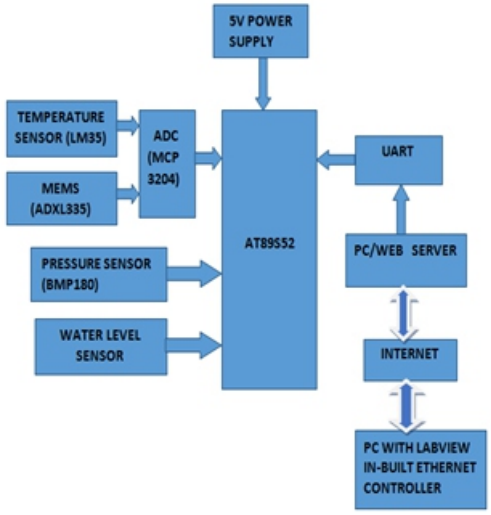

Fig 2 Block Diagram

In our proposed work, we use AT89S52 Micro controller, that is shown in fig 2.This board is provided with constant 5V as input. Here GSM module with internet connection acts like a web server which is linked with the Microcontroller through UART and also the sensors are connected to the controller; the whole system is connected to the remote PC with LabVIEW through internet. By typing the IP address of server system the client gets connected to the remote system and also monitor the values of sensors from anywhere in the world through internet connection.

B. AT89S52 Microcontroller:

AT89S52 (Fabricated by ATMEL) – This is the flash ROM version of traditional 8051 microcontrollers ('C' in the part number denotes CMOS technology). It uses a flash ROM to store programs and Data hence it can be erased quickly,which reduces the development life cycle. It can be programmed through USB. It also comes with DFU (Direct Firmware Update) BOOTLOADER . So no need of any burner to program this microcontroller.This microcontroller has 256 bytes of RAM and 3 timers. It also has same features as of 8051 microcontroller but with an extra timer and has extra 128 bytes of RAM . It has 8K bytes of ROM.

C. UART :

A UART stands for universal asynchronous A UART stands for Universal Asynchronous Receiver/Transmitter. As we don't need a clock pulse for receive or transmit data hence is called asynchronous communication. It provides the microcontroller/processor with the RS-232C Data Terminal Equipment interface facility so that it can exchange data with other serial devices. The MAX232 capable of converting signals from an RS-232 serial port to the suitable signals for use in TTL compatible logic circuits.

The MAX232 is a dual transmitter/receiver.The MAX232 provide RS-232 voltage level outputs (-7.5v to +7.5v) from a single 5 V supply through on-chip charge pumps and external capacitors which makes circuit easy for data communication through seriallyas it do not need any voltages outside the 0 V to + 5 V range.The receivers reduce RS-232 inputs (+25 V to -25V), to standard TTL level voltage. Having a typical threshold of 1.3 V, and hysteresis of 0.5 V.

D. Power Supply:

The circuit board is provided with 5V DC input; as most of the electronic components need 5v DC supply.power supply is a system that supplies electric power to a load.A regulated power supply is one that controls the output voltage/current to a determined value; the controlled amount of supply is held nearly constant in spite of variations in the load current or voltage provided by the supply's source.

E. IOT (Internet of Things):

Internet of Things is network of physical objects which permits the sensors/devices to collect and exchange data. Using IoT objects allows objects to be sensed and controlled remotely across existing network infrastructure.

F. SENSOR MODULES
Temperature:

A linear temperature sensor calibrated directly in centigrade is used for sensing temperature.This temperature sensor provides a scale factor of 10mV/oc. It is suitable to be used in the range of -55oc to 150oc.

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MEMS:

This (Micro-Electro-Mechanical Systems)is the technology that in its most general form it can be defined as miniaturized mechanical and electro-mechanical elements those are created using the micro fabrication techniques. The critical physical dimensions of MEMS can fluctuate from below one micron on the subordinate of the dimensional spectrum, to several millimeters. similarly, the types of MEMS devices can differ from relatively simple composition having no moving elements, to exceptionally complex electromechanical systems with multifarious moving elements under the sway of integrated microelectronics. The most important criterion of MEMS is that there are at rock-bottom some elements having some sort of mechanical processing whether or not these elements can change the state.

Pressure:

A fully calibrated pressure sensor is being used for measurement of barometric pressure.This sensor provided by Robert Bosch is an industrial grade pressure sensor used widely in automotive applications.It has a low altitiude noise of 0.25m at fast conversion time.The pressure varies both with altitude and weather.

Water Level:

A water level sensor based on conduction properties of water has been set up.Level sensors play very important role in variety of consumer/industrial applications.Using this sensor, we can measure level of liquids like water, oil, slurries, etc.

G. GSM MODEM:

A GSM (global system for mobile communication) deviceis generally an external device or a PC PCMCIA Card /Card. Mostly,an external GSM modem is attached to a computer through a USB cable or a serial cable. Computers use AT commands to regulatethe GSM modems. Both GSM modems and dial-up modems carry a common set of AT commands. We can use a GSM modem as Dial-up modems.The microcontrollers can also control the GSM modems through AT commands if they are programmed so.

