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An Improved Approach for Monitoring and Controlling of Flyovers and Bridges Using Internet of Things

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***Abstract*—** The older bridges and flyovers in India have privately and government owned areas. This fact cannot be neglected in today's world when India is rising in the global competitive market where many new structures are coming up. These bridges and flyovers have known or unknown deficiencies and will not be identified unless a disaster is experienced. But by the time a disaster happens, a huge human loss also happens which is undesirable. This needs to conduct health monitoring and providing proper solution to the private owner or government to take care in the interest of the nation. Accidents are happening frequently all over the world due to lack of technology and human attentions at right time. Although these accidental events cannot be completely eliminated but some useful measures can reduce it definitely .In this context, the initial steps are required to avoid human deaths by introducing new technologies. This effort has been taken in this work by adopting real-time health monitoring of the bridge/flyover and automated gate controlling The above said system works on Raspberry Pi-3 embedded with required sensors fitted in the bridge/fly-over.

***Keywords*:** Bridges, Flyovers, Raspberry Pi-3, IOT

I. INTRODUCTION

In developing countries like India there is a strong focus on national infrastructure. New bridges are built every year. The maintenance of these bridges and flyovers is many times overlooked. The present systems use complicated and high cost wired network and high maintenance optical fiber system. So the main objective behind this project is to build a cheap bridge health monitoring system for developing countries. With the discovery of new technologies and materials, the designs of the structures will become more complex and bridges will get longer time spans. Taking these facts into consideration, cost saving is desirable with regard to maintenance and safer environment by preventing structural failures

Bridges are continuously subjected to destructive effects of material aging, widespread corrosion of steel reinforcing bars in concrete structures, corrosion of steel structures and components, increasing traffic volume and overloading, or simply overall deterioration and aging. 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. The condition of one out of three heavily used urban bridges can be classified either as aging or unable to accommodate weights of modern vehicles along with traffic volume. Therefore, a significant number of these structures need strengthening, rehabilitation, or replacement, but public funds are not generally available for the required replacement of existing structures or construction of new ones. There are many bridges in Japan and China which are very advanced as compared to the monitoring systems in India. So our aim is to develop a system that is reliable, cheap and more efficient for Indian bridges flyovers. This system will not only be useful for the bridges but also for the railway bridges, foot bridges and flyovers.

Since Bridges are important lifeline structures, they should have elaborate inspection and maintenance programs. Static and Dynamic Load checkings are carried out in modern bridges to satisfy the Indian standard codes and safety measures. These tests are usually carried out only during major events in the lifespan of bridges like construction period and major repairs. Apart from this, continuous and permanent monitoring is also required for majority of bridges to prevent any human loss. These can also be useful to assess the distress following any major event like earthquake, landslides and storms.

II.LITERATURE SURVEY

Bridges will suffer structural deterioration thanks to aging, misuse or lack of correct maintenance. Among the numerous factors that begin from semiconductor diode to the dissatisfactory condition of bridge structures, one issue that has been neglected is that the unsatisfactory work scrutiny and observation of existing structures [1]. The foremost common objectives for observation of a bridge are to get quantitative information concerning to the structural behavior so as to substantiate style assumptions and to supply time period feedback throughout construction (especially true for brand new bridges), and to gauge the current condition of the bridge and permits the engineers to require educated selections concerning their future and to set up maintenance or repair actions (especially for existing bridges). Within the later, the observation system is employed to extend the security of the structure and supply early warning of associate degree acceleration of the known degradations that area unit being monitored and also the application of SHM to existing bridges to perform a controlled period of time extension of the bridges with known issues has greatly enhanced in recent years. Structural Health Monitoring (SHM) can be very helpful in serving as an alarm system for preventing both types of failures. Bridge Engineers need scientific tools which can give quick information about the health of a bridge. Such instrument shall supplement the periodical manual inspections. But when failures happen with any kind of structure there is loss of human lives and money[2].

