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Pipeline Monitoring using LabVIEW

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Abstract: **Pipelines are the most cost-effective and suitable way to transport large quantities of oil, water and gas over land and below the sea from offshore facilities. However, these pipelines usually travel long distances through environmentally sensitive areas. To ensure protection and avoid disastrous failures, companies use pipeline integrity and environmental safety practices. With the right set of tools, companies can monitor pipeline, pipeline maintenance inspection, and flow behaviour analysis of transported liquid hydrocarbons and gas.**

Catastrophic events can be prevented by monitoring these pipelines and controlling them wirelessly. In this paper idea is to monitor and control pipelines using wireless sensors and LabVIEW software. In this system wireless sensors are attached to pipelines which continuously monitors them and transmits these values to a control room where LabVIEW software is used to monitor these values on basis of reference values we can automatically control the pipelines.

Keywords — Pipeline Monitoring, Microcontroller, ZigBee, LabVIEW.

I. INTRODUCTION

With increase of demand for energy and water in the world, petroleum, natural gas and water resources have become important assets for the world. Maintaining the financial progress of the countries is strongly depending on protecting these resources. One of the main and important facilities for these resources is the pipelines used to transfer water, petroleum, and natural gas. Oil, gas, and water pipelines are considered one of the main infrastructures in many countries. Protecting the pipeline infrastructure is one of the important priorities for their economies.

There are a number of technologies to monitor and control pipelines. Most of these technologies relay on sensors and networks to transfer data collected from inside and outside pipelines to the control stations.

There are usually numerous monitoring points along any pipeline that provide data about the material flowing through the pipeline and the internal and external conditions of the pipelines. In addition, there are some sensor technologies used to monitor the area around the pipelines to detect any unauthorized actions. Data needs to be collected at each of these control points and sent back to a central control station. Network components are usually spread through pipelines to transfer the measurements collected from different distributed sensors scattered through pipelines. A network is usually needed on the pipelines to provide communication media for data acquisition, video monitoring, control and command systems, etc.

II. SYSTEM ARCHITECTURE

In this system various sensors are used. These sensors are connected to pipeline. These sensors can be installed inside as well as outside the pipeline.All the sensors are connected to various pins of PICcontroller. The sensor has the ability to obtain certain value from its operations.

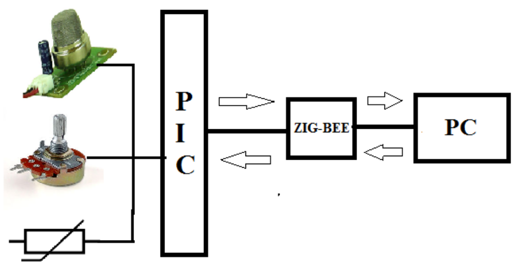

Figure 1 System Archiecture

These sensor values are transmitted to PIC controller. The Controller gathers all the information which is received from the sensors. Now the Controller needs to transmit this information. Therefore the Controller is connected to ZIG-BEE module. ZIG-BEE module routes this information to the receiver which is in control room. Thus this system uses two ZIG-BEE modules to transmit as well as receive the information collected from the sensors. The control room can be anything like a PC or a LAPTOP. This room is used to monitor the data collected from the sensors. Using the LabVIEW software on PC or LAPTOP these values are monitored and on basis of these values automation of pipeline can be achieved. Thus using ZIG-BEE module and LabVIEW software efficient monitoring and controlling of the pipeline can be done.

A. Microcontroller (PIC16F877A)

This unit is the heart of the complete system. It is actually responsible for all the process being executed. It will monitor & control all the peripheral devices or components connected in the system. In short, the complete intelligence of the system resides in the software code embedded in the Microcontroller. The code will be written in Embedded C and will be burned or programmed into the code memory using a programmer. This unit requires +5V DC for it proper operation.

B. ZigBee

ZigBee is a low-cost, low-power, wireless mesh network standard targeted at wide development of long battery life devices in wireless control and monitoring applications. Zigbee devices have low latency, which further reduces average current. ZigBee chips are typically integrated with radios and with microcontrollers that have between 60-256 KB flash memory. ZigBee operates in the industrial, scientific and medical (ISM) radio bands: 2.4 GHz in most jurisdictions worldwide. Data rates vary from 20 kbps (868 MHz band) to 250 kbps (2.4 GHz band). The ZigBee network layer natively supports both star and tree networks, and generic Mesh networking. Both trees and meshes allow the use of ZigBee routers to extend communication at the network level. ZigBee builds on the physical layer and media access control defined in IEEE standard 802.15.4 for low-rate WPANs. The specification includes four additional key components: network layer, application layer, ZigBee device objects (ZDOs) and manufacturer-defined application objects which allow for customization and favour total integration. ZDOs are responsible for a number of tasks, including keeping track of device roles, managing requests to join a network, as well as device discovery and security.

C. LabVIEW

LabVIEW programs are called virtual instruments, or VIs, because their appearance and operation imitate physical instruments, such as oscilloscopes and multimeters. LabVIEW contains a comprehensive set of tools for acquiring, analysing, displaying, and storing data, as well as tools to help you troubleshoot code you write.

In LabVIEW, you build a user interface, or front panel, with controls and indicators. Controls are knobs, push buttons, dials, and other input mechanisms. Indicators are graphs, LEDs, and other output displays. After you build the front panel, you add code using VIs and structures to control the front panel objects. The block diagram contains this code.

