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Three Stage Approach for Water Logging in Cabel Tunnel

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Abstract: *In recent years, rapid population growth has exacerbated numerous challenges for urban areas and their inhabitants, particularly issues such as inadequate infrastructure and frequent waterlogging in underpasses. During heavy rainfall, these underpasses often become inundated, creating significant hazards for vehicles and exacerbating traffic congestion. The root of this problem lies in inefficient drainage systems and suboptimal designs for managing rainwater runoff.*

To tackle these pressing issues, this paper proposes an IoT-based solution aimed at monitoring and managing heavy traffic in underpasses. The primary objective is to create a comprehensive framework that continuously tracks water levels in these areas. By leveraging IoT technology, this framework can activate warning signals and implement real-time traffic control measures, thereby mitigating the risks of waterlogging and alleviating traffic congestion.

This innovative approach not only provides a proactive response to the immediate challenges faced by underpasses but also lays the groundwork for a more sustainable and efficient urban infrastructure management system. By integrating IoT sensors and intelligent control systems, this framework seeks to enhance the resilience of underpasses against adverse weather conditions while improving traffic flow, ultimately contributing to safer and more livable urban environments.

Keywords - *Internet of Things (IoT), sensors, Wi-Fi modules, LCD displays, and cloud architecture.*

I. INTRODUCTION

In a country like India, traffic congestion poses a significant challenge for commuters. During rainy weather, motorists often question whether an underpass along their route will help them bypass the city's gridlock. However, if these underpasses become flooded during heavy rains, drivers can find themselves stranded, forced to wait until the water recedes or is pumped out, regardless of the overall road conditions.

A notable incident occurred in Bangalore on September 26, 2014, highlighting the repercussions of inadequate underpass design and maintenance. Nearly fifty bus passengers were put at risk near Anand Rao Circle when heavy rains inundated the area. Fortunately, swift action from fire and emergency services led to their rescue. This event raised critical concerns about the city's infrastructure agencies regarding the maintenance, construction quality, and disaster preparedness of underpasses. Similar incidents are common across India during the monsoon season, exacerbating the spread of waterborne diseases due to waterlogging and contaminated stormwater.

To address these challenges, the Internet of Things (IoT) offers a transformative solution. Often referred to as the "Internet of Everything," IoT encompasses web-enabled devices equipped with sensors that gather data, which is then processed and analyzed to provide real-time insights for improved decision-making and response**.**

II. RELATED WORK

In [3], the author conducted a comprehensive review of the Internet of Things (IoT), detailing various models and underscoring its significance. In [4], an IoT-based control and monitoring system for water level management was presented. This system employed ultrasonic sensors and microcontrollers to track water levels; however, it had a notable limitation—there was no mechanism to prevent water overflow. Similarly, [5] investigated the application of IoT to enhance drinking water quality. While the concept showed potential, a major drawback was the absence of integration of the monitored parameters into cloud systems for further analysis and action. In contrast, [6] highlighted the expanding applications of IoT in facilitating smarter living, emphasizing the immense potential of IoT technologies to transform

various facets of daily life.

III. PROBLEM STATEMENT AND OBJECTIVE

During the monsoon season, many underpasses in urban areas are susceptible to flooding, leading to significant challenges. These inundated underpasses not only cause severe traffic congestion but also pose serious health risks to pedestrians due to waterborne diseases and infections. In addition to the stress and health concerns for drivers, these situations result in wasted time and resources.

The primary objectives of our project are as follows:

1. To implement an advanced system for effectively monitoring waterlogging in underpasses during heavy rainfall.

2. To provide real-time alerts to road users regarding which types of vehicles are permitted to pass.

3. To upload warning messages to the cloud, ensuring that status updates are readily accessible to the public.

4. To facilitate visual monitoring of underpass conditions for improved management and timely responses to flooding incidents.

IV. PROPOSED FRAMEWORK

A. System Overview

Waterlogging in underpasses [7] persists as a persistent issue, causing difficulties for vehicles navigating the roads. This project aims to explore the application of the Internet of Things (IoT) in managing underpass waterlogging. The block diagram illustrating the proposed system is depicted in Fig 1. This system provides timely warning messages about underpass flooding, and an LCD screen can be installed at the entrance to indicate which types of vehicles are permitted to pass through, thus helping to alleviate traffic congestion.
The system comprises hardware nodes, a Wi-Fi module, cloud architecture, and frontend devices. The methodology consists of two primary components: IoT and Automation.

IoT: The Internet of Things is employed to transmit sensor data through the NODE MCU Wi-Fi module. The data collected from the sensors is then stored in the Things Cloud software for further analysis.

Automation: The automation component includes the use of an LCD screen to display relevant information and a pump to manage water levels, ensuring effective water management.