Since a few years from the activity vibration tests on engineering structures, it became additional clear that environmental parameters have an effect on the dynamic behavior of a structure. For example, the Young’s modulus of concrete decreases with increasing temperature. Additionally the boundary conditions could also be temperature dependent. Harm detection is one amongst the most aims of vibration watching. A loss of stiffness is determined as a decrease of the chemist frequencies. The matter that changes due to break may be fully disguised by changes because of environmental parameters; thanks to their native character, the incidence of harm or a precondition amendment have a selective influence on the chemist frequencies. An action, pertaining to the worldwide material properties, incorporates uniform influenceonthe chemist frequencies. Thus harm identificatio n strategies that take into consideration this selective frequency influence should still add the presence of temperature variations[3]. An automatic modal analysis (AMA) procedure, supported by random mathematical space identification, is projected that is able to extract the modal parameters from stabilization diagrams with none user interaction. The actual fact that the procedure may be machine controlled could be a key issue during a continuous watching system. By fastidiously inspecting the accessible knowledge, the physical development behind the standard linear relation between frequency and temperature is known. Due to comparatively great deal of information, an additional elaborated knowledge analysis is feasible as compared to the classical regression toward the mean analysis, wherever a relation is established between at the same time measured knowledge.A quite distinctive knowledge set may be required to validate the projected technique distinctively during a sense that measurements are accessible for all four seasons which the bridge may be broken at the top of the watching amount. We tend to our showing that it's so doable to filtrate the environmental variations and that we are able to observe the harm [4]. A technique to differentiate nor-mal chemist frequency changes from abnormal changes because of harm. ARX models were fitted to knowledge from the healthy structure. It is evident that ANARX model that embrace the thermal dynamics of the bridge, is superior to a static regression model. Also, it clad that a temperature measuring at one location was spare to seek out AN correct model. The ARX models aroused for simulating the chemist frequencies.If a replacement measured chemist frequency lies outside the calculable confidence intervals, it's probably that the bridge is broken[5].Just in case of the Z24-Bridge and also the applied harm eventualities, we tend to might with success observe harm. A primary and necessary downside is that the alternative and also the range of quantities that need to be enclosed within the watching system. Evidently, the vibration sensors (accelerometers) shouldn't be placed on nodal points of the mode shapes of interest. For the studied Z24-Bridge, an honest place to place a temperature sensing element was the highest of the concrete deck, below the asphalt layer, during a central location of the most span of the bridge. It had been additionally necessary to catch the temperature course of the asphalt. Below zero degree Celsius, the asphalt layer looks to be liable for the frequency variations. Not solely the temperatures at totally different locations are monitored, however additionally the wind characteristics, rain and humidness. but no relation was found between these last 3 quantities and also the chemist frequencies. Thus solely temperature variables are maintained as inputs[6].We can see different techniques for inspecting cracks in railway tracks. Breaks in railway lines square measure lines and square measure still one in all the most important causes of train mischance. The foremost common break could be a crack within the crown of the rail that forms associate approximate seventy angle with the horizon line. This flaw, because of its peculiar form, is understood because the excretory organ defect .Breaks in rail might vary from a slender crack to the separation of a neighborhood of a rail. In some cases, the break happens within the rail throughout its producing method. To notice these defects, the unbearable methodology is employed: unbearable wave’s square measure injected into the rails by special transducers. This high-energy signal is shipped in 2 directions at planned intervals. The transmitted signal is propagated within the rail and is received by receivers. The close transmitters send unbearable waveswith constant frequency. However with completely different periods. during this means, the receivers are going to be able to acknowledge the direction (left or right) from that they receive the signal. If there could be a break or chafe within the rail, the amplitude of the waves received by receivers are going to be reduced associated an alarm signal are going to be plumbed. The detection of Cracks is finished victimization IR rays with the IR transmitter & receiver [7]. Long vary unbearable Testing (LRUT) technique is proposed as a complimentary review technique to look at the foot of rails, particularly in track regions wherever corrosion and associated fatigue cracking is probably going, like at level crossings. Bridge harm standing is monitored by the sensing element and wireless modules, once the sensing element not obtaining signal, now close wireless system notifies and alert or informs to the current train on the track. These task are able to do through micro-controllers, GSM, LVDT. The information from sensors is treated as either a statistic, wherever knowledge square measure made endlessly or sporadically, or a sequence of readings wherever knowledge is generated unintended, for instance, generated on every occasion a train passes. The info will be monitored by finding out thresholds better-known downside signatures distinctive unknown events, or distinctive drift over a extended amount of your time. Track observance systems additionally play a ignificant role in maintaining the security of the railways [8].

