Sensor Technology based Fault Detection and Automated gate system for Bridge

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Abstract - *Monitoring the damages in the bridge is an increasing concern for the benefit of public. The major challenge is to ensure that the condition of the civil infrastructure is capable of withstanding the cumulative weight of all the vehicles that travel on the bridge. In this framework, the Bluetooth protocol is used for monitoring the bridge damages that exist and, these damages are identified by using various types of sensors namely MEMS, temperature & fog sensor, water level sensor & fire sensor and the gates of the bridge are closed after certain duration to let the vehicles currently on the bridge to pass it and go to a safer place. Bluetooth sensor network is designed and tested for wireless communication among sensors. GSM technology is used to send the data to the remote location in which the maintenance office is located.*

***Key Words*: MEMS, Temperature & Fog Sensor,Water level Sensor, GSM, Fire Sensor, Ardino UNO**

1. INTRODUCTION

Advancements in sensor technology have brought about the changes in automated real-time bridge fault detection and closure system. Current system uses complicated and high cost wired network amongst sensors in the bridge and high cost optical cable between the bridge and the management centre, which increases the overall cost of installation and maintenance cost of the monitoring system. The complicated wiring also makes the installation and repair/replacement process difficult and expensive. However, regardless of the advancements of the sensors and sensor data processing technologies, there is one thing that has not been changed: data communication through wires and optical cables. The advancement in wireless technology has been made use in this research and sensor devices such as accelerometer and strain gauge and Bluetooth module, which are combined to make a single fault detection system.

The technology used in this research is called MBM (Monitoring Based Maintenance) that enables the bridge maintenance engineers; monitor the condition of the bridge in real time. The sensors installed on main cables, hangers, decks, towers, etc. detect the strain, acceleration, temperature and wind. The sensory inputs are processed to represent the condition of the bridge against seismic loads and wind loads which in turn signal the maintenance officers and also close the gates of the bridge after some time interval to unload the bridge off the vehicles.

2. LITERATURE SURVEY

Structural health monitoring (SHM) systems have shown great potential to sense the responses of a bridge system, diagnose the current structural conditions, predict the expected future performance, provide information for maintenance, and validate design hypotheses. In [1] wireless sensor networks (WSNs) that have the benefits of reducing implementation costs of SHM systems as well as improving data processing efficiency become an attractive alternative to traditional tethered sensor systems. This paper introduces recent technology developments in the field of bridge health monitoring using WSNs. As a special application of WSNs, the requirements and characteristics of WSNs when used for bridge health monitoring are firstly briefly discussed. Then, the state of the art in WSNs-based bridge health monitoring systems is reviewed including wireless sensor, network topology, data processing technology, power management, and time synchronization. Following that, the performance validations and applications of WSNs in bridge health monitoring through scale models and field deployment are presented. Finally, some existing problems and promising research efforts for promoting applications of WSNs technology in bridge health monitoring throughout the world are explored.

Structures, including pipelines, airplane, ships and common frameworks, for example, spans, structures, dams, among others, are significant pieces of society's financial and mechanical achievement. In [2] extensions are one of the basic cross purposes of a nation's vehicle organize yet they are costly to assemble and keep up. It is fundamentally basic to keep interface hurts from normal disasters, for instance, tropical storm flood, seismic tremor, etc. As requirements be, the thought on water fueled realized framework frustration has been gotten in view of scour issues. Regardless, in-situ interface scour watching is as yet one of the unpleasant works for examiners in their field applications. Guarantee that the platform checking system under typical disasters can function admirably. By imparting advised signs, the progressing information can offer planners to choose right decision and take fitting exercises in time while the augmentation hurt occurs. This audit associated the imaginative scour watching techniques which have been laid out and made in the exploration office, and can be presented and attempted in the field. An innovative remote sensor framework was moreover used to assemble the platform watching system with varied sensors. Watchword: ARM1, GSM2, Sensors3, ZIGBEE4, get together language5 and so forth.

The existing system presents the development and testing of a wireless bridge monitoring system designed [3] within the Laboratory for Intelligent Infrastructure and Transportation Technologies (LIITT) at Clarkson University. The system interfaces with low-cost MEMS accelerometers using custom signal conditioning for amplification and filtering tailored to the spectrum of typical bridge vibrations, specifically from ambient excitation. Additionally, a signal conditioning and high-resolution ADC interface is provided for strain gauge sensors. To permit compensation for the influence of temperature, thermistor-based temperature sensing is also enabled.

3. METHODOLOGY

In this System, the Bluetooth protocol is used for monitoring the bridge damages that exist in civil infrastructure, these damages are identified by using three types of sensors namely Memes, temperature & fog sensor, water level sensor & fire sensor.. The sensors installed on main cables, hangers, decks, towers, etc. detect the acceleration, temperature and Water level. If damage in bridge & any fire accidents or fog covered on bridge is detected then via IoT communication the damage detection & condition of the bridge is informed to the Base Station.

The block diagram of the proposed system is shown below.

