International Journal of Multidisciplinary Engineering in Current Research - IJMEC
Volume 10, Issue 4, April-2025, http://ijmec.com/, ISSN: 2456-4265

Advanced IOT Technology And Machine Learning Techniques For Monitoring Waterlogging In Underpass

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ABSTRACT
Due to recent climate change, it has become very difficult to remove large amounts of rain. Flooding of underpasses during heavy rains is a serious problem in any growing city. Due to the weak infrastructure, water accumulation in underground passages is higher than normal. Both drivers and pedestrians are at risk. The situation is made worse by the fact that Google Maps has no information about the water level in the floodplains below. Here, the underground water level will be monitored through the construction of the framework. Once there are underpasses, the foundation will provide a cheap and environmentally friendly way to manage traffic congestion caused by heavy rain. A popular computer technology related to computer vision and image processing is object detection, which looks at objects or instances of specific objects (people, flowers, animals, etc.) in photos and videos. There are many uses for product search, including analysis and retrieval.

1- INTRODUCTION

Waterlogging in underpasses is a recurring problem, especially in cities with heavy rainfall and dense populations. It disrupts traffic, poses a danger to passengers, and requires expensive repairs and a lot of effort. Traditional flood control methods rely on human intervention and poor measures, which often do not solve the problem well. To solve this problem, the combination of Internet of Things (IoT) and Machine Learning (ML) technologies holds great promise, including real-time monitoring, predictive analytics, and automated responses. The core system of the system uses IoT sensors to monitor the environment and water availability in real time. Water level sensors can detect the height of the water, while ultrasonic sensors can measure the depth of the water. Additionally, weather monitoring devices such as rain gauges and humidity sensors provide supplementary data to assess precipitation trends. This data is transmitted wirelessly to the Raspberry Pi, which acts as a hub for data aggregation and initial processing.

The collected data is then analyzed using machine learning algorithms capable of identifying patterns and predicting water accumulation trends. Supervised learning models, trained on historical data, can predict the likelihood and severity of waterlogging based on current environmental conditions. For instance, a sudden increase in rainfall intensity coupled with pre-existing high soil moisture levels may signal a high risk of waterlogging.

Beyond immediate applications, the use of IoT and ML in waterlogging management offers long-term benefits. By continuously collecting and analyzing data, the system builds a comprehensive database that urban planners can use for better infrastructure design. Insights from this data can help identify underpasses that are most
vulnerable to waterlogging, optimize drainage networks, and improve urban resilience to climate change-induced weather patterns.

In conclusion, the combination of advanced IoT and ML techniques offers a scalable, cost-effective, and data- driven approach to monitoring and managing waterlogging in underpasses. The use of a Raspberry Pi as the processing core ensures that the system remains compact, energy-efficient, and accessible. By enabling real-time monitoring, predictive analysis, and automated responses, this solution addresses the limitations of traditional methods and paves the way for smarter urban infrastructure.

By utilizing the scalability and accessibility of cloud platforms, timely dissemination of crucial information regarding road conditions

hazards, and emergencies can be achieved. This approach enhances public safety by providing individuals with up-to date information, enabling them to make informed decisions while navigating roads and highways. Water accumulation on roads due to rainfall or flooding poses significant hazards to both motorists and pedestrians. To address this challenge, an automated water removal system utilizing water pumps is proposed. This system aims to efficiently clear collected water from roadways, thereby reducing the risk of accidents, hydroplaning, and infrastructure damage. By automating the water removal process, response times can be minimized, ensuring the safety and accessibility of roadways during inclement weather conditions

2- LITERATURE SURVEY

1.“An efficient way to vehicle movement monitor in flooded underpass using IoT”

As the population grows rapidly, people are struggling with various problems. Also, due to the lack of infrastructure suitable for development projects such as roads and underpasses, various problems such as flooding and flooding occur. When heavy rain falls, the underpasses and roads are immediately flooded, causing traffic jams and vehicle stops. Until recently, there was no planned strategy to monitor the amount of water in the underpasses and flooded areas, but this is expected to change in the future. I will have to look it up in the news or on Google Maps. Or see if anyone has reported this incident before. One of the problems with this system is that the information we receive is slow to transmit and can easily be distorted or manipulated. The main purpose of this system is to monitor the amount of water present in underpasses and other flood-prone areas. The data collected by the water level sensor used to monitor the water level is monitored and uploaded via a Raspberry Pi board equipped with an ESP8266 module. A regular data stream is transmitted to the cloud and the vehicle movement is redirected to the most appropriate direction. This means that people driving underpasses or on flooded roads can access the information stored in the cloud and plan their journey accordingly. Another feature is the installation of an as the population continues to grow rapidly, many people are facing various challenges. One significant issue is the lack of infrastructure suitable for development projects, such as roads and underpasses, which often leads to problems like flooding. When heavy rain occurs, underpasses and roads can quickly become inundated, resulting in traffic jams and stalled vehicles.

