Oil and Gas Industries Exploration Monitoring using Ultra Wide Band Sensor Networks

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Abstract:
Industrial automations which are mostly depend upon the power systems & which requires distance controlled and regulated systems. Wireless technology which meets to cost, speed and distance scenario will always be a point of an interest for research. In this research work we mainly monitored power related parameters and enable remote switching devices for proper power management systems using ZigBee. This paper proposes a digital system for condition monitoring, and supervisory control for electric systems parameters like voltage and current using wireless sensor networks (WSNs) based on ZigBee. Its main feature is its use of the ZigBee protocol as the communication medium between the transmitter and receiver modules. Wireless technology, which has boomed in the IT sector over the past years, can be suitable for industrial control networks as well, providing solutions with high ROI for diagnostics, control and safety. Wireless Sensor Networks (WSNs) have revolutionized the design of emerging embedded systems and triggered a new set of potential applications. In addition to building automation, environmental surveillance or military operations Industries.

I. INTRODUCTION

Present industry is increasingly shifting towards automation. Two principle components of today’s industrial automations are programmable controllers and robots. In order to aid the tedious work and to serve the mankind, today there is a general tendency to develop an intelligent operation. The proposed system “ULTRA-WIDE BAND SENSOR NETWORKS IN OIL AND GAS EXPLORATIONS” is designed and developed to accomplish the various tasks in an adverse environment of an industry. The intelligent machine is loaded with several units such as LCD, microcontroller, and temperature sensor, voltage measurement, current measurement Flow sensor which synchronously works with the help of a start-of-the-art PIC microcontroller. This project is an owe to the technical advancement. This prototype system can be applied effectively and efficiently in an expanded dimension to fit for the requirement of industrial, research and commercial applications. Microcontroller is the heart of the device which handles all the sub devices connected across it. We have used as microcontroller. It has flash type reprogrammable memory. It has some peripheral devices to play this project perform. It also provides sufficient power to inbuilt peripheral devices. We need not give individually to all devices. The peripheral devices also activates as low power operation mode. These are the advantages are appear here.

1.1 OBJECTIVE

In this project is to monitor the voltage, current, Temperature, Flow. Voltage measured with the help of a potential transformer. The potential transformer will convert the mains supply voltage to low voltage AC. That AC voltage will be rectified with the help of a precision rectifier. Then the rectified output will be given to the micro controller through an analogue to digital converter. Current is measured with the help of a current transformer. The current transformer will convert the load current in to lower values that current output will be converted in to voltage with the help of the shunt resistor. Then the corresponding the AC voltage will be rectified with the help of a precision rectifier. Then the rectified output will be given to the micro controller through an analogue to digital converter. Analog to digital converter convert the input analogue signal to corresponding digital signal which is given to microcontroller. Flow can be measured in ANALOG INPUT mode with the help of flow sensor. Flow value is compared with the set value. We

BRIEF METHODOLOGY

The project designed by following blocks:

- Potential Transformer
- Current transformer
- Temperature Sensor
- Flow Sensor
- Accelerometer Sensor
- Flow Sensor
- Precision rectifier (2)
- Shunt register
- ADC
- Micro controller
- Driver circuit with relay
- Zigbee Transceiver
- Keypad

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have to enter the set point for the level parameter. We have to do the program such that the set point value is compared with the acquired value from the hardware unit. The difference signal value is then given to the kit via ANALOG OUTPUT mode. As per the difference in value, we will be able control the flow. We can control many number of parameters like as we did for the above-mentioned parameters. The system acquires the values from the hardware unit and process according to the specifications we have mentioned in our program. We can plot the graph for the data acquired and we have alarm unit for indication purpose when it crosses the specified limit.