AT Commands Used: Configuration

•AT+CSMINS? To check whether sim is present or not
•AT+CREG? To check whether SIM is registered on network or not
•AT+CGATT=1 To attach to the network
•AT+CSQ To check signal quality

AT GPRS Commands:

•AT+SAPBR=1,1 To connect to Internet
•AT+SAPBR=2,1 To check whether connection was successful or not

HTTP:

HTTP is used by the virtual machine to send requests to the web server.HTTP is used to transfer hypertext and so all the sensory information is sent to the web server using this protocol in the form of ASCII text.

AT HTTP Commands:

•AT+HTTPINIT used for initializing HTTP protocol
•AT+HTTPSSL=1 used to send the data tothe secured sites (https)
•AT+HTTPACTION=0 To use POST method of http
•AT+HTTTERM To terminate HTTP session

H. WEB SERVER (Things peak):

A web server is used to process requests from our virtual machine using HTTP to serve the files that form Web Pages. The virtual machine will act like a HTTP client. Thingspeak is an open source IoT application and API to store and retrieve data from objectswith the use of the HTTP protocolvia a Local Area Network or over the Internet. It enables the formation of location tracking applications, sensor logging applications and a social network of things with updating the status.Thingspeak has support from MATLAB from Math works and numerical computing software.

IV. SOFTWARE IMPLEMENTATION:

LabVIEW is used for the realization of the remote control system. The standard is used for configuring, programming, and troubleshooting information systems

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comprising Serial Interfaces. NI-VISA includes software libraries and interactive utilities for operating the system. LabVIEW is a development environment for a visual programming language. It is commonly used for instrument control, Industrial automation and data acquisition on a various platforms including Microsoft Windows, various flavors of UNIX, Linux, and Mac OS.

The core idea behind the remote control system is to access and monitor the sensor data from a structural building remotely from any distant place using satisfactory communication method

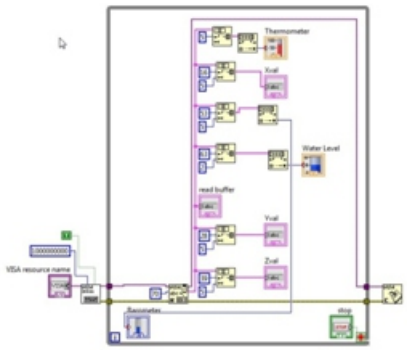

Fig 3 labview backend

It's the The programmer's responsibilityto develope both the server and the client. The above block diagram represents how the server uses the remote address output value of the TCPListen Visual Interface to govern whether a client has the permission to ingress to the server or not.

Block Diagram Panel:

The block diagram is constructed by writing together objects those are having the perform specific functionalities. When we place indicator on the front panel, the software automatically creates a compatible terminal on the block diagram.

When we need the implementation of measurement and control, with a data acquisition card we can attain the following functions, including real-time control., collect the data of the controlled object and dynamic display and In the control system the computer compares the incoming signal from the sensor with the reference value (called as set point).

The controller makes the decision and sends back a control signal to hardware equipment as per the set point.

form a user interface to select the communication port number,number of byte counts, display waveforms of measured physical quantities, setting baud rate, i.e. with-error control techniques and resources name etc.It contains a control for selecting the measurement type, a knob for selecting the number of measurements per average, anindicator to display the output value, and a stop button. The simulation result is shown in fig 4.

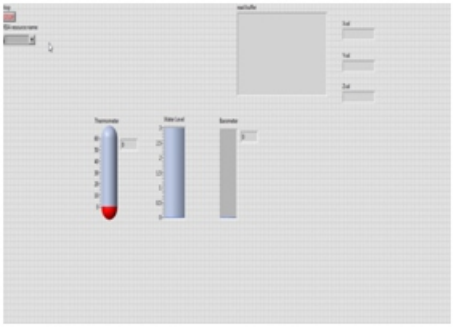

Fig 4 front panel output for remote control system

V. RESULTS AND DISCUSSION:

Using the PC with LABVIEW fulfill the need of a web server which is connected to the internet and the entire device is connected to PC remotely through internet. It's a high flexibility software designed in LABVIEW which offers for variety of data acquisitions. Here the general design concept of the web server is introduced with the policy of TCP/IP reduction. In this project we can able to monitor our building health like temperature, pressure and also we protected from earthquakes using mems and also we can control this parameters.

VI.CONCLUSIONS AND FUTURE WORK:

In this paper, we have revealed the system design and implementation of a structuralhealth monitoring system using IOT.This gives the promising output with faster assessment. So that, it is possible to access that web page through internet and we can able monitor and control the parameters like temperature, pressure. The system has been tested,implemented and we have attainedcanonical and definitive transmission of data to the IP address and representation of graphical view in LabVIEW. In the future, we can ameliorate this system to its portable or handy form of system so that the parameters those will be measured become easier and can perform monitoring and controlling.

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