III.PROPOSED MODEL:

This project consists of 2 major elements that require to be implemented. The2 elements are:(1) dominant (2) observa nce at the start, most effort was devoted on the sensors. Those sensors enclosed the foremost hard-ware connected work. Input is expounded to the tactic accustomed browse the info provided by the sensors and rework it in an exceedingly type that the controller will use. Challenges associated with sensors embody the analog to digital conversion, the interpretation of the input (usually in voltage) to a type that the controller will use (e.g. Vibration) and also the identification of appropriate hardware elements. Output is expounded to the tactic accustomed give knowledge from the controller to numerous devices (e.g. stepper motor) and its transformation in an exceedingly type that devices will use (e.g. voltage or current). Challenges associated with output square measure almost like those associated with input. Resolution, translation of knowledge to voltage and choice of appropriate hardware elements square measure the most challenges. once work on the input and output aspect was completed the controller style and implementation started. The controller half concerned a lot of software package committal to writing. Choices were created on what system identification methodology to use and the way to implement it, what sort of sensing element to use, what tools and libraries is used and also the variety of simulations and experiments which will be used to valuate the system. The procedure started with the planning of block diagrams. In the embedded phase we decided the sensors and the micro controllers that were required in the project. We are using micro computer- Raspberry pi-3 considering its size, afford ability and flexibility for our project. In the web application phase we implemented gateways for the sensors to pump values into the application. We discussed different means to process the values and provide an interface such that the stepper mo-tor control the gate and the access of vehicles through the bridge. In the third phase we decided an IOT platform for the data collection. We decided to use flask which is a web application frame work. We used code in python for processing, analyzing and visualizing the sensor data. Thus provide an interface such that the user could live monitor the flyover/bridge from any part of the world. Once the template was produced, it was time to integrate all the development work to make a complete interface. The python code manages the list of details that are to be displayed to the user. The flask provides various views to control different aspects of the controls, such as how they are managed and how they appear on specific way on web page. Since flask can provide more powerful applications, a more advanced user interface was created.

IV. EXPERIMENTAL AND ANALYTICAL WORK

The implementation of Monitoring and Controlling of Fly-over and Bridges Using IOT is illustrated in 1 which merely shows a schematic diagram. As it is depicted, the system is implemented using a Raspberry pi-3, an ideal micro computer for complex projects due to a larger amount of digital and analog pins. To cater the needs of the users and the system to connect the local Wi-Fi network in order to control and access information is also inbuilt with Raspberry pi. To demonstrate the effectiveness and feasibility of this controlling and monitoring system, we have utilized various sensors serving different purposes and these have been integrated into the system. The following is a brief discussion on the implementation of the various modules using the sensor.

A. Detecting the load of vehicles entering the Flyovers/Bridge.

Vehicles are allowed to pass through the load sensor. For example, vehicle can run through the road where Load sensor is placed on the road. Load sensor is thus send data to server and accordingly the stepper motor open/close the gate. The maximum load has to be determined in order to let the vehicles pass through the bridge. The total load the bridge can withstand should be maintained.

B. Controlling the entry of vehicles through the Fly-over/Bridge.

Controlling the entry of vehicles to the bridge is restricted by the gate. Gate is operated using stepper motor, where the gate opens only if the flyover/bridge is capable of handling the load and no damages are noted on the flyover/bridge

C. Detection of humidity around the Flyover/ Bridge.

Humidity sensor is used to detect the moisture content around the flyover/bridge. Some-times, after rains, the air feels moist. We need to monitor these to understand the atmospheric condition around the bridge, so that accidents due to moisture and bad health of flyover/bridge can be avoided.

D. Detection of vibrations on the bridge.

The vibration sensor, which is useful for a variety of different fields, has the ability to detect vibrations in a given area. This can help to alert the authorities if something that could affect the health of flyover/bridge happens. Earlier detection of vibrations using 18 vibration sensor could prevent the people from entering the bridge/flyover, evacuating people in the bridge and helps protect lives.

E. Detection of bend on the bridge.

Detection of bend on the bridge is found by the flex sensor. A flex-sensor is a sensor that measures the amount of deflection or bending. Usually the sensor is stuck to the surface where the bend can be noted and reported easily.

