Journal of Current Research in Engineering and Science
Bi-Annual Online Journal (ISSN : 2581 - 611X)

Volume 6 –Issue 2,August 2023
Paper:70

Detecting Under Bridge Flood Risks -*An IoT Approach*

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***Abstract*—This project proposes an IoT-based water stagnation detection system for bridges that aims to prevent damage and improve road safety. The system uses a conductivity sensor, an Arduino Nano microcontroller, a SIM800L module, a database, LED boards, a Mobile app, and a check post with a servo motor. The system collects data, processes it to detect water stagnation, and alerts drivers and authorities of the issue. The results show that the system is accurate and reliable in detecting water stagnation, and effective in preventing damage and improving road safety. This IoT-based solution has the potential to significantly impact road safety and infrastructure damage prevention.**

Keywords - IoT, water stagnation detection, bridges, road safety, infrastructure damage prevention.

I. Introduction

Bridges are essential components of transportation infrastructure that must withstand various weather conditions and natural disasters. One of the major problems associated with bridges is water stagnation, which can lead to severe damage and compromise road safety. To address this issue, this project proposes an IoT-based water stagnation detection system for bridges. The system uses a conductivity sensor to detect the presence of water and a series of hardware and software components to process and communicate this information. The system alerts drivers and authorities of the issue and activates a warning system to prevent any potential damage. This paper discusses the proposed system's architecture, methodology, and results, highlighting the system's potential to significantly impact road safety and infrastructure damage prevention.

II. Literature review

Authors Sathish Pasika, Sai Teja Gandla, et al. (2020) has claimed that the advancements in wireless communication has created novel sensor capabilities. Current advancements in sensor networks are indispensable for environmental applications. Internet of Things (IoT) enables connections between diverse devices that can exchange and collect data. Utilising Industry 4.0, IoT addresses environmental concerns in addition to the automation industry. D. Ram Pralad, B. Harinath Reddy, et al. (2020) implemented a product to assist the Indian urban domestic water consumption charging system. The project entails a water flow sensor to provide a worry-free solution for calculating and tracking water usage with an ATMEGA-328 micro controller that generates and transmits SMS at the end of each month. Alternately, we can monitor water consumption through the BLYNK mobile application.

Bikramjit Singh, Amar Shivkar, et al. (2020) have proposed a system that can analyze and monitor in real-time the conditions of a bridge and its surroundings, such as adjacent water levels and other safety conditions. Using wireless sensor nodes, numerous categories of data, including vibration, water level, and Bridge mass, were gathered. According to Amrita Argade, Sanika Chiplunkar, et al. (2018), excessive loads of vehicles, high water levels or pressure, and heavy rainfall can cause bridges to collapse, leading to disaster. Therefore, these structures require continuous surveillance. Consequently, we propose a system composed of a weight sensor, a water level point contact sensor, a Wi-Fi module, and an Arduino microcontroller. This system measures vehicle weight, water level, and pressure. If the water level, water pressure, and vehicle burden on the bridge exceed the threshold value, a buzzer and automatic barrier will sound. In their work, Sangita Gore and Yogesh Angal (2022) utilized IoT to assess the status of the bridge in real time. Using wireless sensor nodes, various types of data, including vibration, water level, temperature, and fire, can be acquired. These particulars would also be useful for evaluating the condition of the structures. In the event of an emergency, the bridge's entrances will close automatically.

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III. PROPOSED SYSTEM

The proposed system involves using a conductivity sensor and an Arduino Nano with a SIM800L module to detect the presence of water stagnation under bridges and alert the relevant parties. The conductivity sensor is placed in a location where water is likely to accumulate, such as at the lowest point of the bridge deck or at the base of the bridge pillars. The Arduino Nano is connected to the conductivity sensor and the SIM800L module, and is programmed to read the conductivity values from the sensor and trigger the SIM800L module to send SMS alerts or make phone calls to notify the relevant parties if the conductivity values exceed a predetermined threshold value for a certain period of time.

The system can be powered by a battery or by a power source available near the bridge. The system can be tested and optimized to ensure reliable operation and accurate detection of water stagnation

Overall, the proposed system provides an automated and reliable way to detect water stagnation under bridges and alert the relevant parties to prevent damage to vehicles passing through the bridge. It also reduces the need for manual inspections, making the process more efficient and cost-effective

A. *Project objectives*

- To identify the water stagnation under bridges and flyovers, alerting the responsible officials and the public about the stagnation of water through SMS and alert boards.
- To identify solutions for evacuating water under the bridges and flyovers, clearing it for transport.
- To avoid accidents and traffic jams due to water stagnation during rainy days.

B. *Ease of use*

The proposed IoT-based water stagnation detection system for bridges is designed to be automated, requiring minimal intervention from the user once it is installed and configured. The system collects data from the conductivity sensor and processes it to detect water stagnation, alerting drivers and authorities of the issue.

The system's hardware components are simple and can be easily installed and maintained by a technician. The system includes a conductivity sensor, an Arduino Nano microcontroller, a SIM800L module, LED boards, and a check post with a servo motor. These components are easy to install and maintain, reducing the need for specialized technical skills.