1.2 EXISTING SYSTEM

Seismic exploration and monitoring for oil and gas reservoirs is a peculiar application that requires a large number (1000-2000 nodes/sq-km) of geophone sensors deployed outdoors over large areas (2 40 sq-km) to measure backscattered wave fields from artificial sources. A storage/processing unit or sink node collects the measurements from all the geophones to obtain an image of the sub-surface. Oil companies are therefore expecting that wireless connectivity will provide the enabling technology for future seismic explorations. This application represents a new challenging research area for the wireless community. Early results suggest that current off-the-shelf radio solutions do not guarantee the minimum requirements in terms of system usability and energy consumption, not even for current deployment size. This article presents a tutorial view to introduce the basic principles of seismic acquisition systems that are necessary to define the wireless geophone network specifications. Strict sampling synchronization constraint over large geographic areas, high precision sensor localization, and high data rate are all requirements calling for a scalable network system where Ultra-Wide Band radio transmissions play a key role as the only viable technology.

1.3 PROPOSED SYSTEM

The oil and gas industry includes processes for exploration, extraction, refining, transporting, and marketing petroleum products. The largest volume products of the industry are fuel, oil and gasoline (petrol). Petroleum is also the raw material for many chemical products, including pharmaceuticals, solvents, fertilizers, pesticides, and plastics. As the demand for fossil fuels continues to grow, oil and gas companies will have to develop new technologies and improve operations in order to increase productivity and expand on their current abilities. The local monitor of oil field consists of data acquisition module, Zigbee communication module, Remote Terminal Unit (RTU), field data acquisition computer and local central server. The transceiver of monitoring centre receives the signals from the air delivered by oil field RTU, and then amplifies and demodulates RF signals, restores the signals into data transfer signals and sends them to central industrial control computer to calculate, real time monitors oil well status.

Applications

1. Tank level monitoring
2. Petroleum industries
3. Chemical industries
4. Power plant

Hardware-Requirements

1. Microcontroller (PIC16F877A)
2. Sensor
3. Zigbee
4. Serial p011

II. ACCELERATION

2.1 ACCELEROMETERS:

An accelerometer is an electromechanical device that will measure acceleration forces. These forces may be static, like the constant force of gravity pulling at your feet, or they could be dynamic caused by moving or vibrating the accelerometer. An
accelerometer is a device that measures the vibration, or acceleration of motion of a structure. The force caused by vibration or a change in motion (acceleration) causes the mass to "squeeze" the piezoelectric material which produces an electrical charge that is proportional to the force exerted upon it. Since the charge is proportional to the force, and the mass is a constant, then the charge is also proportional to the acceleration. There are two types of piezoelectric accelerometers (vibration sensors). The first type is a "high impedance" charge output accelerometer. In this type of accelerometer the piezoelectric crystal produces an electrical charge which is connected directly to the measurement instruments. The charge output requires special accommodations and instrumentation most commonly found in research facilities. This type of accelerometer is also used in high temperature applications (>120°C) where low impedance models cannot be used.

2.2 PRINCIPLE OF OPERATION

The Free scale accelerometer is a surface-micro machined integrated-circuit accelerometer. The device consists of two surface micro machined capacitive sensing cells (g-cell) and a signal conditioning ASIC contained in a single integrated circuit package. The sensing elements are sealed hermetically at the wafer level using a bulk micro machined cap wafer. The g-cell is a mechanical structure formed from semiconductor materials (poly silicon) using semiconductor processes (masking and etching). It can be modeled as a set of beams attached to a movable central mass that move between fixed beams. The movable beams can be deflected from their rest position by subjecting the system to an acceleration Figure. As the beams attached to the central mass move, the distance from them to the fixed beams on one side will increase by the same amount that the distance to the fixed beams on the other side decreases. The change in distance is a measure of acceleration. The g-cell beams form two back-to-back capacitors Figure. As the center beam moves with acceleration, the distance between the beams changes and each capacitor's value will change, \( C = \frac{A \varepsilon}{D} \).

Where \( A \) is the area of the beam, \( \varepsilon \) is the dielectric constant and \( D \) is the distance between the beams. The ASIC uses switched capacitor techniques to measure the g-cell capacitors and extract the acceleration data from the difference between the two capacitors. The ASIC also signal conditions and filters (switched capacitor) the signal, providing a high level output voltage that is ratio metric and proportional to acceleration.

