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HEALTH MONITORING OF A MACHINE USING WIRELESS MODEMS

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Abstract Health monitoring of machinery in Industries is a major problem in the present day's industry. There are different methods and equipment available for this purpose. But most of the methods are offline, in the field and wire based. We propose a new method involving Wireless sensor networks to sense the vibrations of a machine from a remote location. Determining the Vibrations helps in studying the health condition of the machine Predictive and preventive maintenance requires some means of assessing the actual condition of the machinery, and we can often detect early failure using condition monitoring techniques. We need to build a continuous machine condition monitoring system to capture real-time data from equipment under test, such as rotating and reciprocating machinery. By comparing actual and desired performance behaviour, we can predict and identify problems before they actually cause the equipment to stop working, thereby reducing the overall number of failures.

1. INTRODUCTION

In industries there exits different types of process continuous as well as batch (sequential), for performing to complete a particular action there exits different steps to complete and different reactions taking place to complete the particular action. Consider an example of cement production industry there exits different batch as well as continuous processes to produce the final product. A Raw mill is the equipment used to grind raw materials into "Raw meal" during the manufacture of cement. Raw meal is then fed to a cement kiln, which transforms it into clinker, which is then ground to make cement in the cement mill. Roller mills is one of the types of dry raw mills(ball mills, roller mills and hammer mills).These are the standard form in modern installations, occasionally called vertical spindle mills. In a typical arrangement, the material is fed onto a rotating table, onto which steel rollers press down. A high velocity of hot gas flow is maintained close to the dish so that fine particles are swept away as soon as they are produced. The gas flow carries the fines into an integral air separator, which returns larger particles to the grinding path. The fine material is swept out in the exhaust gas and is captured by a cyclone before being pumped to storage.

When no material feeding onto the rollers ,there exit a lot of vibration which could damage the machine, so there is a need for measurement of vibration parameter comes under health of a machine. Suppose the capacity of raw mill 6000TPH ,then there is need to inlet the raw material in the desired region which is depend on the speed of the conveyor belt which is operated by motor. If the motor speed is unfortunately fallen then the feeding system may not able to reach optimum desired level, so then is a requirement of measure the parameter like speed which is come under health monitoring techniques for a particular machine. So there are parameters like pressure, temperature, level, humidity, speed, vibration, etc. We will measure vibration, temperature and other parameters through wireless modem.

2. METHODOLOGY

The block diagram in figure 1 explains the wire based health monitoring of a machine which is having the following stages

Sensor + Signal conditioning stage: In this stage, the sensor measures the physical parameter vibration which is a vector quantity. The signal conditioning like amplification, linearization, filtering, isolation, etc. are done inside the sensor ADXL321 which is one of the advantage of MEMS based sensor. The output of ADXL321 is around (0-5V) which is analog in nature.

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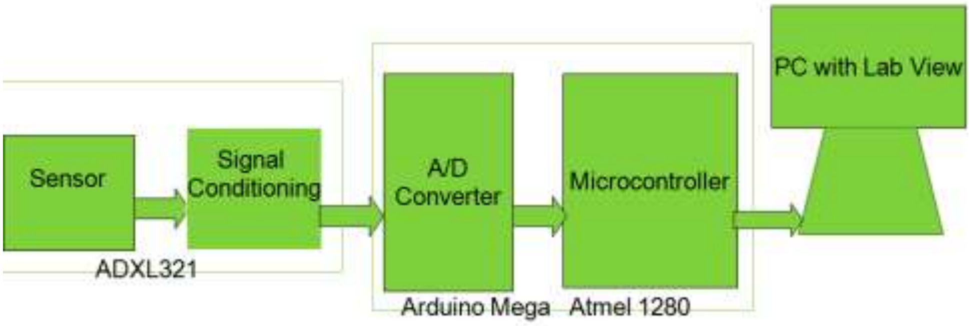