F. Live monitoring and controlling of flyover/bridge using Web Application.

Flask is a micro web application framework written in Python. Flask-Bootstrap pack-ages Bootstrap into an extension that mostly consists of a blueprint named bootstrap which allows user to access the web page through mobile phones. We have designed the web application in a way that the authorized official has to login by entering the login I.D and password to access the live monitoring facility. User will re-directed to a home page which has two options as Monitoring and control-ling which will lead to those respective pages. In monitoring part, we can evaluate the flyover/bridge damage percentage, Moisture content on flyover/bridge and information regarding the vibration on bridge/flyover. There is also a go-back button to go back to Home page. In controlling part, we can control the gate by closing or opening it through the respective buttons. By this we can control the access of vehicle to bridge/flyover in emergency situations.

V. MODELING, ANALYSIS AND DESIGN

Initially a Raspberry pi-3 micro computer with various sensors (which includes humidity sensor, load cell, flex sensor and vibration sensor) and stepper motor acting as gate for the bridge/flyover is connected using wires and is designed as per the hardware requirements of the project. Values from these sensor are considered as the input sensor data values which are transferred to the computer interface via serial communication. These input sensor data are raw input data and need to be processed before they can be used. These sensor data also contain a lot of noise values which is not needed in this project. These noise values are obtained from the surrounding or environment interferences and their presence with the sensor values will cause performance and accuracy decrease in the output. Next these sensor values are evaluated and coded such a way that the health of flyover/bridge is monitored well and the entry to the flyover/bridge is controlled. . Now in the interface, these separated or individual sensor values are considering in the coding part where we can show the output respectively. Here in our project we are using web application for the controlling of gate and live monitoring of the flyover/bridge. Next we explained the procedures in analyzing the closing and opening of gate by looking at the data received from load sensor. Here if the load exceeds than the limited load then load sensor sends data so that stepper motor will rotate in a way the gate get closed. Thus we can keep the flyover/bridge from the unnecessary damages due to excessive load bearing. In this project we can the gate from anywhere around the world by accessing the web page through login by login I.D and password. This could be useful if any natural disasters such as earth quack, flood etc occurs. The vibrations can be detected by the vibration sensor which gives the warning through buzzer alarm. Any kind of bend in the bridge/flyover can be known by the flex sensor so that we could fix it accordingly and even well get to monitor the damage and health condition of fly-over/bridge live through the web page. We can also know about the climate conditions specially the moisture percentage around the flyover/bridge using the humidity sensor so the we can warn the passengers about it also by implementing facilities to remove the moisture contents we can make the area possible for transportation with clear atmosphere. Thus once all these sensors are placed across the bridge we can have a proper bridge/flyover monitoring and controlling and also safety of passengers can be ensured too.

VI. CONCLUSION

The current work shows positive results providing clear and user interactive outputs. The result was also promising and easily manageable as it is designed to fix all the troubles and issues with the health of flyover/bridge. Having worked with various sensors related to our project we understood the significance of each sensors in the monitoring and controlling of bridges/flyovers.

Every sensor has their own importance in this project when we consider the monitoring part we can see that certain sensors are only used for controlling purpose and certain sensors are used for only monitoring purpose .We have managed the model in a way that vehicles enter the bridge/flyover through the load sensor and load sensor is connected with the stepper motor. Stepper motor acts as the controlling medium which opens and closes according to the load vehicle carrying. If the load is over than the limit the gate (stepper motor) will close the gate else it will be open. The flex sensor is the sensor which we use to detect the cracks and bends in the flyover/bridge. This sensor monitors the health of bridge time to time by evaluating the cracks/bends in the flyover/bridge. This is also connected with the buzzer which alarms when the damage exceeds in bridge. The another sensor we are using here is vibration sensor, sensitive of this has to be checked and then we use this sensor in a way that any natural hazards like earthquake, typhoon could alarmed earlier and the gates could close suddenly after the alarm starts. We are using humidity sensor which detects the moisture content around the flyover/bridge and through the live monitoring we can analyze this and we could aware about the climatic condition around the flyover/bridge. And Using web application we could control the gate which makes our project differ and distinct from the present Bridge monitoring systems in existence.

This work can be enhanced to provide better results. As this is just the first working model of the same we can include a lot of improvements which can help the officials in monitoring and controlling of the bridges and flyovers. The major improvements includes: Adding more sensors to monitor the health of the bridge more precisely, Security should have more improvements, A database should be there to store all the collected information so that it will help in the future.

