Building Risk Monitoring From Earthquakes Using Wireless Sensor Network

Rubeena Khatoon
M.Tech Student Scholar
Department of Electronics & Communication Engineering,
VIF College Of Engineering and Technology,Himayathnagar,RR DT Telangana, India
EMail : ruby.cute178@gmail.com

Mrs. Imthiaz Unnisa Begum
Head Of The Department of Electronics & Communication Engineering,
VIF College Of Engineering and Technology
Himayathnagar,RR DT Telangana, India.
EMail: imthiazunnisa19@gmail.com

Abstract: Analysis of the stability of the building is a needed measurement process for all buildings in the cities. Periodic monitoring of the structure for such damage is therefore a key step in rationally 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 economically viable, the sensor modules must be wireless to reduce installation costs, must operate with a low power consumption to reduce servicing costs of replacing batteries, and use low cost sensors that can be mass produced such as MEMS sensors.

Keywords: MEMS sensors

(I) INTRODUCTION

Due to the Natural calamity, Material aging, Design error the buildings can get damage during their lifetime, to eradicate this kind of problem a continuous monitoring on the building should be maintained. It's very difficult to monitor manually, Hence automatic system should be proposed for safety and serviceability of the buildings and humans. The emergence of wireless sensor networks has enabled new classes of applications for distributed systems that filter into very many interdisciplinary fields. These networks have been used for solving problems in the fields of distributed control, tracking and inventory, structural monitoring, fire-safety, habitat monitoring etc.However, in order for the installation of a permanently installed sensing system in buildings to be economically viable so a wireless sensor should be made in low cost that can be mass produced such as MEMS sensors. The capability of MEMS and wireless networking for monitoring civil structures is well documented.

(II) System Architecture

Two types of sensor modules have been developed in the monitoring system i.e., Strain sensing modules and Acceleration sensing modules. They are placed in the building as the lowest level of the building the strain sensor modules are mounted for the estimating the vertical column loads and to measure the settlement and the plastic hinge activation of the building after an earthquake. Horizontal acceleration is measured by two 3D acceleration sensing modules (where only the two horizontal axes are really required) at each level during an earthquake, allowing analysis of the seismic response of the whole structure. To monitor a building for e.g. a 7-story, 24-Column building requires approximately 72 strain sensors (3 per column) and 14 accelerometer modules (2 per floor).

The data received by the sensor system is wirelessly transmitted by the base station using a line of sight link with a range of less than 1 km. The line of sight link uses directional antennas to improve the link budget, but not so directional that alignment is required, which could pose a problem during seismic events. The receiver base station can store and process the data or forward them, immediately or later, using classical wide area network connection technology.

The modules and the receiver base station will have the battery back-up power, which records the data acquired during seismic events even in case of outages of the electric power and communication networks. Multi hop network architecture is used to form a robust wireless link from all modules, including the strain sensor modules at the basement of the building towards the receiver the base station. A router module (without sensor) is placed at the roof of the building to forward the data between the sensor network and the receiver base station. Some accelerometer modules on intermediate floors can be configured as additional intermediate routers when required to obtain a robust link from all sensor modules in the building towards the roof router module. It is recommended to place the router modules in or close to the stairwell for improved vertical floor-to-floor propagation through the building.

In the sensor modules to consume low power the network is implemented using indirect data transfer using polling on top of a standard 802.15.4 MAC. In this way, the end nodes' radio is powered down most of the time. Only the routers and base station have their receivers constantly on. To avoid the battery depletion, the modules with router functionality are mains-powered through an AC/DC adapter, with the battery serving only for back-up power in case mains power is interrupted.

The end nodes (i.e., the large majority of installed sensor modules) are powered exclusively by their battery.