Figure 1: Block diagram

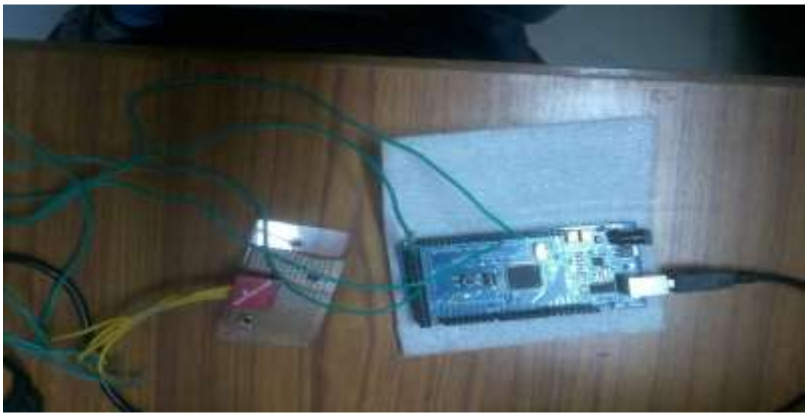

Figure 2: Experimental setup of the health monitoring system

A/D converter + Arduino Microcontroller: In this stage, the analog signal is converted into digital with the help of in-built A/D converters which are present inside the Arduino. The Arduino program is written in such a way that it manipulates the input data which is coming from the sensor output, and then gives the output to the computer with the help of USB cable.

Computer with LabVIEW software: In this stage using VISA, a VI is written for presenting the data which is coming from the Arduino board.

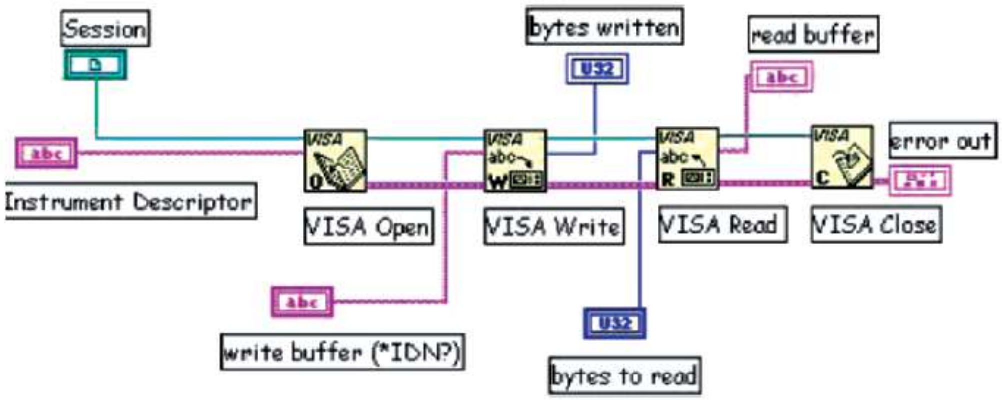

Figure 3: Connecting arduino board to the system using labVIEW

Figure 3 shows the VI where VISA open is used to configure the COM port and their specifications. VISA write is used to send the data to peripherals, VISA read is to Read the data from peripherals, VISA close is used to terminate the operation. All data transfer for instruments to PC, PC to Instruments in terms of ASCII Values, so we used ASCII to numeric converter inside the VI Block diagram. And we displayed the result into both graph as well as numeric indicator.

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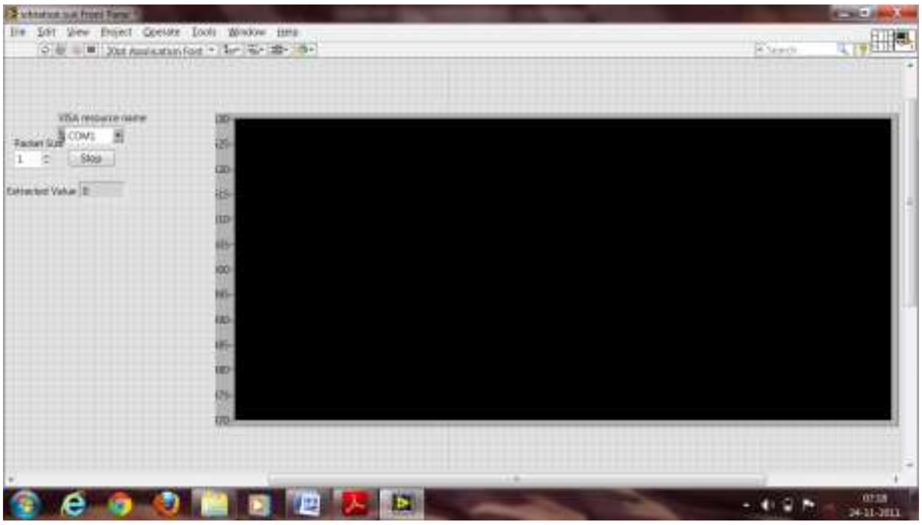