2.3 FLAME DETECTOR

Circuit description:
The fire then became short-circuit. When there is no fire the sensor become open circuit. The flame sensor is connected with resistor. This connection formed the voltage divider network which is connected with inverting input terminal of the comparator. The reference voltage is given to non inverting input terminal. The comparator is constructed with LM 741 operational amplifier. When there is no fire, the flame sensor became open circuit. So the inverting input terminal voltage is greater than non inverting input terminal (reference voltage). Now the comparator output is -12V which is given to the base of the switching transistor BC547. So the transistor is turned OFF. The 5V is given to 7404 IC. The 7404 is the hex inverter with buffer. Hence zero voltage is given to microcontroller. When there is fire occurred, the flame sensor became short circuit. So the inverting input terminal voltage is less than non inverting input terminal (reference voltage). Now the comparator output is +12V which is given to the base of the switching transistor BC547. So the transistor is turned ON. The zero voltage is given to 7404 IC. Hence +5V voltage is given to microcontroller. In the microcontroller we can detect the fire with the help of software.

2.4 GAS SENSOR

The LPG (Propane) Gas Sensor is used in gas detection equipment for detecting Propane gas in home, automotive or industrial settings. This sensor is compatible with all Parallax microcontrollers, and would be a good addition to any projects needing to sense the presence of Propane. Manufacturer datasheet below has more information and circuit recommendations.

Figure.3. Pin circuit

Figure.4. Pin Circuit of Flame Detector

Figure.5. GAS SENSOR
III. VOLTAGE MEASUREMENT

This circuit is designed to monitor the supply voltage. The supply voltage that has to be monitored is stepped down by the potential transformer. Usually, we use the 0-6v potential transformer. The step-down voltage is rectified by the precision rectifier. The precision rectifier is a configuration obtained with an operational amplifier in order to have a circuit behaving like an ideal diode or rectifier. The full-wave rectifier is the combination of half-wave precision rectifier and summing amplifier. When the input voltage is negative, there is a negative voltage on the diode, too, so it works like an open circuit, there is no current in the load, and the output voltage is zero. When the input is positive, it is amplified by the operational amplifier and it turns the diode on.

There is current in the load and, because of the feedback, the output voltage is equal to the input. In this case, when the input is greater than zero, D2 is ON and D1 is OFF, so the output is zero when the input is less than zero, D2 is OFF and D1 is ON, and the output is like the input with an amplification of R2 / R1. The full-wave rectifier depends on the fact that both the half-wave rectifier and the summing amplifier are precision circuits. It operates by producing an inverted half-wave rectified signal and then adding that signal at double amplitude to the original signal in the summing amplifier. The result is a reversal of the selected polarity of the input signal. Then the output of the rectified voltage is adjusted to 0-5v with the help of variable resistor VR1. Then given to ripples are filtered by the C1 capacitor. After the filtration, the corresponding DC voltage is given to ADC or other related circuit.

Figure 6. Voltage measurement

3.1 CURRENT MEASUREMENT

This circuit is designed to monitor the supply current. The supply current that has to be monitored is stepped down by the current transformer. The step-down current is converted by the voltage with the help of shunt resistor. Then the converted voltage is rectified by the precision rectifier. The precision rectifier is a configuration obtained with an operational amplifier in order to have a circuit behaving like an ideal diode or rectifier. The full-wave rectifier is the combination of half-wave precision rectifier and summing amplifier. When the input voltage is negative, there is a negative voltage on the diode, too, so it works like an open circuit, there is no current in the load, and the output voltage is zero. When the input is positive, it is amplified by the operational amplifier and it turns the diode on.

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Figure 7. Current measurement
4.2 PRESSURE MEASUREMENT

Pressure
Pressure (symbol: p) is the force per unit area applied on a surface in a direction perpendicular to that surface. Mathematically:

\[ p = \frac{F}{A} \]

Where:
- P is the pressure
- F is the normal force
- A is the area

Pressure is a scalar, and has SI units of Pascal, 1 Pa = 1 N/m².

