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Underpass Water Logging System Using IOT and ML

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Abstract: *In recent years, the surge in population growth has exacerbated numerous challenges for both humans and the environment, including issues like inadequate infrastructure and frequent occurrences of waterlogging in underpasses. During heavy rainfall, underpasses often become inundated, posing significant risks to passing vehicles and exacerbating traffic congestion. This is primarily due to ineffective drainage systems and flawed designs for diverting rainwater away from the underpasses. To address these pressing issues, this paper proposes an IoT-based solution aimed at monitoring and managing heavy traffic within underpasses. The primary objective is to establish a comprehensive framework capable of continuously monitoring the water levels within underpasses. By leveraging IoT technology, this framework can activate warning signs and implement traffic control measures in real-time to mitigate the risks posed by waterlogging and alleviate traffic congestion. This innovative approach not only offers a proactive solution to the immediate challenges faced by underpasses but also lays the foundation for a more sustainable and efficient urban infrastructure management system. Through the integration of IoT sensors and intelligent control mechanisms, this framework promises to enhance the resilience of underpasses to adverse weather conditions while optimizing traffic flow, ultimately contributing to safer and more livable urban environments*

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Keywords — *Internet of Things, sensors, Wi-Fi module, LCD, cloud architecture.*

I. INTRODUCTION

In a country like India, grappling with traffic congestion is a major challenge for commuters. Every time the skies open up, motorists are left pondering if there's an underpass along their route to evade the city's gridlock. However, if these underpasses become flooded during heavy rains, drivers are left stranded, forced to wait until the water recedes or is pumped out, regardless of road conditions.

One notable incident occurred in Bangalore on September 26th, 2014, highlighting the consequences of poor underpass design and maintenance. Nearly fifty bus passengers found themselves perilously close to a watery disaster near Anand Rao's Circle. Thanks to the heroic efforts of fire and emergency services, they were eventually rescued. This incident sparked questions about the city's infrastructure agencies regarding maintenance, construction quality, and disaster preparedness. Similar scenarios unfold across India during the monsoon season, exacerbating waterborne diseases due to waterlogging and contaminated stormwater. Amidst these challenges, the Internet of Things (IoT) emerges as a transformative technology capable of alleviating human strain. Often referred to as the Internet of Everything, IoT encompasses web-enabled devices equipped with sensors to collect data, which is then processed and communicated for analysis and visualization.

II. RELATED WORK

In [3], the author provided a comprehensive review of IoT, elucidating various models and emphasizing its significance. Meanwhile, [4] introduced an IoT-based control and monitoring system specifically designed for water level monitoring. Utilizing ultrasonic sensors and microcontrollers, the authors monitored water levels. However, a notable limitation was the absence of a mechanism to mitigate water overflow. Similarly, [5] proposed enhancing drinking water quality through IoT. Although the concept was promising, a drawback was identified: the sensed parameters were not integrated into cloud systems for further analysis and action. Contrastingly, [6] highlighted the burgeoning applications of IoT in facilitating smarter living. The author underscored the immense potential of IoT technologies in revolutionizing various aspects of daily life.

III. PROBLEM STATEMENT AND OBJECTIVE

During the monsoon season, numerous underpasses become inundated, posing a significant challenge for cities across the board. These submerged underpasses not only result in heavy traffic congestion but also pose a serious health hazard to pedestrians due to waterborne diseases and infections. Such circumstances add to the stress and health concerns of vehicle drivers, besides wasting their time.

The primary objectives of our project are as follows:

1.Implementing an advanced solution to effectively monitor underpass waterlogging during intense rainfall.
2.Providing real-time alert information to road users regarding the types of vehicles permitted to pass through.
3.Uploading warning messages to the cloud and making the status updates accessible to the public.
4.Visual monitoring of the underpass situation to ensure effective management and response 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 overall system comprises hardware nodes, a WIFI module, cloud architecture, and frontend devices. The methodology involves two key components: IoT and Automation.

1. IoT: The Internet of Things is leveraged to upload sensor data using the NODE MCU Wi-Fi module. The data collected from sensors are then stored in the Things Cloud software.

2.Automation: The automation aspect includes the utilization of an LCD screen and a pump to manage water levels.