B. Hardware components used

- Node MCU ESP8266 Breakout Board
- Water level Sensor
- General Purpose Transistor NPN
- LED
- Resistor
- Buzzer
- Motor driver
- Breadboard

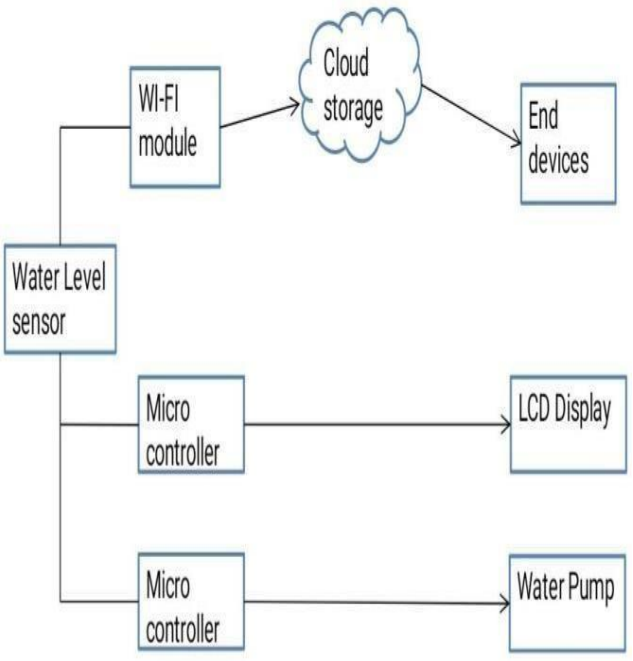


Fig 1. Underpass waterlogging system

C. *Software Tools used*

- Arduino IDE
- thingsio.ai

D. *System Architecture*

The water level sensor produces an analog input that is received by the Atmega 328p microcontroller. Operating at 20 MIPS with a clock frequency of 20 MHz and a voltage range of 2.7-5.5V, the microcontroller processes the data and transmits it to an LCD screen positioned at a strategic location. This setup enables vehicles to be informed and redirected away from the flooded underpass based on the information displayed.

To manage the water accumulation in the underpass, a DC pump is employed, which can be controlled either by the Wi-Fi module or the microcontroller. A motor driver is used to facilitate the on and off switching of the DC pump. The data from the water level sensor is uploaded to the ThingSpeak platform through a channel established via the Node MCU [8-9]. Instructions from the ThingSpeak website are then sent to the motor driver to activate the DC pump as needed.

E. *Implementation*

Initialization: The system begins with an initialization phase. The Read/Write and enable pins of the LCD are configured, and a pin is designated for the water level sensor, which is set up as an analog input. Data is then collected from the water level sensor and transmitted to the Atmega microcontroller. If the sensor output is zero (indicating no data) or a negative value, the system will loop back to collect data again.

Display Messages: Based on the water level detected by the sensor, the LCD screen displays the following messages: If the water level is below 31.25mm, the message "ALL VEHICLES CAN PASS" is shown. If the water level is between 31.25mm and 36.87mm, the message "CARS AND TRUCKS ONLY" is displayed. If the water level exceeds 36.87mm, the message "NOT ALLOWED" appears. This loop repeats every 200ms to ensure that the information is continuously updated.**Pump Control:** The microcontroller also oversees the operation of the pump. If the water level exceeds 31.25mm, indicating a potential flood, the pump is activated. Otherwise, the pump remains off. This iterative process allows for real-time monitoring of water levels in the underpass, facilitating timely traffic management and flood prevention measures.

V. RESULTS AND DISCUSSION

The proposed system effectively monitors and analyzes traffic conditions within the underpass. Sensor data is collected and transmitted to a microcontroller [10], which then displays the information on an LCD screen positioned at an elevated location for clear visibility to passing vehicles. When the water level exceeds a predefined threshold, the motor pump is activated, either manually or automatically.

Furthermore, the system uploads data to the ThingSpeak server via a Wi-Fi module, allowing road users to view alert messages remotely on their smartphones. The LCD screen dynamically displays which types of vehicles are allowed to enter based on the current water level in the underpass [11]. The system is also capable of controlling a DC pump to remove accumulated water and send alert messages to relevant authorities. These warning messages are uploaded to the internet, providing real-time updates to the public.