Pressure is transmitted to solid boundaries or across arbitrary sections of fluid normal to these boundaries or sections at every point. It is a fundamental parameter in thermodynamics and it is conjugate to volume.

Circuit description

This circuit is designed to measure the varying pressure. The pressure is measured by diaphragm which is one type of transducer to measure the varying pressure. The pressure is measured by transducer. When pressure is applied, the diaphragm is moving in the forward side. The diaphragm moving depends on the pressure. So it generates the voltage pulse depends on the movement of diaphragm. The voltage pulses are in the range of milli voltage. Hence the voltage pulse is given to Instrumentation amplifier section in order to amplify the signals. The important features of instrumentation amplifier are high gain accuracy, high CMRR, low output impedance. Here the instrumentation amplifier is constructed by dual operational amplifier that is two operational amplifiers n amplifier acts as differential instrumentation amplifier. TL 082 operational amplifier, The TL 082 is the dual operational amplifier is fabricated in single chip. Here the instrumentation amplifier acts as a differential instrumentation amplifier. The diaphragm transducer terminals are connected to A1 and A2 amplifier of the differential instrumentation amplifier. The difference of the varying voltage signals from the transducer is amplified by the instrumentation amplifier. The A4 amplifier is used for zero adjustment. When there is no pressure the diafragm may be sliding in the forward or reverse side. Due to that instrumentation amplifier delivered some voltage at the output. To avoid this problem A4 amplifier is used for zero adjustment. Hence when there is no pressure the output is zero. The A5 amplifier acts as gain amplifier in which variable resistors is connected as feedback resistor. By adjusting the feedback resistor we can vary the gain of the output signal. Then the final gain adjusted signal is amplified by the A6 amplifier.

3.3 RS 232 COMMUNICATION

RS 232:

In telecommunication, RS232 is a standard for serial binary data interconnection between a DTE (Data Terminal Equipment) and DCE (Data Circuit-terminating Equipment). It is commonly used in computer serial ports.

Scope of the Standard:

The Electronic Industries Alliance (EIA) standard RS-232-C [3] as of 1969 defines:
- Electrical signal characteristics such as voltage levels, signaling rate, timing and slew-rate of signals, voltage withstand level, short-circuit behavior, maximum stray capacitance and cable length
- Interface mechanical characteristics, pluggable connectors and pin identification
- Functions of each circuit in the interface connector
- Standard subsets of interface circuits for selected telecom applications

The standard does not define such elements as character encoding (for example, ASCII, Baudot or EBCDIC), or the framing of characters in the data stream (bits per character, start/stop bits, parity). The standard does not define protocols for error detection or algorithms for data compression. The standard does not define bit rates for transmission, although the standard says it is intended for bit rates lower than 20,000 bits per second. Many modern devices can exceed this speed (38,400 and 57,600 bit/s being common, and 115,200 and 230,400 bit/s making occasional appearances) while still using RS-232 compatible signal levels. Details of character format and transmission bit rate are controlled by the serial port hardware, often a single integrated circuit called a UART that converts data from parallel to serial form. A typical serial port includes specialized driver and receiver integrated circuits to convert between internal logic levels and RS-232 compatible signal levels.

Circuit working Description:

In this circuit the MAX 232 1C used as level logic converter. The MAX232 is a dual driver/receiver that includes a capacitive voltage generator to supply EIA 232 voltage levels from a single 5v supply. Each receiver converts BIA-232 to 5v TTL/CMOS levels. Each driver converts TTL/CMOS input levels into BIA-232 levels.
Figure.9. circuit working description

IV. ACCELEROMETER

Figure.10. Accelerometer

Features

- Selectable Sensitivity (1.5g/2g/4g/6g)
- Low Current Consumption: 500 µA
- Sleep Mode: 3 µA
- Low Voltage Operation: 2.2 V 3.6 V 6mm x 6mm x1.45mm QFN
- High Sensitivity (800 mV/g @ 1.5g)
- Fast Turn on Time
- Integral Signal Conditioning with Low Pass Filter
- Robust Design, High Shocks Survivability
- Pb-Free Terminations
- Environmentally Preferred Package
- Low Cost
- Pin Descriptions

