A Novel SHM Approach for Bridge Monitoring and Alert Generation System Using IOT

[1]R.Nandhini., [2]A.Amirtha, [3]M.Pavithra, [4] N.lakshmi priya,[5]A.N.Sivadharshini
[1] UG Scholar, Mangayarkarasi college of Engineering,Madurai
[5]Assistant Professor, Mangayarkarasi college of Engineering,Madurai

Abstract

Many of the bridges in cities built on the river are subject to deterioration as their lifetime is expired but they are still in use. They are dangerous to bridge users. Due to heavy load of vehicles, high water level or pressure, heavy rains these bridges may get collapse which in turn leads to disaster. So these bridges require continuous monitoring. So we are proposing a system which consists of a weight sensor, water level point contact sensor, WI-FI module, and Arduino microcontroller. This system detects the load of vehicles, water level and pressure. If the water level, water pressure and vehicle load on the bridge cross its threshold value then it generates the alert through buzzer and auto barrier. If it is necessary then the admin assign the task to the employees for maintenance

I. INTRODUCTION

Bridge monitoring aims to provide an accurate diagnosis of the condition of civil infrastructures during their life-span by analyzing data collected by sensors. To this purpose, detection and localization of damages are fundamental tasks. This paper introduces a wireless sensor network for Bridge damage detection and localization in which the sensor nodes, in order to estimate the energies of specific frequency bands, process the acceleration data locally in real-time using the Goertzelalgorithm.

In this study, a new wireless sensing unit for operation within an automated Bridge Monitoring (SHM) system is proposed, designed and validated. The design of the wireless sensing unit emphasizes minimization of its power consumption characteristics to ensure it is suited for long-term field deployment in civil structures.

An important fundamental element of all BM systems is the data acquisition (DAQ) system that is used to collect and store sensor measurements in a centralized location. Current commercial DAQ systems designed for permanent installation in civil structures are often adaptations of laboratory based systems that employ coaxial wires between sensors and the data repository

II. EVALUATION OF BRIDGE MONITORING TECHNOLOGIES

Hardware and software realization of these design objectives are presented in detail within this paper. After the wireless sensing system is designed and constructed, an extensive amount of laboratory and field testing is conducted to validate the system performance within the complex environment posed by civil structures. Wireless sensor networks (WSNs) have the capability to efficiently reach the main goals of Bridge monitoring (BM), which consists of accurately diagnosing the of civil infrastructures such as bridges, dams, road tunnels, etc. from data collected by sensors. Specifically, BM targets a correct detection, localization, and quantification of Bridge damages, and the assessment of the remaining life time of the monitored structure. Compared to the traditional wired systems, the advantages of applying WSNs to BM are many: firstly, by eliminating the cabling, they allow consistent savings in installation time and costs. Moreover, the low cost of the nodes composing the wireless network allows the deployment of a large number (potentially hundreds) of measurement units on the structure, thus increasing the total amount of data available for off-line analysis and improving the screening resolution of the system. However, the design and implementation of a reliable and efficient low-power WSN for BM is made challenging by the limitations of the sensor nodes in terms of available power, micro-controller unit (MCU) computational power, RAM memory space, and, in the case of low-power IEEE 802.15.4 radios, communication bandwidth and range. Some of the requirements of BM, such as high time synchronization accuracy and storage and transmission of large data sets, are not straightforward to be implemented in a multi hop network. Among all the operations that a sensor node can perform, transmissions and receptions of packets have by far the heaviest impact on power consumption. Due to this fact, it becomes particularly important to minimize the amount of data that need to be transmitted in the network, especially when the number of hops from the data source to the sink node is high.

3.Reduce system latency and facilitate applications with a reduce tolerance for delay; future latency enhancements on the means of communication relation bottle plus be quite realized.

This project presents a WSN in which the nodes, equipped with a 3-axis accelerometer, process the collected vibration measurements by the Goertzel algorithm [1] in real-time. The nodes then share the results of the computations inside the network in order to derive transmissibility functions, which are finally exploited to correctly detect and localize Bridge damages. By applying the Goertzel algorithm, the nodes perform a frequency-domain analysis of the acceleration signals in an efficient way: the key parameters of the algorithm are dynamically adjusted by the end-user operating at the sink node to e.g. perform a low resolution scan of the entire frequency spectrum, or accurately monitor those specific ranges of frequencies known to show significant changes in presence of damages. This procedure could also be (partly or totally) automated, and interrupted by the operator only if needed.

