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Highly Predictable Low Power Wireless Sensor Network for Buildings/Bridges Monitoring

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Abstract: A wireless sensor network is proposed for monitoring buildings to evaluate Earthquake, Gas leakage, and Fire attacks. Buildings can increasingly accumulate damage during their operational lifetime, due to seismic events, unexpected foundation settlement, material aging, design error, gas leakages, fire attacks etc., Periodic monitoring of the structure for such damage is therefore a key step in sensibly planning the maintenance needed to guarantee an adequate level of safety and serviceability. However, in order for the installation of a permanently installed sensing system in buildings to be reasonably, the sensor modules must be wireless to condense installation costs, must activate with a low power expenditure to reduce servicing costs of replacing batteries, and use low cost sensors that can be mass produced such as MEMS, GAS,TEMPARTURE Sensors.. The presented work addresses all of the above requirements. This paper aims at using those sensors for monitoring the Building/Bridges in the appearance of any disturbances will be sensed and indicates an alarm. When any disturbances monitored by sensors at their frequency level buzzer will sound an alarm. During this period, execution of the entire process is controlled and monitored by microcontroller. Disturbances monitored by these sensors will send signal to the ARM7 work parallel, by giving signal to GSM which sends to the programmed SIM number and ARM sends a statement to LCD with the buzzer sound.

Keywords: Earthquake, Gas leakage, Fire attack, Sensors, ARM7, MEMS, GSM.

I. INTROCUTION

The introduction of network enabled devices has proceeded with a unique rate. Due to the noticeable advantages of such systems, their influence on the conservative home was predicted and finally, in 1988, the term domotics came to be used. A modern definition of domotics could be the interaction of technologies and services applied to different buildings in order to increase security, comfort, communication and energy saving. Building automation is the introduction of technology within the building to enhance the quality of life of the occupants, through the specification of different services such as tele health, multimedia entertainment and energy conservation. ARM7 microcontrollers can be easily used to create building automation appliances. This paper shows the implementation of an ARM7 microcontroller to create a home controller. ARM7TDMI an 8 KB SRAM block intended to be utilized mainly by the USB can also be used as a general purpose RAM for data storage and code storage and execution. To demonstrate the feasibility and effectiveness of the proposed system, four devices which are, MEMS, GAS, FIRE Sensor, and GSM have been developed and evaluated with the building automation system. All the information regarding the home appliances and parameters sensed by the sensor will send data to the GSM using ARM7.

II. LITERATURE SURVEY

Research has been conducted for over a decade regarding structural control systems for the purpose of infrastructure protection during natural catastrophes such as earthquakes, hurricanes, and strong winds. Continuous structural health monitoring could provide data from the inside of a structure to better understand its structural performance and to forecast its stability and remaining life time. In Europe, many structures originate from the middle of the last century replacing structures destroyed during the Second World War. Concrete structures are typically designed for a 50- to 100-year life. This problem becomes even more evident at railway bridges that are confronted with increasing axle loads and higher train speeds that already very often exceed the structure is for. In this context a European Research Project was approved in the Sixth Framework Program [Sustainable Bridges 2007] where, among others, the Department of Nondestructive Testing and Monitoring of the University of Stuttgart was involved. Monitoring techniques that could help the bridge owners to specify the real structural behavior of their bridge stock in paper [1].

Risk of buildings and civil engineering structures from natural hazards is large and growing. The 1995 Kobe earthquake in Japan killed over 6,400 people and the number of completely destroyed buildings and houses was over 100,000. The 2004 and 2007 Niigata earthquake in Japan, tsunami by the 2004 Indian Ocean earthquake, and the 2005 Hurricane Katrina in New Orleans caused heavy damage. Wireless sensor network (WSN) is key technology to realize the present computing and networking environment and it is expected that such an advanced technology will play an important role for natural hazard mitigation. A research on present part of the structure of buildings are monitored by using wireless sensor networks is discussed and actual application to high-risk buildings are described [2]. A survey of Wireless Sensor Networks technologies, main applications and standards, features in WSNs design with case study, and evolutions in paper [3]. The past decade, has seen several research activities that have been taking place to develop wireless monitoring system, fire alarm, toxic gas leakage remote automatic sound alarm [4].

III.SYSTEM ARCHITECTURE

The Block diagram of the system architecture is shown in the figure .1.

A. Micro Electro Mechanical Systems (MEMS)

The ADIS16220 is a ±70 *g 2*-Axis accelerometer with digital output .It is with 22 kHz sensor resonance and 100.2 KSPS sample rate provide enough response for most machine-health applications. The averaging/decimating filter provides optimization for lower bandwidth applications. The ADIS16220 is a digital vibration sensor that combines Indus ture, and a suitable serial peripheral interface (SPI). The serial peripheral interface (SPI) and data buffer structure provide suitable access to wide-bandwidth sensor data. The device is in a 9.2 mm × 9.2 mm × 3.9 mm LGA package. It has an extended operating temperature range of −40°C to +125°C. The ADIS16220 also offers a digital temperature sensor, digital power supply measurements, and peak output capture. An internal clock drives the data sampling system, which fills the buffer memory for user access. The data capture function has three different trigger modes: automatic data collection, manual data capture, event capture mode.