B. Hardware components used

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

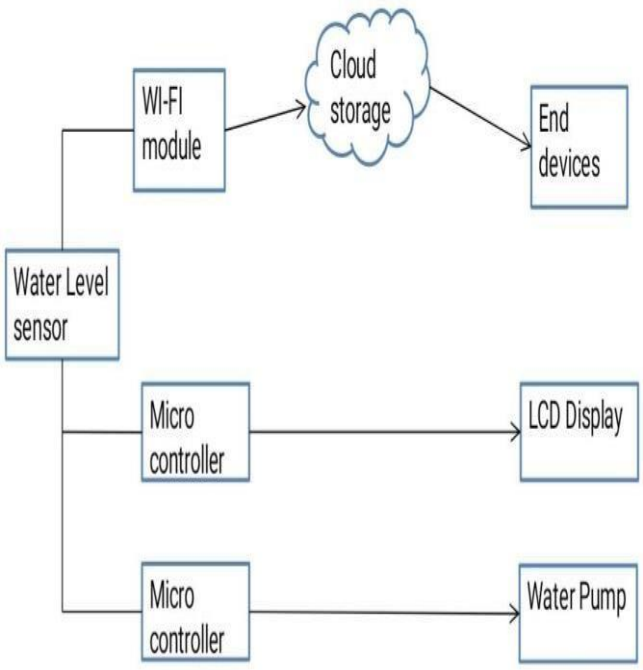

Fig 1. Underpass waterlogging system

C. Software Tools used

- Arduino IDE
- thingsio.ai

D. System Architecture

The water level sensor provides analog input, which is received by the Atmega 328p microcontroller. This microcontroller operates at a speed of 20 MIPS and a clock frequency of 20 MHz, functioning within a voltage range of 2.7-5.5V. The microcontroller then transmits this data to an LCD screen positioned at a strategic location where vehicles can divert from the flooded underpass based on the displayed information.

To address the accumulated water in the underpass, a DC pump is employed, which is controlled either by a WIFI module or a microcontroller. A motor driver facilitates the switching ON and OFF of the DC pump. The water level sensor's input is uploaded to the ThingSpeak website by establishing a channel with the assistance of the Node MCU [8-9]. Instructions from the website are subsequently relayed to the motor driver to activate the DC pump as necessary.

E. Implementation

The flowchart depicted in Fig 2 outlines the proposed work process. Initialization: Begin by initializing the system. Set up the Read/Write and enable pins of the LCD. Allocate a pin for the water level sensor, initializing it as an analog input. Collect data from the water level sensor and pass it to the Atmega Microcontroller. If the sensor output is zero, indicating no data or a negative value, loop back to collect data. Display Messages: Based on the water level detected by the sensor, the LCD screen displays appropriate messages: If the water level is up to 31.25mm, display "ALL VEHICLES CAN PASS". If the water level is between 31.25mm and 36.87mm, display "CARS AND TRUCKS ONLY". If the water level exceeds 36.87mm, display "NOT ALLOWED". This loop repeats every 200ms. Pump Control: Additionally, the microcontroller controls the pump. If the water level exceeds 31.25mm, indicating potential flooding, the pump is turned ON. Otherwise, it remains OFF until needed. This iterative process ensures real-time monitoring of water levels in the underpass and takes necessary actions to manage traffic and prevent flooding.

V. RESULTS AND DISCUSSION

This 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 strategically positioned at an elevated location for clear visibility by passing vehicles. If the water level exceeds a predetermined threshold, the motor pump is activated, either manually or automatically. The system also uploads data to the ThingSpeak server via a Wi-Fi module, allowing road users to view alert messages remotely via smartphones.The LCD screen dynamically displays which types of vehicles are permitted to enter based on the current water level in the underpass [11]. Additionally, the system can interface with a DC pump to facilitate the disposal of

accumulated water, and it sends alert messages to relevant authorities. These warning messages are uploaded to the internet, providing real-time status updates to the public.All sensors are connected to the Wi-Fi module, which relies on internet connectivity. Therefore, mobile data or Wi-Fi is essential for the system's functionality.