(III) MEMS SENSORS

A wireless sensor network plays an important role in such strategies and can be connected to the internet so that this information can be used to monitoring future risks. Wireless sensors are easy to install, remove, and replace at any location, and are expected to become increasingly smaller (i.e., “smart dust”) by using MEMS technology.MEMS are the most appropriate devices for motion compensation which is a technology that in its most general form can be defined as miniaturized mechanical and electro-mechanical elements (i.e., devices and structures) that are made using the techniques of micro-fabrication. The critical physical dimensions of MEMS devices can vary from well below one micron on the lower end of the dimensional spectrum, all the way to several millimetres. They will provide a ubiquitous, networked sensing environment in buildings. For example, the acceleration and strain at numerous locations on each beam and column, temperature and light in each room, images and sounds in desired regions can be obtained by the “smart dust” sensors, as illustrated in. Additionally, a single type of sensor such as a condenser microphone can be used for multiple purposes, for example, to detect earthquake, fires and intrusions. Furthermore, a fiber optic network is not only utilized as infrastructure for information technology, but also as a “wired” sensor network. Table 1 shows various kinds of hazards, and possible applications/combination of sensors.

Table 1 Sensor Applications

Hazard	Application	Sensor
Earthquake/ Wind	Observation	Acceleration
	Experiment	Acceleration, Strain
	Structural Control	Acceleration
	Health monitoring	Acceleration, Strain
	Damage detection	Acceleration, Strain, displacement
Fire	Fire Detection	Temperature, Smoke, Acoustic, Acceleration, Olfactory
	Gas leak detection	Olfactory
	Alarm Warning	Sounder
	Evacuation Control	Temperature, Smoke, Acoustic, light, Olfactory
Crime	Surveillance	Acceleration, Acoustic, Light, Camer
	Security	Sounder

(IV) EXISTING SYSTEM

There is no proper system for measuring the stability of the buildings hence we go for the proposed system.

DISADVANTAGES:

- Stability is very less.
- Low reliability

(V) PROPOSED SYSTEM

In this project we have MEMS accelerometer to sense the shaking of the building which in sends to the microcontroller which in turn sends to the monitoring section through Zigbee wireless technology. Here we have two sections, the floor section has Arduino microcontroller, Zigbee device and MEMS accelerometer. The monitoring section has ARM 11, ETHERNET and a Zigbee wireless device, which will collect the data from the floor section and analyze the stability of the building.

ADVANTAGES:

- Prevention of devastation
- Can be implemented in multi storey building in the city area.
- The major advantage of this system is the use of wireless communication to transfer the data.
- Usage of cable is removed.
- Easy to implement and low cost technique.

(VI) BLOCK DIAGRAM

Building Section

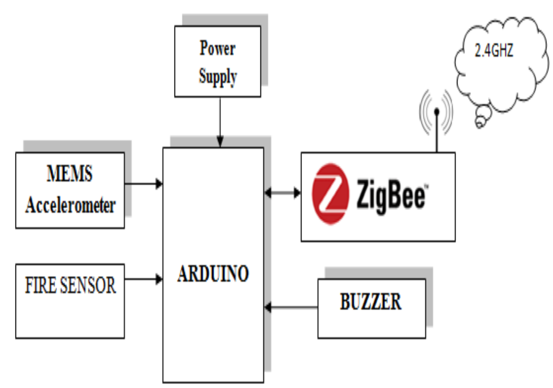

FIG 1 Block Diagram of floor

p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 03 Issue 17
November 2016

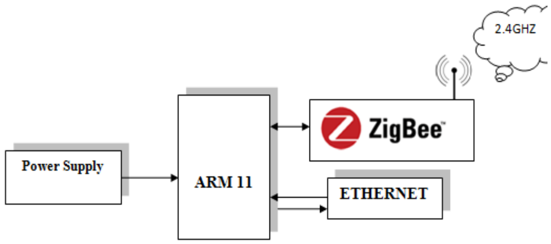

FIG 2 Block Diagram of Monitoring Section

(VII) HARDWARE COMPONENTS

A. Raspberry Pi

Raspberry Pi [7] could be a tiny laptop board engaged on the UNIX software package that connects to a laptop monitor, keyboard, and mouse. Raspberry Pi is applied to a electronic structure and programming network work, it can even served as a private laptop and Apache Web server, MySQL may be put in within the board. A GPIO [10] pin are often used as either a digital input or a digital output, and each operate at three.3V. in contrast to the Arduino, the Raspberry Pi that doesn't have any analog inputs. For that you simply should use AN external analog-digital converter (ADC) or connect the Pi to AN crossing point panel should be used.

