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IOT Based Bridge Collapse and Flood Detection System

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Abstract: *Knowledge on the dynamic properties of bridges improves condition assessment, maintenance scheduling and emergency planning to better serve the public. The Crack inspection is an important task in the maintenance of bridge and it is closely related to structural health of the bridge. It is done through a very manual procedure, an experienced human inspector monitors the whole bridge visually and try to detect cracks on the bridge and marks the location of the crack. The proposed system is implemented using a real time wireless sensor network for bridge monitoring is of lossless data transmission over several minutes continuously. Overall information about the bridge will be stored on the cloud. The cracks will be detected automatically and send the real time data with location of crack to the PWD department. If bridge will be collapse because of any accident or a flood that time the barriers will be open and the Vehicles will stop at some distance, and also notify about the accident to the nearby government departments like Police station, Hospitals and Society. After the accident detected by system up to previous and next 5KM the alert notification will shows another route for travellers.*

Keywords: Structural health monitoring, wireless sensor network, Arduino

I. INTRODUCTION

Detecting the bridge health and collapse by using the sensors and notifying the nearest Government Offices like Police Station, PHC to providing the emergency help to the injured People. Notifying the bridge collapsing message to travelers and also to the Transportation Departments by showing signals to previous and next 5km for preventing the traffic. After the bridge was collapsed or the water level will be increased with the maximum pressure then the barrier will be automatically opened and the transportation will be stopped. Detecting the cracks of bridge and predict the health of bridge. The river bridges are usually constructed so as to hold only light weighted vehicles. Bridges play a significant role in the economic development for the conveniences to the traffic and transportation. The frequently collapsed accidents of the bridges endanger social well-being and stabilization. In the view of importance of bridge security. Safety is the major concern in post disaster reconnaissance; after an event such as overflow of water over the bridge, structures have to be examined to determine the extent of damage. To ensure the structural integrity and user safety the regular monitoring and inspection of the bridges is the necessary parameter. To prevent the accidents caused by the poor health bridge evaluating the condition of existing bridges and monitoring the engineering behaviors of new bridges become more significant. These factors, combined with defects of design and construction and accidental damage, prompt the deterioration of bridges and result in the loss of load carrying capacity of bridges. During which they analyzed the causes that lead to many road accidents and established a strategy for avoiding them in the future mainly based on the implementation of Structural Health Monitoring (SHM) systems on bridges. Structural Health Monitoring (SHM) systems aim at implementing damage identification strategies for a struct

II. LITERATURE SURVEY

- In 2007, Harutoshi Ogai, Jong-In Cheon, Ming-Yuan Hsieh, Hiroshi Inujima, Noriyoshi Ya- mauchi developed the system which monitored the level of water, vibration, health of the bridge. Store this information and send to the authorised department.
- In 2015, Shinae Jang and Billie F. Spencer, Jr. next checks the health of bridge, monitor periodically by using

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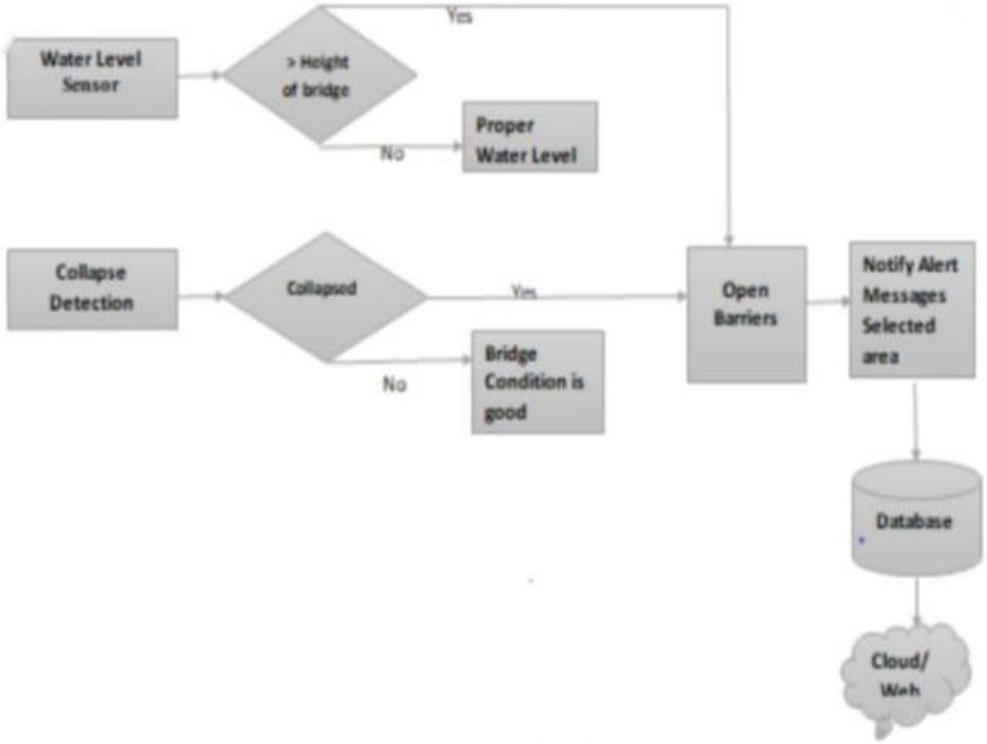
smart sensors and send the data to the server.