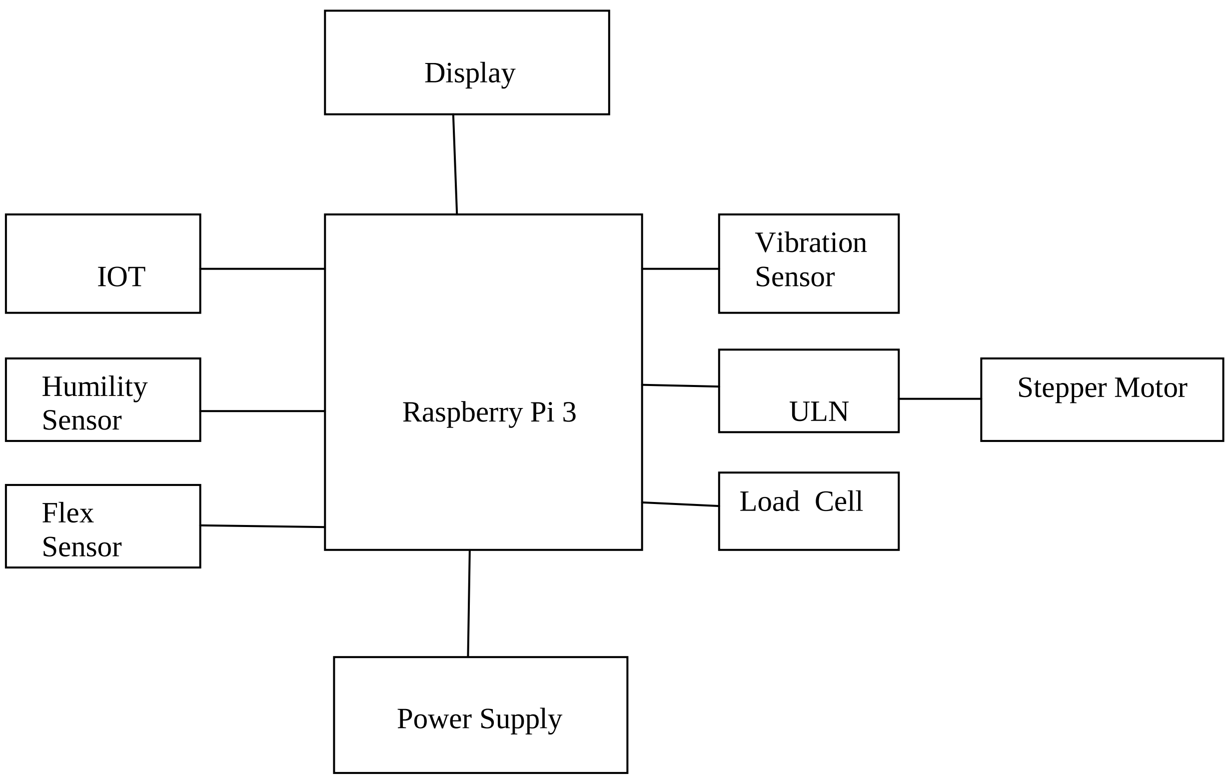

Figure 1: Architecture

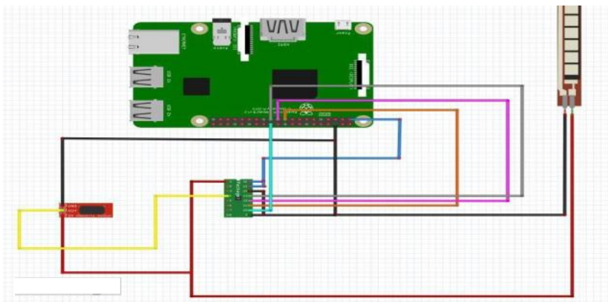

Fig. 2: Analog to digital circuit

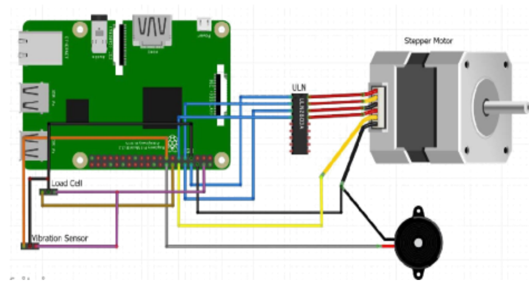

Fig 3: Digital Circuit

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