<table>
<thead>
<tr>
<th>Pin no.</th>
<th>Pin name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>g-select 1</td>
<td>Logic input pin to select g level</td>
</tr>
<tr>
<td>2</td>
<td>g-select 2</td>
<td>Logic input pin to select g level</td>
</tr>
<tr>
<td>3</td>
<td>V DD</td>
<td>Power Supply Input</td>
</tr>
<tr>
<td>4</td>
<td>V SS</td>
<td>Power Supply Ground</td>
</tr>
<tr>
<td>5 – 7</td>
<td>N/C</td>
<td>No internal connection Leave unconnected.</td>
</tr>
<tr>
<td>8 – 11</td>
<td>N/C</td>
<td>Unused for factory trim Leave unconnected</td>
</tr>
<tr>
<td>12</td>
<td>Sleep mode</td>
<td>Logic input pin to enable product or Sleep Mode</td>
</tr>
<tr>
<td>13</td>
<td>Z out</td>
<td>Z direction output voltage</td>
</tr>
<tr>
<td>14</td>
<td>Y out</td>
<td>Y direction output voltage</td>
</tr>
<tr>
<td>15</td>
<td>X out</td>
<td>X direction output voltage</td>
</tr>
<tr>
<td>16</td>
<td>N/C</td>
<td>No internal connection. Leave unconnected</td>
</tr>
</tbody>
</table>

4.1 FIRE DETECTION

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Application

It is mainly used to prevent the fire accident.
4.2 GAS SENSOR

4.3 VOLTAGE MEASUREMENT

4.4 CURRENT MEASUREMENT

4.5 PRESSURE MONITORING

Pressure sensors can be classified in terms of pressure ranges they measure, temperature ranges of operation, and most importantly the type of pressure they measure. In terms of pressure type, pressure sensors can be divided into five categories:

- **Absolute pressure sensor**

  This sensor measures the pressure relative to perfect vacuum pressure (0 PSI or no pressure). Atmospheric pressure is 101.325 kPa (14.7 PSI) at m with reference to vacuum.

- **Gauge pressure sensor**

  This sensor is used in different applications because it can be calibrated to measure the pressure relative to a given atmospheric pressure at a given location. A tire pressure gauge is an example of gauge pressure indication. When the tire pressure gauge reads 0 PSI, there is really 14.7 PSI (atmospheric pressure) in the tire.

- **Vacuum pressure sensor**

  This sensor is used to measure pressure less than the atmospheric pressure at a given location. This has the potential to cause some confusion as industry may refer to a vacuum sensor as one which is referenced to either atmospheric pressure (i.e., measure Negative gauge pressure) or relative to absolute vacuum.

- **Differential pressure sensor**

  This sensor measures the difference between two or more pressures introduced as inputs to the sensing unit, for example, measuring the pressure drop across an oil filter. Differential pressure is also used to measure flow or level in pressurized vessels.
• Sealed pressure sensor

This sensor is the same as the gauge pressure sensor except that it is previously calibrated by manufacturers to measure pressure relative to sea level pressure. The RS-232 standard is used by many specialized and custom-built devices. This list includes some of the more common devices that are connected to the serial port on a PC. Some of these such as modems and serial mice are falling into disuse while others are readily available. Serial ports are very common on most types of microcontroller where they can be used to communicate with a PC or other serial devices.

V. CIRCUIT DIAGRAM

VI. RESULT AND CONCLUSION

The above said objective met successfully with a working prototype
• The local monitor of oil field consists of data acquisition module, Zigbee communication module remote terminal unit (RTU) Discuss in this paper are limited in output constraint handling because of inevitable modeling errors.
• This features and more, if appropriately embedded on a low-cost chip can bring substantial economic benefits to industries.

VII. REFERENCE


