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Real Time River Bridge Monitoring and Alert System using GSM

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Abstract- In India, many bridges built by the British east India company 100 years ago. Due to long time span, it is required to monitor them. The main objective of the proposed system is to read the water level and vibration of the bridge continuously. Upon crossing the threshold level, a short message get send to the observation section periodically by using GSM (Global System for mobile communication).This system may help in flood situation and may be a communication tool between the traveler and government. This proposed system also avoids the traffic jam due to availability of time with users for finding an alternative solution before they are going to be stuck at flood.

Keywords: PIC32MM0256GPM064, LiDAR sensor, vibration sensor, GPS Module GSM Module.

I. INTRODUCTION

The technology is basically designed for betterment of society to solve their problems. We also started the designing of proposed system with same motivation. It is observed in Konkan region that heavy rainfall makes sudden increase in the level of river water. It reduces the strength of the bridges on the river and increases mortality rate. Increase in accidents is a major outcome of this issue. The proposed system avoids such damage by using continuous monitoring and communication with authority. Objectives of proposed work are:

1. To design and develop sensor based bridge monitoring system.
2. To create real time communication system between transmitter and receiving authority.

The system is designed with the use two sensors along with GSM and GPS modules. The paper is organized in six sections. State-of-art is briefed in section II. The complete methodology is explained in section III with detail block diagram and flowchart. Section IV overviews experimentation and results followed by highlighted features of proposed work in section V. The paper concludes with future scope and remarks in section VI.

II. STATE-OF-ART

Major contributions in the field of electronics are given with the use of sensors for data acquisition. We compared various state-of-art methods for security based electronics applications and briefed in table I.

Each technology stated in below table has few merits and demerits. However, real time monitoring requires high speed along with better precision. Thus, proposed system explained in section III uses light detection and ranging (LiDAR) sensor.

Table-1: State-of-Art

Sr. No.	Technology	Ref. No.	Remarks
1	Ultrasonic Sensors	1,2	Low Range & low resolution
2	Wireless Sensor Network (WSN)	3,4	Short range
3	Code Division Multiple Access (CDMA)	5,6	Medium Range Low Data Speed
4	Global System for Mobile (GSM)	7,8,9	User friendly and high data speed
5	Internet of things (IoT)	10,11	Efficient but network dependent

III. METHODOLOGY

We propose complete system for real time monitoring of river bridges. The block diagram of proposed system is given in fig.1.

Real time Detection

Proposed system is attached to lower part of the river bridge for measuring water level of the river and vibration of the bridge.

We used LiDAR and SW-420 vibration sensor as sensing devices. LiDAR has excellent sensing range of 50 meters and resolution 1mm [12]. Based on availability of three UART ports and our required number of external interfaces, PIC32MM0256GPM064 is chosen [13].

Looking at roadside location of proposed application, we made the system electricity independent. It is made possible by replacing electricity by solar energy. Use of solar panel makes the system completely self dependent.

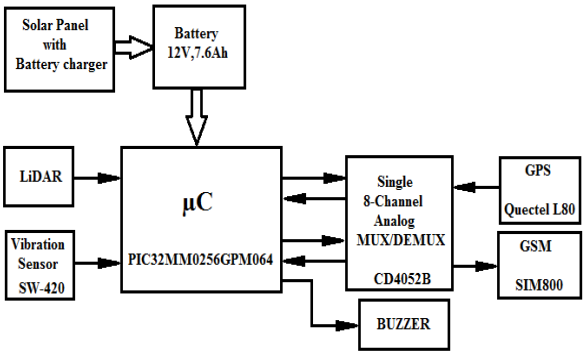

Fig-1: Block Diagram of Proposed System

Two threshold levels are chosen based on height of the bridge to intimate water level. LiDAR is connected to UART3 having baud rate 115200 bits per second, it continuously senses river water level and communicate to microcontroller. Vibration sensor is connected in similar fashion but as an external interrupt to microcontroller.

Single 8-channel analog MUX/DEMUX (CD4052B) is attached to UART2. Two combinations out of four options are used in this proposed system with the baud rate 9600 bits per second as given in table 2.

Table-2: Device selection input combination

Select input		Select Device
S0	S1	
0	0	GPS
0	1	GSM

Communication and Monitoring

Once system is ON, GPS and GSM get initialized sequentially. Four times retry facility is provided in proposed system in case of failure in initialization. Readiness of the system is informed to authority person via SMS through GSM and also indicated at base location by buzzer and LED blinking.

The detection of abnormal water level i.e. above threshold level 1 and 2 by LiDAR is immediately informed to authority person with its latitude and longitude. Non-uniform vibration due to heterogeneous load on bridge is detected on priority basis and indicated to the authority as an external emergency interrupt.

The complete working explained above is showcased in figure 2 and 3.