You can use LabVIEW to communicate with hardware such as data acquisition, vision, and motion control devices, as well as GPIB, PXI, VXI, RS232, and RS485 instruments.

III. IMPLEMENTATION

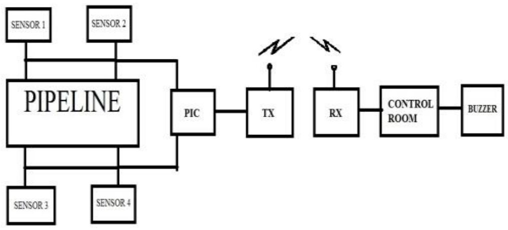

Figure 2 Block Diagram

In the above block diagram we have four sensors viz. a gas sensor, a fluid level sensor, a speed flow sensor and a temperature sensor. We also have a PIC controller, power supply unit, relay circuit, 16*2 LCD Display and ZIG-BEE modules. In this paper we use a PIC 16F877A controller. This controller is connected to a power supply to power itself. A crystal oscillator is used as a clock for this controller. The MCLR pin is the reset pin which is pulled up by a resistor. This pin is used whenever gets hanged during the operation. There are 5 ports viz. port A, port B, port C, port D and port E. Port A has a built in ADC. Therefore all the sensors are connected to this port. The temperature sensor senses the temperature. To sense the temperature of the pipe a Thermistor is used which has negative temperature coefficient. The output of this sensor is sent to port A pin number 0. To check the exact level of the fluid inside the pipe we use a float which is connected to a 10k ohm angular pot. The float goes up and down according to the fluid level and angular pot changes its voltage according to it. These fluctuations in voltage are noted at pin 1 of port A. to check the leakage in the pipe we use a gas sensor. The sensor used is MQ6 gas sensor. It senses any LPG or flammable gases. The sensing plate will provide an output at pin 2 of port A. 3V DC Techogenerator is used to check to flow of the fluid inside the pipeline. The output of this techogenerator is sent to pin 3 of port A. An LCD display is used at the site so as to see to sensor outputs on spot. The LCD is set to 4-bit mode where 4 pins are used to collect 8 bit data. The outputs from four sensors need to be transmitted. This is done using ZIG-BEE. The transmitter and receiver pin of PIC are connected to transmitter and receiver pin of ZIG-BEE.

Another ZIG-BEE is used at control room to acquire this data. TTL to USB converter is used to collect data received from ZIG-BEE to transfer it to PC or LAPTOP. The received data is a serial data. This data is collected from a virtual serial port from present inside the PC. The control room has a special data acquiring software named LabVIEW. The serial data is fed to this software. A threshold value is set for each sensor and when exceeded, a feedback command is sent back to transmitter side. A relay circuit is used which takes necessary actions whenever a command is sent back from control room. LabVIEW is a highly productive development environment for creating custom application that interact with real world data or signal in field such as science and engineering. LabVIEW itself is a software development environment that contains numerous components several of which are required any type of test, measurement or control application. The G programming language is central to LabVIEW so much so that it is often called 'LabVIEW programming' using it, you can quickly tie together data acquisition, analysis and logical operation and understand how data is being modified. LabVIEW contains a powerful optimizing compiler that examines your block diagram and directly generates efficient machine code, avoiding the performance penalty associated with interpreted or cross-compile language.

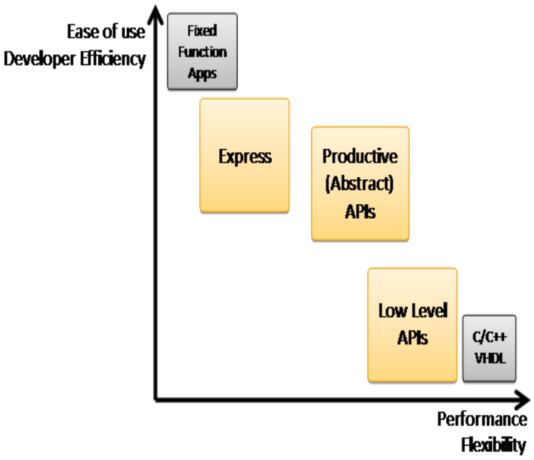

Figure 3 Low level flexibility of Lab VIEW

With the debugging tools in Lab VIEW, you can slow down execution and see dataflow through your diag or you can use common tools such as breakpoint and data probe to step through your programme node by node. The cross platform nature of Lab VIEW also allows you to deploy your code to many different computing platforms. In addition to the popular desktop Oss, Lab VIEW can target embedded real time controller, ARM microprocessor, and field programmable gate arrays (FPGAs), so you can quickly prototype and deploy to the most appropriate hardware platform without having to learn new tool chain.

There are various advantages such as it can wirelessly route information, high data encryption, predetect a problem and automatically control valve. It can also be implemented easily with no hardware/software interfacing required and only one routing protocol.

IV. CONCLUSION

As the technology grows day by day, we can imagine about the future in which every human activity is replaced by machines. The proposed system based on PIC16F877A microcontroller is found to be more compact, user friendly and less complex, which can readily be used in order to perform several tasks. We can use 256 more sensor to make the system more reliable and accurate. This system consists of Zig-Bee and LabVIEW software for controlling and monitoring the pipeline. The protocol has the feature of load balancing maximizing individual node battery life as well as extending network lifetime with minimal maintenance requirement. Using GSM and zigbee we can cover long distance without having network complexity.

V. REFERENCES

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