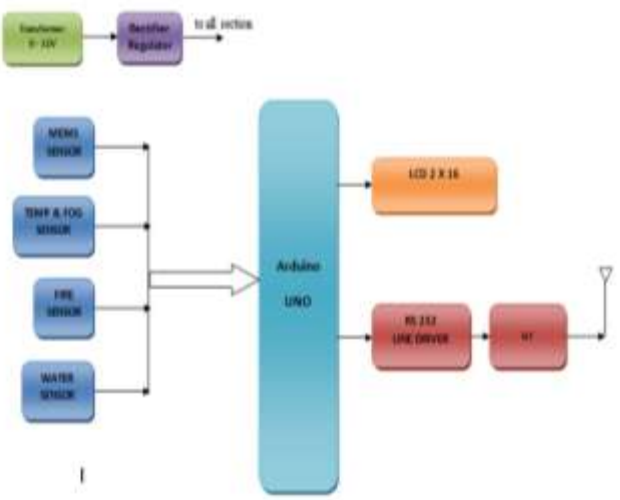


Fig-1. Block diagram of proposed system

2.1 HARDWARE COMPONENTS.

a) MEMS Accelerometer:

The MMA7260QT low cost capacitive micro machined accelerometer features signal conditioning, a 1-pole low pass filter, temperature compensation and g-Select which allows for the selection among 4 sensitivities. Zero-g offset full scale span and filter cut-off are factory set and require no external devices. Includes a sleep mode that makes it ideal for handheld battery powered electronics.

b) TEMPERATURE SENSING CIRCUIT:

In this block, two op-amps are used to form two different stages, the first stage is configured as differential amplifier and the second stage is configured as gain amplifier. In the first stage an 'NPN' General purpose transistor (SL100) is used as a temperature sensor and this transistor is having 'TIN' metal body so that it can absorb the heat properly. This transistor is connected in feedback loop (input to output). This first stage is designed in such a way so that, as the transistor body temperature rises, according to the temperature, the base- emitter or base-collector junction resistance decreases. This first stage is designed to generate 2mv/0C which is not sufficient for the calibration. Hence, using 2nd stage this voltage is amplified, and the gain of the 2nd stage is 10, so that (2x10) 20mv per degree centigrade can be obtained at the output of the second stage. This variable voltage (according to the temperature) from the output of second stage is fed to the analog to digital converter for converting the analog information in to the digital information and this digital information is fed to the microcontroller for taking the necessary action.

c) Temperature and Humidity Sensor

DHT11 is a part of DHTXX series of Humidity sensors. The other sensor in this series is DHT22. Both these sensors are Relative Humidity (RH) Sensor. As a result, they will measure both the humidity and temperature. Although DHT11 Humidity Sensors are cheap and slow, they are very popular among hobbyists and beginners.

d) Fire/Flame Sensor Module:

Flame sensor is the most sensitive to ordinary light that is why its reaction is generally used as flame alarm purposes. This module can detect flame or wavelength in 760 nm to 1100 nm range of light source. Small plate output interface can and single chip can be directly connected to the microcomputer IO port. The sensor and flame should keep a certain distance to avoid high temperature damage to the sensor. The shortest test distance is 80 cm, if the flame is bigger, test it with farther distance. The detection angle is 60 degrees so the flame spectrum is especially sensitive. The detection angle is 60 degrees so the flame spectrum is especially sensitive.

e) LCD DISPLAYS:

Liquid crystal display (LCD) has material which joins together the properties of both liquid and crystals. They have a temperature range within which the particles are essentially as mobile as they might be in a liquid, however are gathered together in an order form similar to a crystal.

f) Wi-Fi ESP8266:

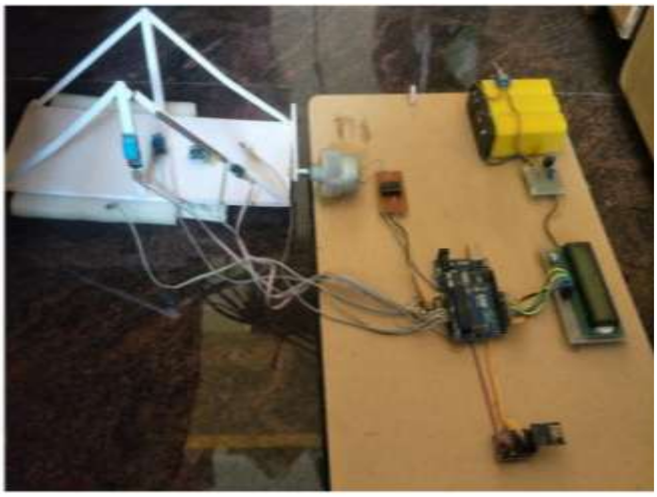
ESP8266 offers a complete and self-contained Wi-Fi networking solution, allowing it to either host the application or to offload all Wi-Fi networking functions from another application processor.

g) Arduino UNO

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

4. RESULTS.

The proposed system was built in the lab and the set up is as shown below.



4.1 Advantages.

- The installation cost is low because the sensors do not require wiring.
- Low maintenance cost and time saving.
- No additional supporting structure such as pipeline for cable is required.
- Sensors are easily replaced when malfunctioning.
- This system makes it possible to measure and manage bridge performance data such as displacement, ambient temperature for evaluation and diagnosis.

5. CONCLUSIONS

This system is intended to recognize the faults around the bridge utilizing Arduino UNO. The interior harms and tilting of extension can be distinguished by Flex and MEMS sensors and nature around the extension can be distinguished by temperature and moisture sensor, flame sensor. The progressions of detecting conditions on bridge and bridge condition will be shown in the LCD and the gates to the bridge will be closed automatically after a stipulated time. The Bluetooth convention is utilized to control and screen the sensors and the distinguished data or information sent to the IC (Arduino UNO). If the fault is identified, through IoT correspondence the fault discovery is sent to the base station.

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