- In 2015, Mehrisadat Makki Alamdari ?, Thierry Rakotoarivelo, Nguyen Lu Dang Khoa CSIRO analyze spectral based clustering for structural health monitoring.
- In 2017, Thomas Matarazzoa Mohammad Vazifeha, Shamim Pakzadb, Paolo Santia,cand Carlo Ratti extracting the bridge information from mobile sensor data, it was cover the higher spatial area for notifying the bridge health to travellers.
- In 2018, Xiaolin Meng 1 , Dinh Tung Nguyen, Yilin Xie 1, John S. Owen, Panagiotis Psi-moulis design and implement a New System for Large Bridge Monitoring-GeoSHM. The purpose of the SHM is to help engineers to understand the behaviour of structures, ensuring their structural integrity and the safety of the public. communication and digital multimedia applications such as digital camera, handset video etc.

III. PROBLEM STATEMENTS

Traditional methods of bridge safety management have the following problems: failure to collect data or monitor on-site conditions in real time and failure to comprehensively record or analyze the collected data of on-site conditions in real time, resulting in poor disaster rescue efficiency; and data collection through visual assessments or use of large-size electronic equipment, often resulting in inaccurate monitoring results or higher costs and higher power consumption. A Accelerometer Sensor detect the Vibration of bridges, if Vibrations goes to particular threshold then Barrier will automatically down and also notify to authorized department. A real-time water monitoring system using the water level recognition and surface velocity recognition. Using Water level sensors to takes a long time to detect the condition of flood and this process is difficult to detecting flood.

IV. SYSTEM ARCHITECTURE



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V. DESIGN OF THE PROJECT

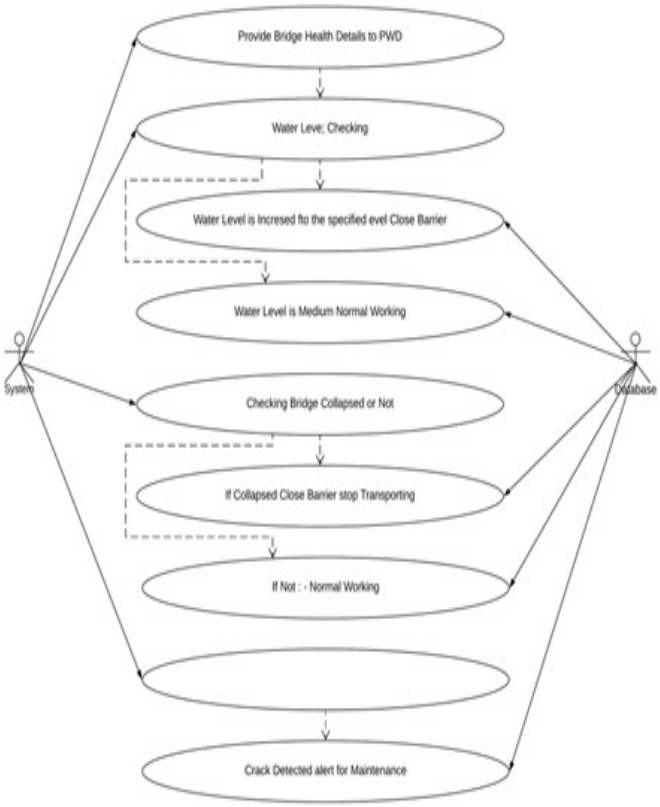

Figure: UML Case Diagram

There are three major components for our system are client App, cloud (Back-end) and data sources.

5.1 External Interface Requirements

- User Interfaces - When user receive notification they stopped transportation for safety.
- Hardware Interfaces - As in the Bridge collapse detect system Arduino is used for the connectivity between the system and Database. Arduino and Sensors will be interfacing with each other. The data is captured through the sensors and sends to the Arduino. From Arduino working of the main system starts.
- Software Interfaces - Use of salesforce platform as a software. The data is given to the google map director to show the available paths in case of any mischance related to bridge.
- Communications Interfaces: Water level sensor checks the water level and if the water level will be increased then Arduino sends data to the servo motor. And servo motor is responsible for closing the barrier. In case of Accelerometer sensor if the vibration of the bridge goes above the vibration limit and the accelerometer sensor will be tilde then overall data goes to Arduino. After that through Arduino data goes to servo motor and the barrier will be opened. Arduino acts as a middle interface between the overall Systems. Through GSM module data will be stored on cloud.