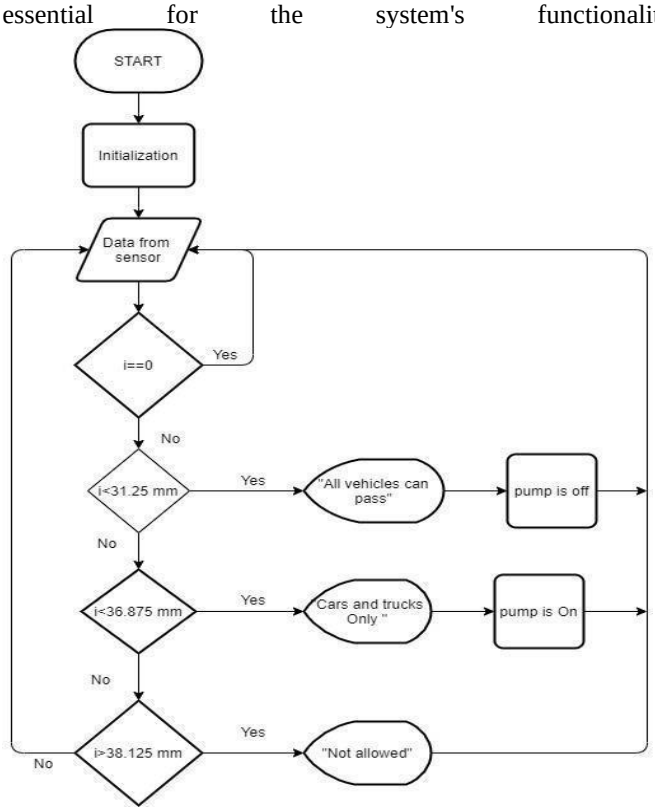

Fig 2. Flowchart of the proposed work

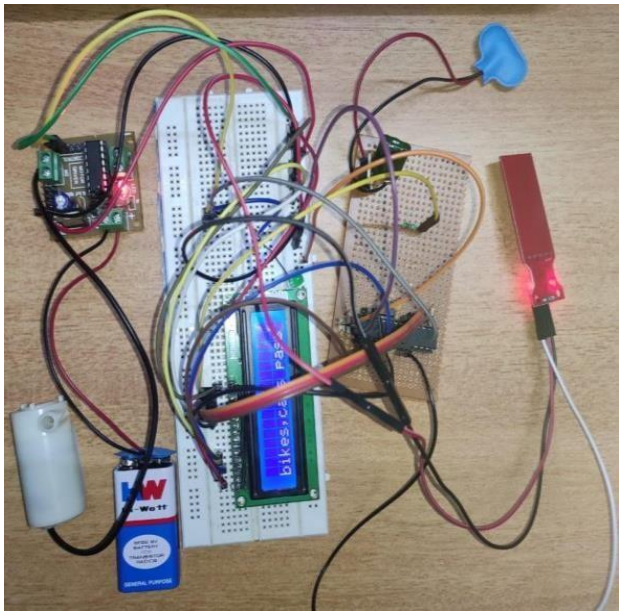

Fig 3. Underpass management system

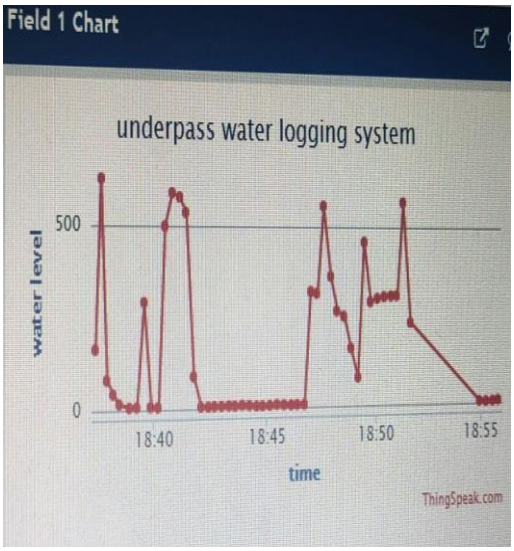

Fig 4-5. Proposed system output

VI. CONCLUSION

The implementation of underpass water level monitoring using IoT has been successfully executed. Utilizing an LCD display, users can easily discern the current water level, thereby determining whether it's safe for vehicles to pass through. Moreover, alert messages are efficiently relayed to users remotely via their mobile phones, ensuring timely notifications from afar. To address water accumulation during heavy rainfall, a DC pump is deployed for efficient water disposal. Sensors play a crucial role in both mitigating water-related issues and providing warnings to users. By uploading essential information to the cloud, accessibility is greatly enhanced, allowing anyone to retrieve data effortlessly. The transformative power of the internet has significantly reshaped human interaction, with IoT presenting opportunities for

smarter object communication. This project presents a straightforward yet effective water level monitoring system, offering clear indications of water levels and corresponding safety requirements.Looking ahead, future work could focus on analyzing water levels in specific areas to prevent water wastage and optimize resource management. This forward-thinking approach ensures continual improvement and adaptation to evolving needs and challenges.

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