Figure 4: Front panel of the VI

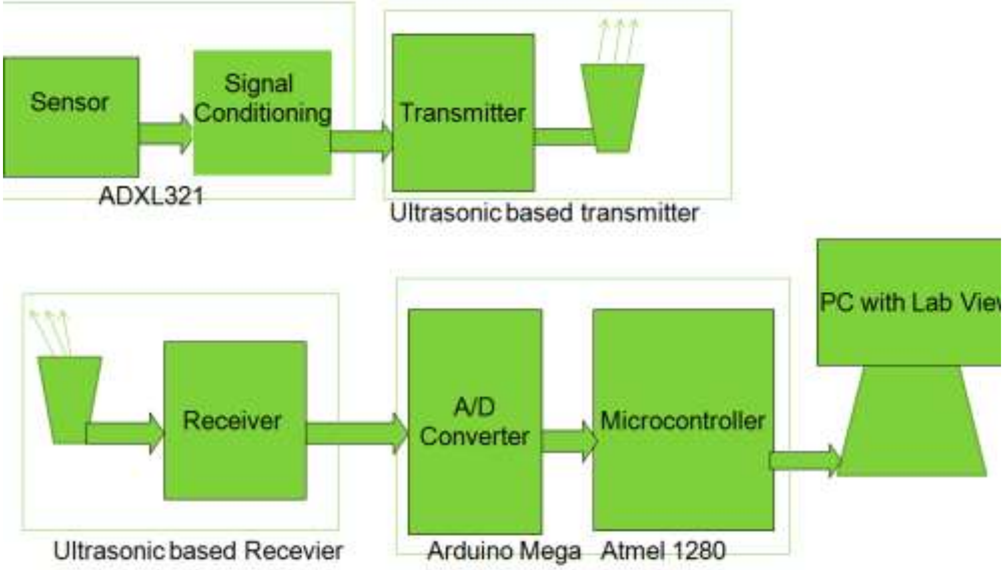

Figure 5: Block diagram of the health monitoring system used in water medium

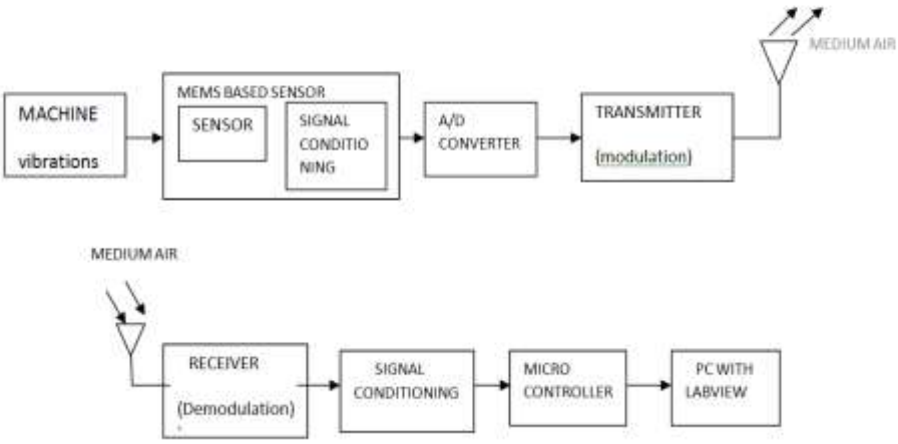

Figure 6: The transmitter receiver model using a microcontroller and Xbee to communicate with the System.