The system's mobile application developed using Flutter allows drivers to view the status of bridges in real time, making it easy for them to plan their routes and avoid potential dangers. The application provides a user-friendly interface that displays the data collected by the system, including the location of the bridge, the water level, and the warning status.

The system's ease of use makes it accessible and practical for both technical and non-technical users, increasing its potential for widespread adoption and impact.

C. *Implementation*

As mentioned in Fig 1, The proposed system involves the integration of several hardware and software components. The hardware components include a conductivity sensor, Arduino Nano, SIM800L module, LED boards, servo motor, and a check post. The software components include a database and a mobile application.

The first step in the implementation process is to assemble the hardware components. This involves connecting the conductivity sensor to the Arduino Nano, which is then connected to the SIM800L module. The LED boards and servo motor are also connected to the Arduino Nano.

Once the hardware components are assembled, the software components can be implemented. A cloud-based database is created to store the data collected by the system, including the water stagnation levels and the location of the device. The database is designed to be accessible by the mobile application, which is used to display the data in real-time.

The mobile application is designed to be user-friendly and easy to use. It displays the water stagnation levels in real-time, along with the location of the device. The application can be accessed by anyone with a smartphone, making it easy for people to check the water levels before passing through the bridge.

The LED boards are installed outside the bridge and are connected to the Arduino Nano. When the water level reaches a certain threshold, the Arduino Nano sends a signal to the LED boards, which display warning messages to alert drivers of the high water level.

The check post is also installed near the bridge and is controlled by a servo motor. When the water level reaches a certain threshold, the Arduino Nano sends a signal to the servo motor, which closes the check post and prevents vehicles from passing through.

The implementation of the proposed system requires careful planning and attention to detail. Each component must be properly installed and connected to ensure that the system functions as intended. Testing and calibration are also important steps in the implementation process, as they help to ensure that the system is accurate and reliable.

Overall, the implementation of the proposed system is designed to be straightforward and easy to follow. By following the steps outlined above, the system can be

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implemented successfully and provide effective monitoring and control of water stagnation levels under bridges.