A. Flexibility-Based Damage Localization Method

In the proposed architecture, the cluster head nodes first aggregate the power spectrums (obtained by FFT) of the cluster members beneath them in the hierarchy, then extract the mode shapes of the structure which are finally transmitted to the central sink node where the actual flexibility calculation is executed. The latency at the cluster heads (approximately 110 s) can be attributed to time synchronization of the sensor nodes and data transmission from the cluster members to their cluster heads. Indeed, WSNs are gradually becoming prevalent for BM applications, focusing on reliable collections of raw signals at relatively high sampling rates, synchronization

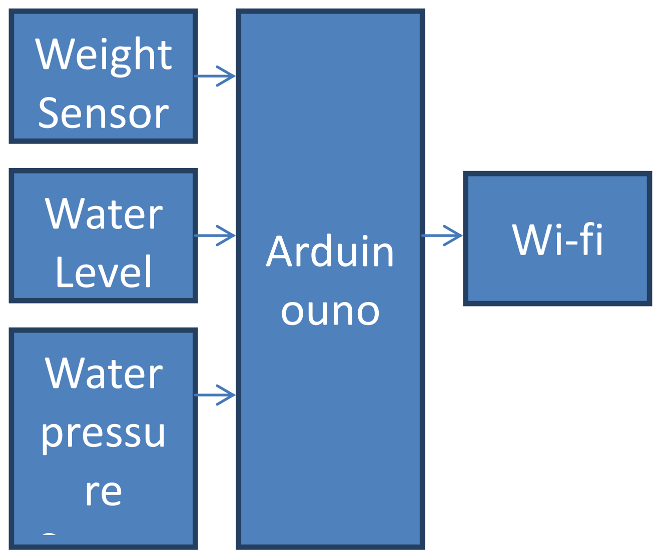
B. Based On The Wired Sensor Deployment

A noteworthy work on WSN deployment, SPEM, is suggested and is also verified on the GNTVT [11]. The main idea of SPEM is to adjust the sensor locations of the structure, using an engineering method to better fit both engineering and CS requirements. However, we found that such adjustments (with a reduction of location quality for sensor placement) may lead to the loss of some optimal locations. This may be inappropriate for BM. In addition, it is fully centralized and may not assure the quality of BM, if a fault on a sensor (which is placed at an optimal location) or on a packet transmission occurs. Moreover, some sensors work as relays form any other sensors to support data collection at the BS. They may fail during operation.

III. PROPOSED SYSTEM

In this proposed system, we will use sensors like weight sensor, water level point contact sensor as sensing devices. These sensors will be responsible for sensing the load on the bridge, pressure of the water,level of the water rising in the river.The data sensed by sensors will get converted into an electrical signal.The devices which generate output are generally called as actuators (buzzer).sensors are collectively called as a tranducer.The electrical signal will get transmitted to the arduino Microcontroller.

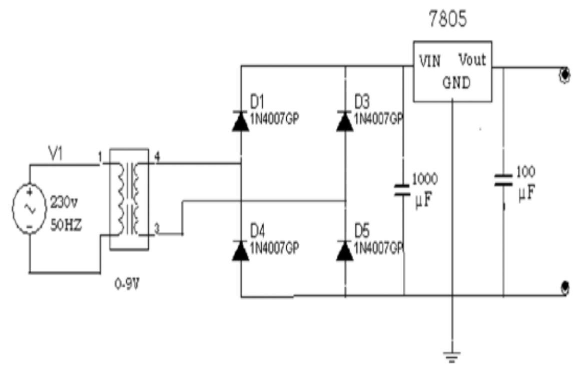
Block Diagram:



Every circuit needs a source to give energy to that circuit. The Source wills a particular voltage and load current ratings. The following is a circuit diagram of a power supply. We need a constant low voltage regulated power supply of +5V, providing input voltages to the microcontroller RS232, LM311 and LCD display which requires 5 volts supply.

Every power supply has the following parts,

- **Transformer**
- **Rectifier**
- **Capacitor (filter)**
- **Regulator**
- **Resistors**



Arduino Uno

Arduino is an open-source computer hardware and software company, project and user community that designs and manufactures kits for building digital devices and interactive objects that can sense and control the physical world. Arduino boards may be purchased preassembled or as do-it-yourself kits; at the same time, the hardware design information is available for those who would like to assemble an Arduino from scratch.