Fig. 3 the Raspberry Pi B+ Board

B.ARM 11: ARM is a 32-bit RISC processor architecture developed by the ARM corporation. ARM processors possess a unique combination of features that makes ARM the most popular embedded architecture today. First, ARM cores are very simple compared to most other general-purpose processors, which means that they can be manufactured using a comparatively small number of transistors, leaving plenty of space on the chip for application specific macro cells. A typical ARM chip can contain several peripheral controllers, a digital signal processor, and some amount of on-chip memory, along with an ARM core. Second, both ARM ISA and pipeline design are aimed at minimizing energy consumption — a critical requirement in mobile embedded systems. Third, the ARM architecture is highly modular: the only mandatory component of an ARM processor is the integer pipeline; all other components, including caches, MMU, floating point and other co-processors are optional, which gives a lot of flexibility in building application-specific ARM-based processors. Finally, while being small and low-power, ARM processors provide high performance for embedded applications.

For example, the PXA255 X Scale processor running at 400MHz provides performance comparable to Pentium 2 at 300MHz, while using fifty times less energy.

C. Arduino

Arduino is AN ASCII text file microcontroller compatible with developed platforms. The controller seems to not be costly and uses low electric power, 5.5 volts. C and C++ were utilized for this development. Arduino will hook up with a laptop via the Universal Serial Bus (USB) and perform with compatible connected accessories in each analog signal and digital signal. The Arduino [9] could be a microcontroller platform, mounted on a board that plugs simply into most computers. It permits the user to program the aboard Atmega chip to try to to numerous things with artificial language, in programs referred to as sketches.

D. ETHERNET:

Ethernet is a family of computer networking technologies for local area networks (LANs) commercially introduced in 1980. Standardized in IEEE 802.3, Ethernet has largely replaced competing wired LAN technologies. Systems communicating over Ethernet divide a stream of data into individual packets called frames. Each frame contains source and destination addresses and error-checking data so that damaged data can be detected and re-transmitted. The standards define several wiring and signaling variants. The original 10BASE5 Ethernet used coaxial cable as a shared medium. Later the coaxial cables were replaced by twisted pair and fiber optic links in conjunction with hubs or switches. Data rates were periodically increased from the original 10 megabits per second, to 100 gigabits per second.

E.FIRE SENSOR

FIG 4 Fire sensor

There are several types of flame detector. The optical **flame detector** is a detector that uses optical sensors to detect flames. There are also ionization flame detectors, which use current flow in the flame to detect flame presence, and thermocouple flame detectors.

Infrared Flame Detector

Infrared (IR) flame detectors work within the infrared spectral band. Hot gases emit a specific spectral pattern in the infrared region, which can be sensed with a thermal imaging camera (TIC) a type of thermo graphic. False alarms can be caused by other hot surfaces and background thermal radiation in the area as well as blinding from water and solar energy. A typical frequency where single frequency IR flame detector is sensitive is in the 4.4 micrometer range. Typical response time is 3-5 seconds.

F.ZIGBEE TECHNOLOGY

- There are a multitude of standards that address mid to high data rates for voice, PC LANs, video, etc. However, up till now there hasn't been a wireless network standard that meets the unique needs of sensors and control devices. Sensors and controls don't need high bandwidth but they do need low latency and very low energy consumption for long battery lives and for large device arrays.
- There are a multitude of proprietary wireless systems manufactured today to solve a multitude of problems that also don't require high data rates but do require low cost and very low current drain.
- These proprietary systems were designed because there were no standards that met their requirements. These legacy systems are creating significant interoperability problems with each other and with newer technologies.

WORKING PRINCIPLE:

In this project, we are giving the complete description on the proposed system architecture. Here we are using Raspberry Pi board as our platform. It has an ARM-11 SOC with integrated peripherals like USB, Ethernet and serial etc. On this board we are installing Linux operating system with necessary drivers for all peripheral devices and user level software stack which includes a light weight GUI based on XServer, V4L2 API for interacting with video devices like cameras, TCP/IP stack to communicate with network devices and some standard system libraries for system level general IO operations. The Raspberry Pi board equipped with the above software stack is connected to the outside network and a camera is connected to the Raspberry Pi through USB bus.