D. Diagrams and flow charts:

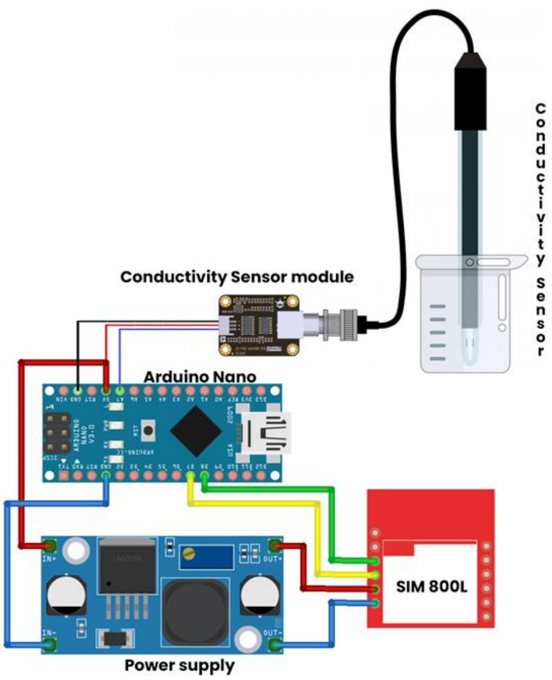

Fig. 1. Overall basic reference of the project

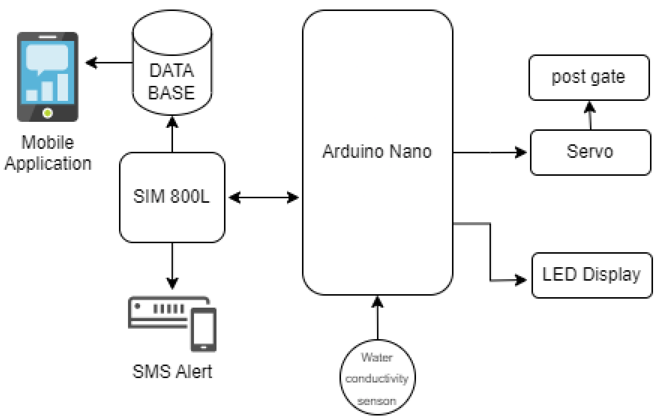

Fig. 2. Overall block diagram of the project

E. Advantages

- Early detection: The project uses a conductivity sensor to detect the presence of water under bridges, providing early warning of potential flooding. This allows for timely action to be taken, reducing the risk of damage to vehicles passing through the area.
- Real-time monitoring: The project provides real-time monitoring of water levels, allowing for timely alerts and notifications to be sent to relevant authorities and the public. This ensures that everyone is informed and can take necessary precautions in the event of flooding.
- Easy to install and use: The project is designed to be easy to install and use, requiring minimal technical knowledge. This makes it accessible to a wider range of users, including those in rural areas or developing countries.
- Cost-effective: The project is cost-effective compared to other flood warning systems, making it accessible to organizations and communities with limited financial resources.
- Integration with other systems: The project can be integrated with other systems, such as LED boards and servo motors, to provide additional warning and safety measures. For example, LED boards can be used to display warnings to drivers, and servo motors can be used to close roads and prevent access during floods.
- Data collection and analysis: The project collects and stores data on water levels, which can be used for analysis and future planning. This can help organizations and communities better understand flood risks and develop more effective mitigation strategies.
- Mobile application: The project includes a mobile application that provides easy access to real-time data and alerts. This allows users to stay informed and take necessary precautions, even when they are on the go.
- Environmentally friendly: The project is environmentally friendly, as it does not require the use of harmful chemicals or materials. This makes it a sustainable and eco-friendly solution for flood warning and monitoring.

As shown in Fig 2, the project offers a range of benefits, including early detection, real-time monitoring, ease of use, cost-effectiveness, integration with other systems, data collection and analysis, mobile accessibility, and environmental sustainability.

F. Outcomes of the project

- Prevention of damage to vehicles: By detecting water stagnation under bridges and alerting the relevant parties, the system can prevent damage to vehicles passing through the bridge. This can reduce the risk of accidents and save lives.

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- Real-time detection and monitoring of stagnant water: The proposed system uses a conductivity sensor to detect stagnant water under the bridge in real-time. This helps to monitor the water level continuously and alert authorities when the water level reaches a dangerous level.
- Efficient communication system: The proposed system uses a SIM800L module to communicate with the central server, sending data about the water level, bridge location, and other relevant information. This helps authorities to take action quickly in case of an emergency.
- Increased safety: By automating the detection of water stagnation, the system can improve safety for drivers and pedestrians who use the bridge. This can also increase the confidence of the public in the safety of the infrastructure.
- Data collection and analysis: By collecting data on water stagnation, the system can provide valuable insights into the frequency and duration of water accumulation under bridges. This data can be used to improve the design and construction of bridges and to inform future maintenance and repair decisions.
- Database management: The collected data is stored in a database with the location of the bridge and device address, which can be accessed by authorized personnel using a web-based application. This helps to keep track of the water levels and identify bridges that are prone to flooding.
- Potential for scalability: The system can be replicated and scaled up to monitor water stagnation under other bridges or in other locations prone to flooding or water accumulation. This can expand the reach and impact of your project beyond the initial scope.
- User-friendly interface: The system includes a user-friendly interface that can be accessed through a web-based application or a mobile application. This makes it easy for authorized personnel to access the data and take appropriate action.
- Warning system: The proposed system includes LED boards that display warning messages to alert motorists when the water level is high. In case of flooding, a servo motor can be used to close the road using a check post, preventing vehicles from passing through and avoiding accidents.

IV. Result and discussions

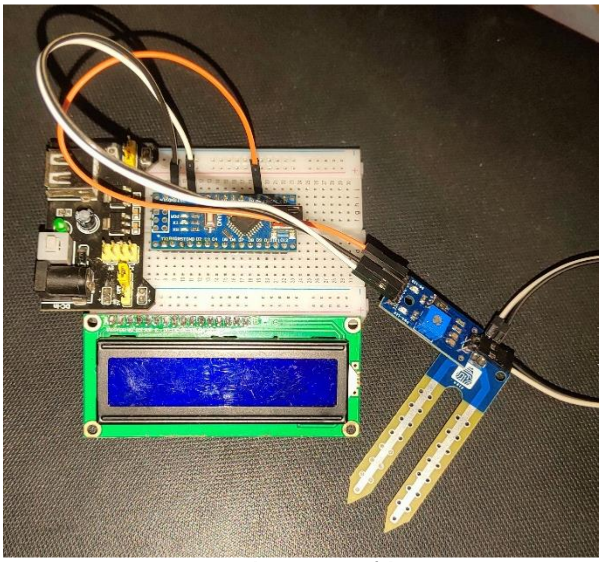

Fig. 3. Basic implementation of the project

Real-time monitoring: As shown in Fig 3, the system was able to detect the presence of stagnant water in real-time and send alerts to the central server. This helped authorities to take necessary actions and avoid accidents and damages to vehicles.

Database management: The system was able to store the collected data in a database along with the device address and bridge location. This helped in identifying the bridges that were prone to flooding and taking necessary measures to prevent flooding in the future.

Communication system: The SIM800L module was able to communicate with the central server efficiently and reliably. This helped to keep track of the water level, bridge location, and other relevant information.

Warning system: The LED boards were able to display warning messages in real-time, alerting motorists of the high water level. The servo motor was also able to close the road using a check post during floods, preventing vehicles from passing through and avoiding accidents.

User-friendly interface: The mobile applications was user-friendly and easy to navigate. Authorized personnel were able to access the data and take appropriate actions easily.

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be provided under earth embankment for the crossing of Road traffic, railway traffic across the level crossing of Railway line, etc.

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