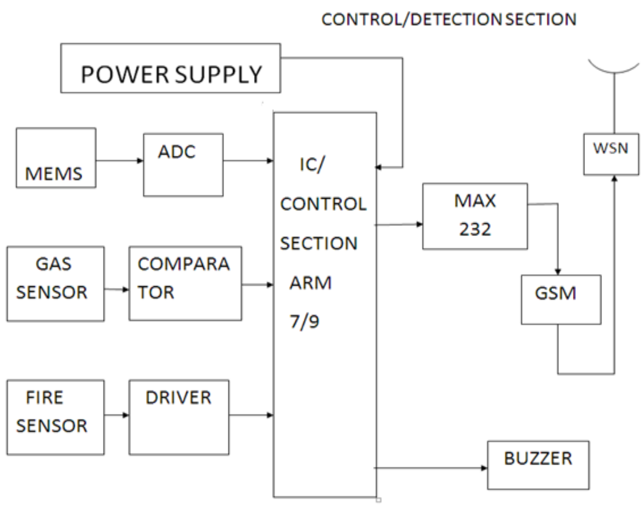

Figure 1.Block diagram of the sensor module.

The automatic data collection allows for periodic wake-up and capture, based on a programmable duty cycle. The manual data capture mode allows the user to initiate a data capture, providing power and read-rate optimization. The event capture mode continuously updates the buffers and monitors them for a preset trigger condition. This mode captures pre-event data and post-event data and produces an alarm indicator for driving an interrupt.

B. GAS Sensor

GAS sensor MQ-6 in Figure 2 is used to detect the presence of dangerous flammable gas leaking . It has high sensitivity to propane, butane and LPG, also response to natural gas. This sensor could be used to identify different combustible gas, especially Methane: it is with low cost and suitable for different application. Sensitive material of MQ-6 gas sensor is SnO2, which with lower conductivity in clean air. This sensor can detect gas concentrations anywhere from 100 to 10000ppm.

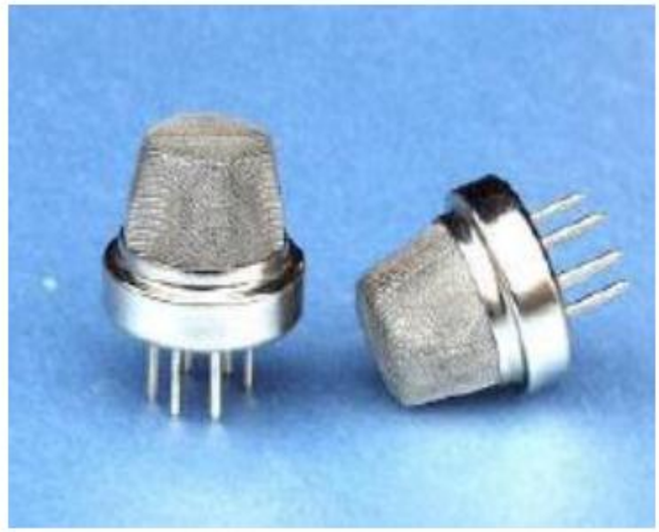

Figure 2 . MQ-6 gas sensors.

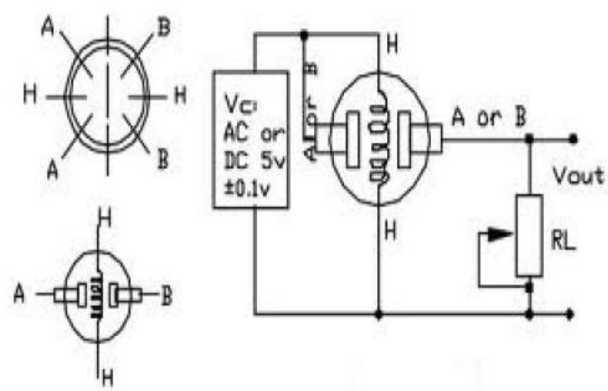

Figure .3 Gas sensor circuit diagram.

Due to the high sensitivity and low cost, semiconductor gas sensors are preferably suited for safety and security applications. To evaluate the performance of gas sensors, several indicators should be considered: (1) sensitivity: the minimum value of target gases' volume concentration when they could be detected; (2) selectivity: the capability of gas sensors to recognize a specific gas among a gas mixture;(3) response time: the period from the time when gas concentration reaches a exact value to that when sensor generates a warning signal; (4) energy consumption; (5) reversibility: whether the sensing materials could come back to its original state after detection; (6) adsorptive capacity (also affects sensitivity and selectivity); (7) fabrication cost. Besides, gas sensors should exhibit a stable and reproducible signal for a period of time. Gas sensor circuit digram is shown in figure 3.