5.2 Other Nonfunctional Requirements

- Performance Requirements- This application will available for the society needs. For safety of people the application works properly. Checks health of the bridge and cracks using sensors. It is real time system that sends real time data up to date on cloud.
- Safety Requirements- Not major safety issues but can take backup of database.
- Security Requirements- Authentication - Verify the user for authorization so that only valid user can allowed.
- Software Quality Attributes –
  - Availability - The web interface will always be available.

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- Reliability - A system is reliable in terms of the data accuracy and time accuracy. Data accuracy is checked to make sure that wrong data should not be provided. Time accuracy is achieved by hardware part.

5.3 Software Hardware Requirements

1. Programming Language: Embedded C
2. Tools : Arduino IDE
3. Cloud / Database : MySQL

VI. TEST CASES

In this phase all the implemented modules are integrated together and then testing is perform on these modules by the test cases in unit testing, integration testing and functional testing.

- Black box testing.
- Integration testing.
- Scenario based testing.

6.1 Requirement gathering and analysis:

In requirement gathering phase we gather all the necessary information related to the system. Also we make a literature survey on 10 IEEE papers related to the system.

- Requirement about bridge condition.
- Accelerometer data check, water level check
- Notification and barriers status.

6.2 System Design

In system design phase we design a models on the basis of gathered information and literature survey. Also decides software and hardware requirements that are required for project.

- UML Diagrams
- DFD Level 0,1,2.

6.3 Implementation

In this phase all the implemented modules are integrated together and then testing is perform on these modules by the test cases in unit testing, integration testing and functional testing.

- Accelerometer sensor to check condition of bridge.
- Water level sensor to check water level and flood detection.
- Notification to authorized department and users

6.4 Deployments of System

Finally functional testing get over, then system is deploy at customer end and also step of system installation is provide in the user manual.

- User Feedback.
- User Security

6.5 Maintenance

In this phase there are various issues which arise in the client environment and these issues are fixed.
User Guide.

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Phases	Cost/Hour	Hours	Cost Estimation
Requirement gathering	30/-	20H	600
Design	50/-	30H	1500
Code Development	50/-	20H	1250
Implementation	60/-	40H	2400
Testing	40/-	10H	400

Cost Estimate

6.6 Risk Identification

Project Risk Management includes the processes of conducting risk management planning, identification, analysis, response planning, and controlling risk on a project. The objectives of project risk management are to increase the likelihood and im- pact of positive events, and decrease the likelihood and impact of negative events in the project. Project Risk identification is the most important process in the Risk Management Planning. Risk Identification determines which risks might affect the project and documents their characteristics. However, we should not spend too much time in identifying risks. After the list is made, qualitative and quantitative analysis is done to figure out which risks you spend time and/or money on. In our project the requirements of end user is fully understood which minimizes the risk. To develop the software the development team is skilled and has appropriate knowledge about the tools which we are using to develop the software. Each team member is equally involved in the development of project in each stage. The numbers of peoples required for developing are sufficient. The requirement gathered is constant or stable which minimizes the risk of developing a inaccurate project.

6.7 Risk Analysis

The risks for the Project can be analyzed within the constraints of time and quality

ID	Risk Description	Probability	Impact
1.	Connectivity	Low	Low| High | Low
2.	Security	Low	Low| High |High

Table: Risk Analysis

Probability	Value	Description
Medium	Connectivity	31-70 Percent
Less	Security	Less than 30 Percent

Table: Probability

Impact	Value	Description
High	5-10 Percent	Connectivity
Medium	Less than 5 Percent	Sensor Fail

Table: Impact

6.8 Overview of Risk Mitigation, Monitoring, Management

Risk ID	1
Risk description	Continuous network connectivity.
Category	Development Environment
Source	Platform(bridge)
Probability	Low
Impact	Low
Response	Managed By the Admin

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Strategy	Continuous network connectivity
Risk Status	Occurred

Table: Risk-2

6.9 Software Requirement Specification

- System Implementation
- Software required
- Programming Language: Embedded C,PHP
- Tool: Arduino IDE
- Database: MySQL

6.10 Product Scope

Detecting the bridge health collapse by using the sensors and notifying the nearest Government Offices like Police Station, PHC to providing the emergency help to the injured people. Notifying the bridge collapsing message to travellers and also to the Transportation Departments by showing signals to previous and next 5km for preventing the traffic. After the bridge was collapsed or the water level will be increased with the maximum pressure then the barrier will be automatically opened and the transportation will be stopped. Detecting the cracks of bridge and predict the health of bridge.

VII. CONCLUSION

As previously there were no forecasted notifications of bridge health, proposed system will send notifications to specified authorities . Accelerations from sensors distributed over the bridge will be analysed using an accelerometer. The environmental conditions will be taken into considerations during updating health of structure. The water level sensor will monitor the level of water that will be displayed using Arduino board. The overall data will be analyse on the cloud Finally, the Bridge diagnosis system using sensor network and sensor module is introduced.

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