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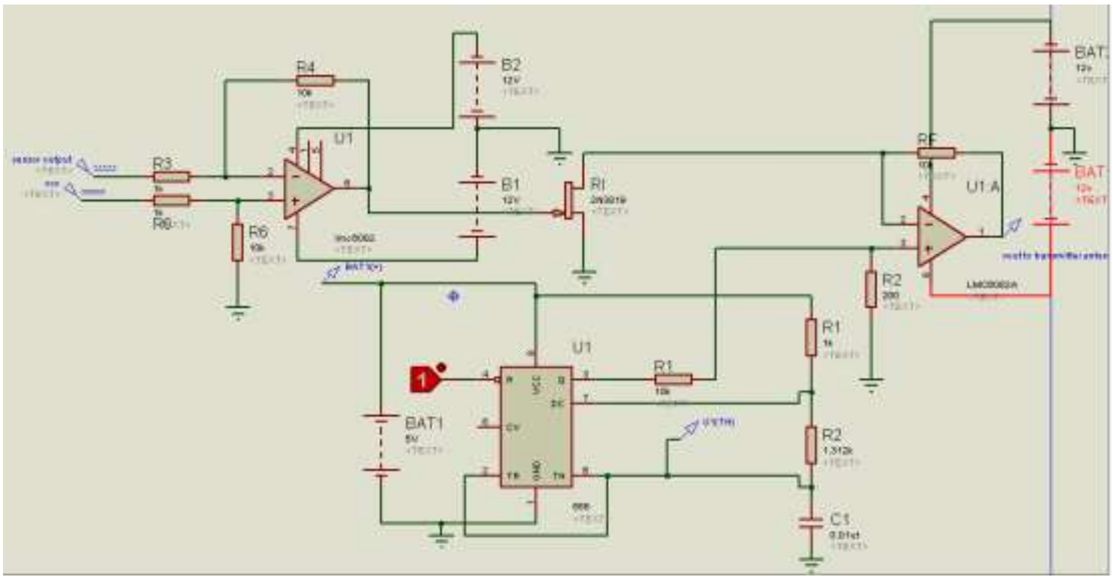
Figure 5 and 6 explain the wireless based communication which the information can able to transfer in both air as well as water because of using ultrasonic transceivers. Ultrasonic transceivers are analog type modules.

3. TRANSMITTER

In the above block diagram the following stages are possible:

Transmitter: In the transmitter the analog signal modulated and transmits in the range of 40 kHz. Here, we are using Amplitude Modulation technique for transmitting the sensor output signal of range (0-5V). We designed the modulating circuit using BJT, after implementation we were observed that it consumes high power even it is require to apply the supply $+V_{CC}$ in the range of 26V around which is a disadvantage . So we designed the circuit using OPAMP, FET which can able to work in small voltage ranges which is an advantage thing.

Here the following circuit explains the amplitude modulation which is occurring at transmitter side.



The op-amp is configured to amplify the carrier signal that's applied at its non-inverting input which is generated by astable multivibrator using 555 timers. The gain of the amplification is given by Gain = 1 + (Rf / Ri), wherein Ri is the resistance exhibited by the FET. The FET acts as a variable resistor whose source-to-drain resistance depends on the input signal applied at its gate. Note the negative bias (-Vcc) applied at the gate of the FET which is used to keep the gate-source junction reverse-biased.

The input signal to the FET's gate is the modulating signal. An increase in the input signal will cause a decrease in the FET's resistance, causing the gain of the op-amp to increase. This results in a corresponding increase in the output voltage. On the other hand, a decrease in the input signal will cause an increase in the FET's resistance, causing the gain of the op-amp to decrease. This results in a corresponding decrease in the output voltage. The FET in this circuit must be properly biased so that its resistance will behave linearly over a wide range of input signal.

4. RECEIVER

Receiver: At the receiver side the demodulation is taking place where the process of retain back the original signal which is coming from the ultrasonic transmitter. In this stage we designed Instrumentation amplifier and rectifier circuit of range 40khz, which is the process of demodulation. After get the original signal is given to the arduino board. Computer with LabView software: In this stage using VISA, a VI is written for presenting the data which is coming from the Arduino board.

5. RESULTS

It can be seen from table 1 and table 2 that when the distance between the transmitter and receiver are increasing the signal strength is falling.