C. Fire sensor

The AD22100 is a monolithic temperature sensor with on-chip signal conditioning. It can be operated over the temperature range −50°C to +150°C, making it ideal for use in abundant HVAC, instrumentation, and automotive applications. The signal conditioning eliminates the need for any extra, buffering, or linearization circuitry, greatly simplifying the system design and reducing the overall system cost. The output voltage is proportional to the temperature x the supply voltage. The output swings from 0.25 V at −50°C to +4.75 V at +150°C using a single +5.0 V supply.

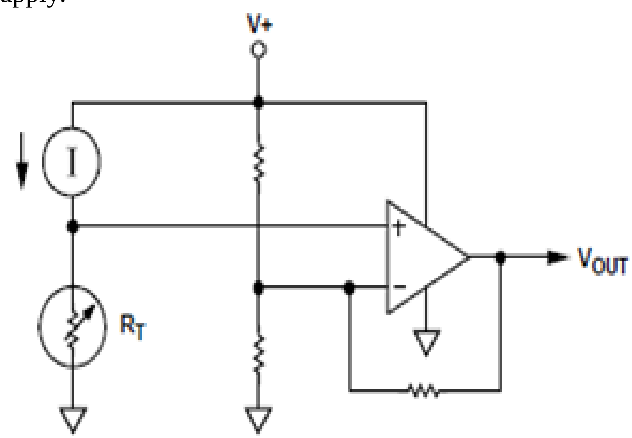

Figure.4 Block diagram of fire sensor.

Due to its ratio metric nature, the AD22100 offers a cost-effective solution when interfacing to an analog-to-digital converter. This is capable by using the ADC's +5 V power supply as a reference to both the ADC and the AD22100 eliminating the need for and cost of an accuracy reference. In this LM35 is used as comparator.Figure4 shows block diagram of fire sensor.

D. Microcontoller

In this paper, ARM7TDMI-S is used, which is a general purpose 32-bit microprocessor, which offers high performance and very low power utilization**.** Microcontroller is used to perform three tasks converting analog signals to digital signal,timer and triggering. The microcontroller takes in three inputs from the MEMS, GAS and FIRE sensor.whenever any distrubances observed by these three sensors the input signal from the various sensors is taken by microcontroller. The microcontroller will then select the task to be performed and after processing the task it will then display the output on the LCD. Buzzer will be turned ON for the specified operation. The output of microcontroller is given to MAX232 where RS 232 IC is a driver IC used to convert the microcontroller TTL logic (0-5) to the RS 232 logic (±9v). Many device today, work on RS 232 logic such as PC, GPS, GSM etc. So, in order to communicate with such devices we have to bring the logic levels to the RS232 logic (±9v).

E. Global System for Mobile communication (GSM)

GSM RS232 Modem is built with SIMCOM Makes SIM300 Quad-band GSM engine, Works on frequencies 850 MHz, 900 MHz, 1800MHz and 1900 MHz it is very condensed in size and easy to use as plug in GSM Modem. The baud rate can be configurable from 9600-115200 through AT command. Modem with a low power consumption of 0.25 A during normal operations and around 1 A during transmission. It uses the highly popular SIM300 module for all its operations. It comes with a standard RS232 interface which can be used to easily crossing point the modem to microcontrollers and computers. It provides serial TTL interface for easy and direct interface to microcontrollers. When AT commands are send to the GSM module by the microcontroller, the receive (Rx) and transmit (TX) pin of the GSM module's RS232 port are connected to the transmit. (TX) and receive (Rx) pin of ARM7TDMI-S serial port, respectively. This eliminated the role of computer and just the controller's circuit provides a complete user interface for the module.

IV.CONCLUSION

The existing state of building automation systems has been studied, identified and the five areas that over-involved consumer adoption of such technologies include; complexity and expense of the architectures, the intrusiveness of the system installations, the lack of interoperability between different home automation technologies, and the lack interoperability between system developed by different manufacturers that utilize the same technology. A building automation system is proposed and implemented, using wired communication. The use of wired communication technology helps lower the expense of the system and the intrusiveness of the respective system installation. The appropriateness of the proposed architecture and its possibility has lead to the creation of a low cost, flexible and secure system. The proposed system being highly developing project with further scope for experimentation, the outcome of it is worthy of further analysis. The critical success for the research will be the completion of a whole cycle of control between a remote device and the building. Once this is done a tedious study has to be carried out about how users and the system interact. This concept can also be extended to Bridges.

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