The project is based on a family of microcontroller board designs manufactured primarily by Smart Projects in Italy, and also by several other vendors, using various 8-bit Atmel AVR microcontrollers or 32-bit Atmel ARM processors. These systems provide sets of digital and analog I/O pins that can be interfaced to various extension boards and other circuits. The boards feature serial communications interfaces, including USB on some models, for loading programs from personal computers. For programming the microcontrollers, the Arduino platform provides an integrated development environment (IDE) based on the Processing project, which includes support for C and C++ programming languages

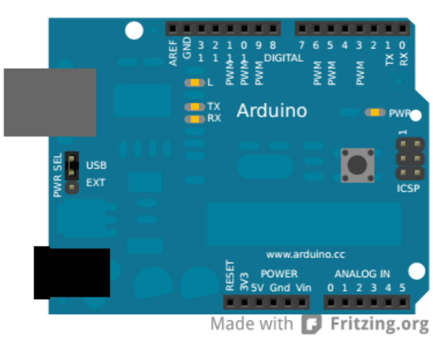


Fig. Arduino Board

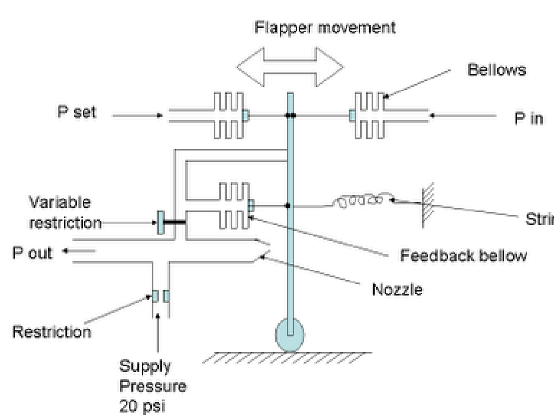
WATER Level sensor

Level sensor

Level sensors are used to detect liquid level. The liquid to be measured can be inside a container or can be in its natural form (e.g. a river or a lake). The level measurement can be either continuous or point values. Continuous level sensors measure level within a specified range and are used to know the exact amount of liquid in a certain place and Point level sensors only measures a specific level, generally this is used to detect high level alarms or low level alarms. There are many physical and application variables that affect the selection of the optimal level monitoring solution for industrial and / or commercial processes. The selection criteria include the physical: state (liquid, solid or slurry), temperature, pressure or vacuum, chemistry, dielectric constant of medium, density or specific gravity of medium, agitation, acoustical or electrical noise, vibration, mechanical shock, tank or bin size and shape; and the application constraints: price, accuracy, appearance, response rate, ease of calibration or programming, physical size and mounting of the instrument, monitoring or control of continuous or discrete (point) levels.

A level sensing from the perspective of the state of the material - solid, liquid, and slurry-type - and how their physical and electrical properties may affect the performance of the sensor. Table 1 lists commonly available level sensors and their suitability for use with different states of materials, and Table 2 lists the physical and electrical characteristics one will need to evaluate before choosing a sensor or sensing technology for their application.

Pneumatic Proportional Derivative controller



In this pneumatic controllers in proportion and proportional integral types. The method discusses about pneumatic controllers with derivative control. A variable restriction is attached before the feedback bellow as shown in the figure and you can find difference between the integral and derivative controllers from the images when you scroll down and you can find a string attached at the other side of the flapper which gives a tension to the flapper to stand with the pivot.

Now let's study this case by assuming that the input pressure P in increases above the set point, the Bellow attached with pin expands the flapper moves in a direction such that it closes the gap between the flapper and nozzle and the output pressure increases directly because the restriction provided prevents the feedback bellow to act immediately . Thus the output increases very fast and then the increased pressure leaks through the restriction into feedback bellows. This leakage provide a force to expand the feedback which will make the flapper to move left and thus the gap increases and output is reduces and the increased input pressure is controlled.

IV. CONCLUSION

The project "Bridge Monitoring and Alert Generation system Using IOT" has been completed successfully and the output results are verified. The results are in line with the expected output. The project has been checked with both software and hardware testing tools. In this work "LCD, Microcontroller, Sensors and WI-FI Modules " are chosen are proved to be more appropriate for the intended application. The project is having enough avenues for future enhancement. The project is a prototype model that fulfills all the logical requirements. The project with minimal improvements can be directly applicable for real time applications. Thus the project contributes a significant step forward in the field of "Monitoring system", and further paves a road path towards faster development s in the same field. The project is further adaptive towards continuous performance and peripheral up gradations. This work can be applied to variety of industrial and commercial applications.

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