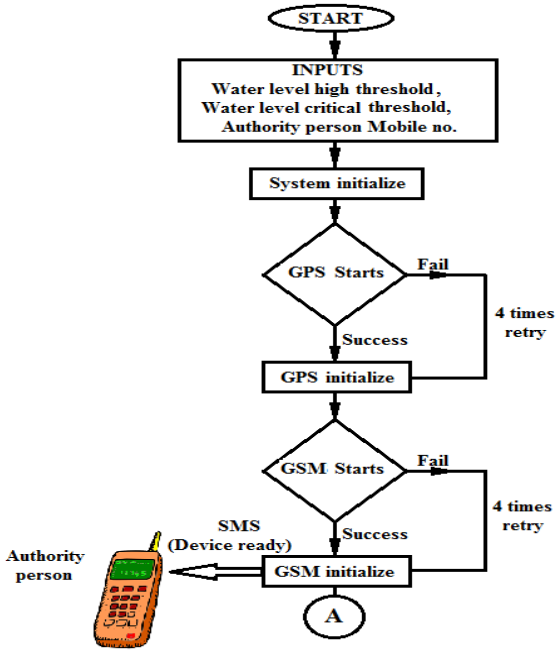

Fig-2: Flowchart (Part-A)

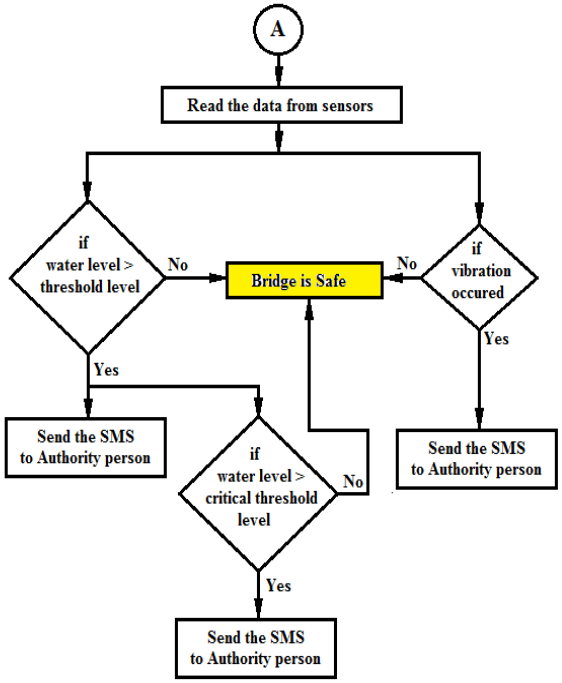

Fig-3: Flowchart (Part-B)

IV. EXPERIMENTATION AND RESULTS

The complete system tested at various nodes and it has given efficient accuracy.

System Setup

Experimental setup is shown in figure 4.

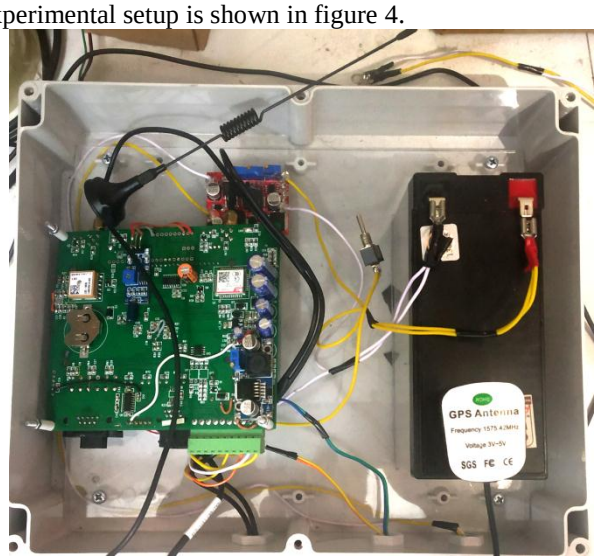

Fig.-4: Experimental setup

Testing is done at five different test points. Intimation of readiness of setup, indication of water level threshold crossing, alarm after critical reach of the water and emergency vibration indication are preferred test points.

Indication through SMS is not kept limited to one time. However, continuous SMS get sent to authority person. It will get stopped after either necessary monitoring done by authority or decrease in the water level below threshold.