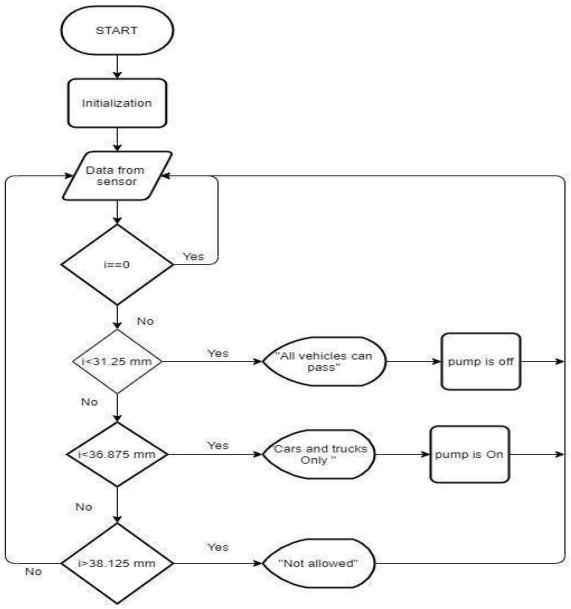


Fig 2. Flowchart of the proposed work

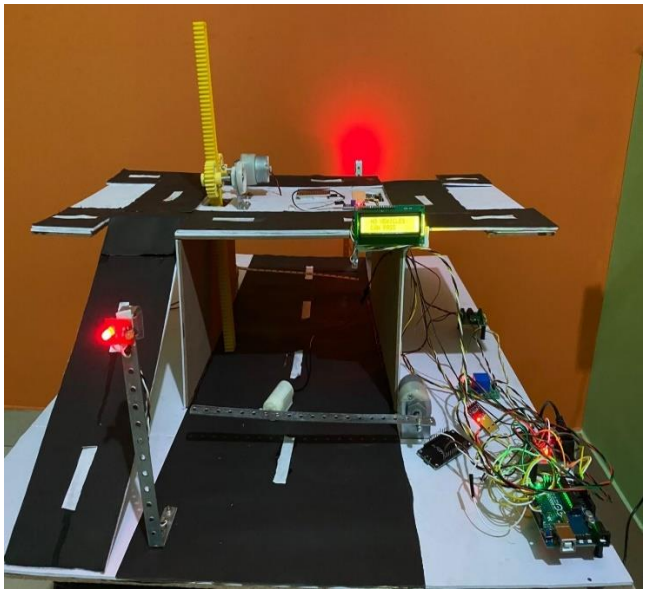
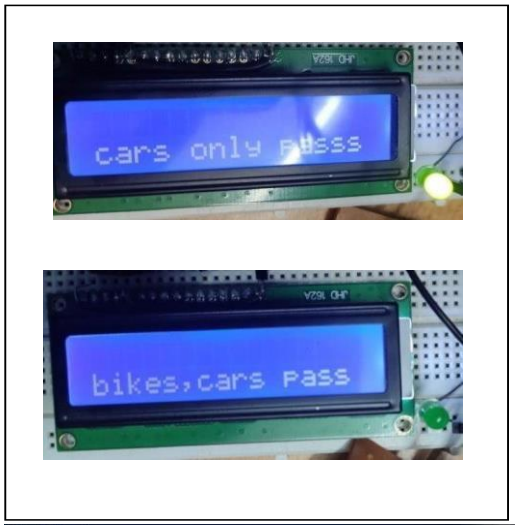


Fig 3. Underpass management system



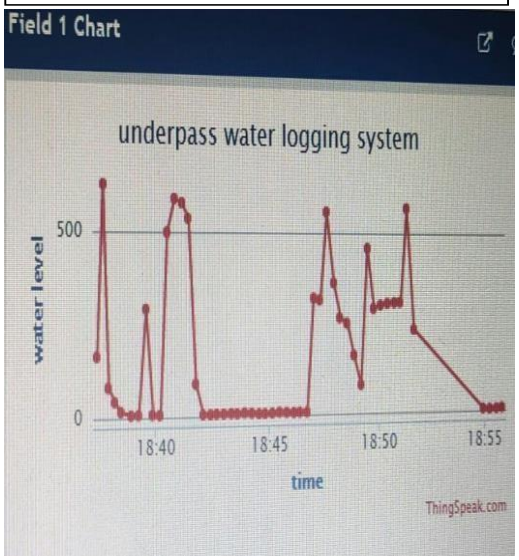


Fig 4-5. Proposed system output

VI. CONCLUSION

The implementation of an IoT-based water level monitoring system for underpasses has been successfully completed. With the integration of an LCD display, users can easily evaluate the current water level and determine whether it is safe for vehicles to pass. Additionally, alert messages are promptly sent to users' mobile phones, providing timely notifications from a distance. To manage water accumulation during heavy rainfall, a DC pump is employed for efficient water removal. Sensors play a crucial role in both addressing water-related issues and delivering essential warnings to users. By uploading critical data to the cloud, accessibility is greatly enhanced, allowing for easy retrieval of information from any location.

The transformative influence of the internet has changed the way we interact with technology, and IoT is leading the way for smarter communication between devices. This project offers a straightforward yet effective system for monitoring water levels, providing clear indicators and corresponding safety recommendations. Looking ahead, future efforts could focus on analyzing water levels in specific areas to prevent water wastage and improve resource management. This proactive approach ensures continuous enhancement and adaptation to the evolving needs and challenges of urban infrastructure.

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