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Table 1: Ultrasonic sensors at a distance of 0.5 meters

Transmitter		Receiver	
Input Voltage (V)	Input Frequency (KHz)	Output Voltage (V)	Output Frequency (KHz)
5	40	0.2	40
5.5	40	0.22	40
6	40	0.25	40
6.5	40	0.265	40
7	40	0.28	40
7.5	40	0.3	40
8	40	0.32	40
8.5	40	0.335	40
9	40	0.37	40
9.5	40	0.39	40
10	40	0.4	40

Table 2: Ultrasonic sensors at a distance of 1 meter

Transmitter		Receiver	
Input Voltage (V)	Input Frequency (KHz)	Output Voltage (V)	Output Frequency (KHz)
5	40	0.1	40
5.5	40	0.11	40
6	40	0.12	40
6.5	40	0.135	40
7	40	0.14	40
7.5	40	0.15	40
8	40	0.16	40
8.5	40	0.165	40
9	40	0.167	40
9.5	40	0.18	40
10	40	0.2	40

6. CONCLUSION

We calibrated the sensor ADXL321 (2-AXIS) Accelerometer for force full vibrations which are applied manually to the sensor. We implemented LabVIEW VI for monitoring the vibration. We also calibrated the Ultrasonic modules which are kept under distance of 0.5m to 5m. We designed the modulating as well as demodulating circuits. Ultrasonic modules produced good results in both water and air as a medium which is advantage having some limitations because of analog communication technique.

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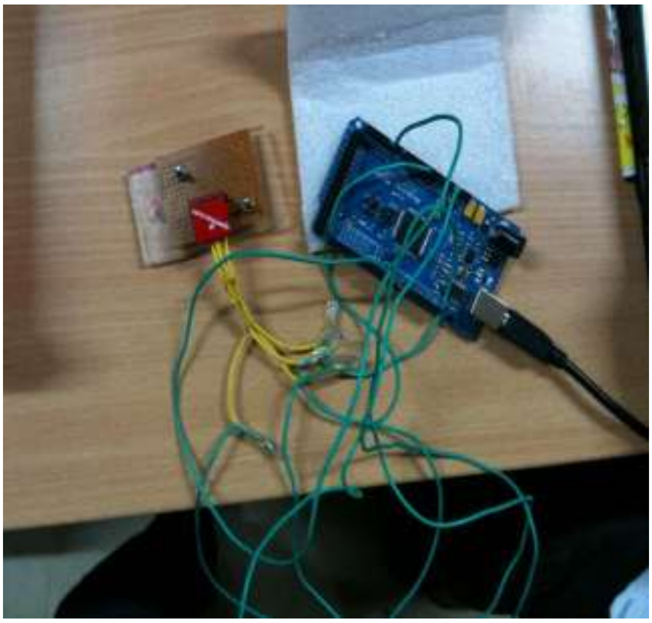
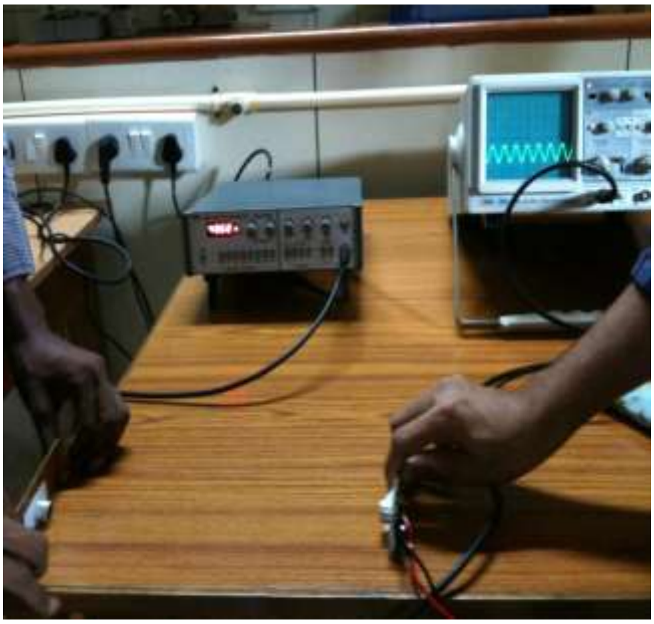
Appendix

Experimental setup