The architecture of the web server has the following layers.

- In the lower level the web server has the physical hosting interfaces used for storing and maintaining the data related to the server.
- Above the Physical hosting interface the server has HTTP server software and other web server components for bypass the direct interaction with the physical interaction with the lower levels.
- The final layer has the tools and services for interacting with the video streams which includes the Image codec and storing interfaces, connection managers and session control interfaces etc.

After connecting all the devices power up the device. When the device starts booting from flash, it first load the linux to the device and initialize all the drivers and the core kernel. After initialization of the kernel it first check weather all the devices are working properly or not. After that it loads the file system and start the startup scripts for running necessary processes and daemons. Finally it starts the main application. When our application starts running it first check all the devices and resources which it needs are available or not. After that it check the connection with the devices and gives control to the user.

Applications:
Remote device control, automated control of home appliances, Surveillance.

Advantages:
• As ARM11 CPU is used, future modification is done easily according to our need.
• It can be modified & can be applied to other automation applications also.

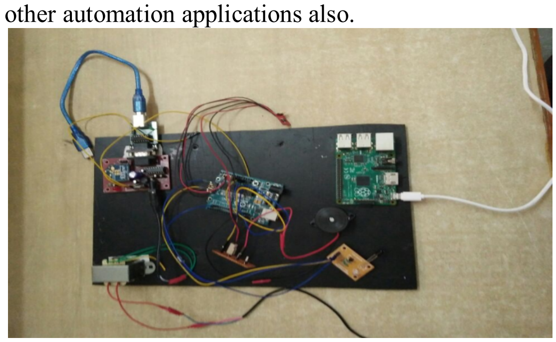

FIG 5 Output screen

(VIII) FUTURE SCOPE

- The cost of ARM11 is more that's why in future we can implement this system using ARM CORTEX A8, Beagle bone etc as well as updated processors with high frequencies will work fine.

- As the storage space is also less in future we can also record these live streaming data by connecting external memory storage.
- We can complete our project using wireless technology.

(IX) CONCLUSION

The project "BUILDING RISK MONITORING FROM EARTHQUAKES USING WIRELESS SENSOR NETWORK" has been successfully designed and tested. It has been developed by integrating features of all the hardware components and software used and tested. Presence of every module has been reasoned out and placed carefully thus contributing to the best working of the unit. Secondly, using highly advanced ARM 11 Processor board and with the help of growing technology the project has been successfully implemented.

REFERENCES

[1] Wireless Medical Technologies: A Strategic Analysis of Global Markets [online]. International Telecoms Intelligence. http://www.itireports.com

[2] G. Y. Jeong, K. H. Yu, and Kim. N. G. Continuous blood pressure monitoring using pulse wave transit time. In International Conference on Control, Automation and Systems (ICCAS), 2005.

[3] K. Hung, Y. T. Zhang, and B. Tai. Wearable medical devices for telehome healthcare. In Procs. 26th Annual International Conference on the IEEE EMBS, 2004.

[4] Fang, Xiang et al: An extensible embedded terminal platform for wireless telemonitoring, Information and Automation (ICIA), 2012 International Conference on Digital Object Identifier: 10.1109/ICInfA.2012.6246761 Publication Year: 2012 , Page(s): 668 - 673

[5] Majer, L., Stopjaková, V., Vavrinský, E.: Sensitive and Accurate Measurement Environment for Continuous Biomedical Monitoring using Microelectrodes. In: Measurement Science Review. - ISSN 1335- 8871. - Vol. 7, Section 2, No. 2 (2007), s. 20-24.

[6] Majer, L., Stopjaková, V., Vavrinský, E.: Wireless Measurement System for Non-Invasive Biomedical Monitoring of Physiological Processes. In: Journal of Electrical Engineering. - ISSN 1335-3632. - Vol. 60, No. 2 (2009), s. 57-6