Intimation of readiness of setup

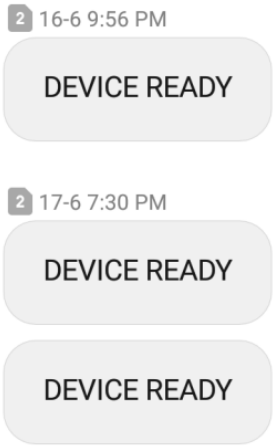

Fig.-5: Readiness indicating SMS

Indication of water level threshold crossing

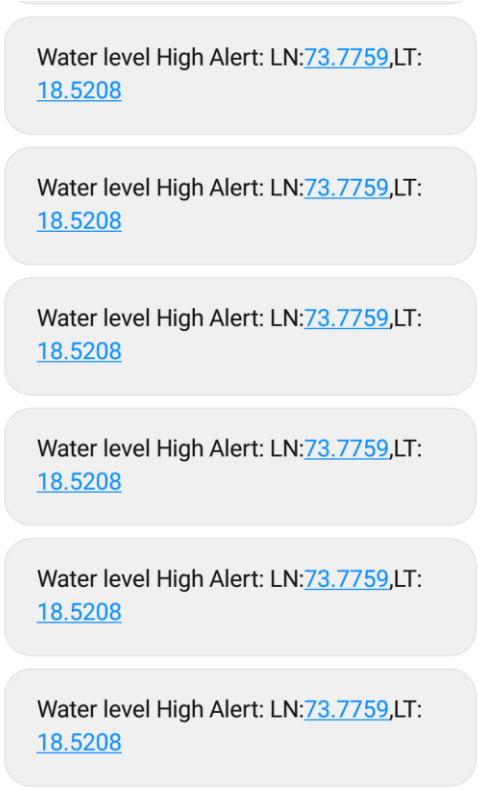

Fig.-6: Water level high alert indicating SMS

Alarm after critical reach of the water and emergency

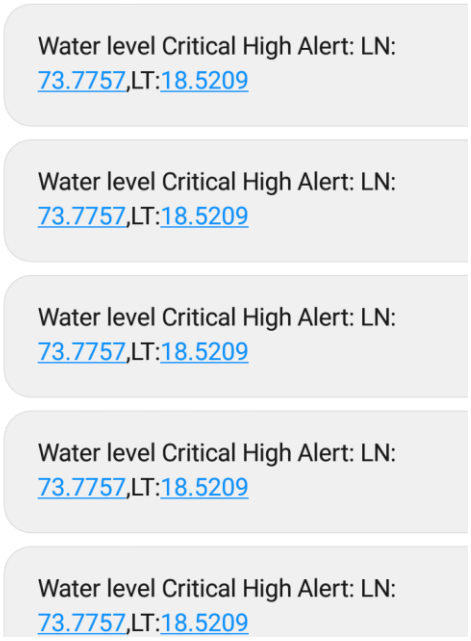

Fig.-7: Water level critical high alert indicating SMS

Latitude and longitude information make the authority awarded about location of the bridge where emergency situation is created.

Emergency vibration indication

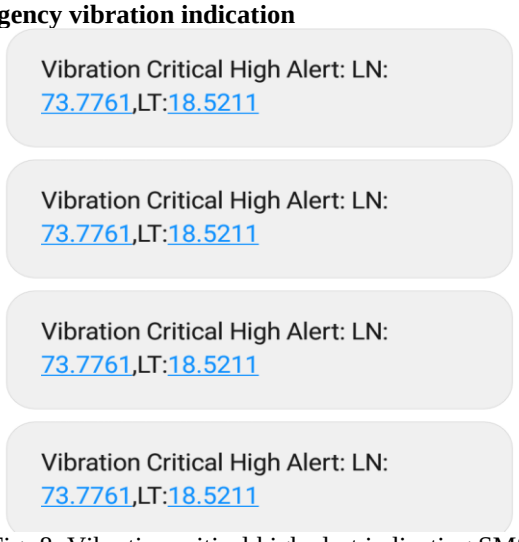

Fig.-8: Vibration critical high alert indicating SMS

Results proved the system performance at various levels. Failure probability is very less irrespective of mobile range issues.

V. HIGHLIGHTED FEATURES OF PROPOSED SYSTEM

Self dependent system

Many of the bridges are in rural area and there is problem with electricity. However, this proposed system has solar panel with large battery backup. Thus, it is self dependent. System can last for a week due to which it can perform well in cloudy days also.

Compact system

In this proposed system, GSM, GPS, CD4052B and PIC32MM0256GPM064 are fabricated on a single board. Therefore this system is very compact and has less external wire connections.

Internet independent

There is no need of internet connection. This system is purely works on the basis of coverage area of GSM.

VI. CONCLUSION AND FUTURE SCOPE

The proposed system has proven its efficiency in real time water level bridge monitoring in rural area. When the water level of the river is greater than threshold level, automatic indication is sent on authority person mobile and also buzzer gets on at bridge side. An authority person also gets the latitude and longitude position of bridge which is useful for monitoring purpose.

Use of load cell to measure actual load on bridge can be an extension of this work. It will make overload indication of the bridge. Connection of displays at both the sides of bridge at a certain distance will give prior indication to travelers and avoid any wrong incidence.

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