Until recently, there has been no systematic strategy for monitoring water levels in underpasses and flood-prone areas, but this is expected to improve in the future. To obtain timely information, I will need to check news sources, and Google Maps, or see if there are any reports related to this issue.

One of the challenges with the current system is that the information we receive can be delayed and susceptible to distortion or manipulation. The main goal of the new monitoring system is to track the water levels in underpasses and areas prone to flooding. Water level sensors will collect data and transmit it via a Raspberry Pi board equipped with a specific module. This data stream will be sent to the cloud, allowing vehicle movements to be redirected to safer routes.

This means that drivers approaching underpasses or flooded roads can access real-time information stored in the cloud, enabling them to plan their journeys accordingly. Additionally, an LCD will be installed near each underpass to continuously update the water level, helping people in the area determine whether it is safe for vehicles to pass. When the water level exceeds a predefined threshold, a DC motor pump will activate to remove excess water. As the population grows rapidly, people are facing various challenges. One major issue is the lack of infrastructure to support development projects, such as roads and underpasses, which leads to problems like flooding. Heavy rainfall quickly floods underpasses and roads, resulting in traffic jams and halted vehicles.

Until recently, there was no structured strategy to monitor water levels in underpasses and flood-prone areas, but this is expected to change in the future. I plan to check the news or Google Maps for updates and see if anyone has reported these incidents before.

A key issue with the current system is that the information we receive tends to be slow to transmit and can easily be distorted or manipulated. The main goal of the new system is to monitor the water levels in underpasses and areas vulnerable to flooding.

To achieve this, we will use water-level sensors connected to a Raspberry Pi board equipped with an ESP8266 module. This setup will allow for a continuous data stream to be transmitted to the cloud, enabling vehicle movements to be redirected to safer routes. This means that drivers using underpasses or traveling on flooded roads can access real-time information stored in the cloud and plan their journeys accordingly.

Additionally, we will install an LCD near the underpass, which will continuously update the water level so that everyone nearby can determine whether it is safe for vehicles to pass. If the water level exceeds a predetermined threshold, a DC motor pump will be activated to remove the water. LCD near the underpass. This display

continuously updates the water level so that everyone in the area can determine whether it is safe for vehicles to pass. Then, when the water level exceeds the set threshold, a DC motor pump is used to pump the water.

Advanced IOT Solutions to Monitor Vehicular Movement in Flooded Underpass

In recent years, humans and other living beings have faced problems due to the rapid increase in population. In addition, various problems such as flooding of underground passages occur due to the lack of proper infrastructure. When heavy rain comes, underground passages can quickly become flooded, which can cause serious situations for passing vehicles. In addition, there are serious problems with vehicle movement in underground passages. This is because the drainage system is inadequate and the design to filter rainwater into the ground is poor. In this article, we will discuss the challenges faced by humans and other living beings due to the rapid increase in population in recent years. In addition, the lack of proper infrastructure has led to various problems such as flooding of underpasses. When heavy rain falls, these underpasses can quickly flood, posing a danger to passing vehicles. Furthermore, the underground passages suffer from severe congestion due to inadequate drainage and poor design that does not effectively drain rainwater into the ground. In this paper, we propose an IoT-based solution to monitor and manage the heavy traffic in these underpasses. In recent years, humans and other living beings have been facing problems due to rapid population growth. In addition, various problems such as flooding of underpasses have occurred due to insufficient infrastructure. When heavy rain falls, these underpasses can quickly flood, which can cause a dangerous situation for passing vehicles. In addition, underground passages suffer from severe congestion due to inefficient drainage systems and poor design that does not allow rainwater to drain properly into the ground. In this paper, we propose an IoT-based solution to monitor and manage the congested traffic in these underpasses. Underground passage.

A framework for mobile application of flood alert monitoring system for vehicle users using Raspberry Pi device

This article aims to create an Android app that allows car owners to receive flood alerts on their smartphones while driving. Combined with a Raspberry Pi model for flood monitoring, the app warns users whether their vehicle can safely drive through flood waters, whether they need to be careful, or whether the road is passable due to flooding. The app uses the smartphone's GPS to determine the user's location. When the car owner selects the vehicle model based on the driver's location, the vehicle model will notify the car owner of the surrounding flood sound and whether it is passable. This also helps prevent them from getting stranded in flood waters, or worse, having their car engines damaged by flood water because they did not realize how deep the flood waters were. The main purpose of this research is to implement a mobile application that will help drivers monitor road flooding and determine if the road is excessively flooded.

Real Time Flood Monitoring and Prevention Using IoT Sensors in Developing Countries

Floods are one of the most devastating and destructive natural disasters that cause significant damage to life, property, and the economy. Due to climate change, it is difficult for scientists to know where the next flood will be devastating, so there is no way to predict when people will be warned. Damage to homes and property is extensive, and medical expenses are high. Flood monitoring is a smart way to always monitor floodwaters and prevent losses in the event of a major disaster. It is important to issue flood warnings to residents in safe areas so that they can be prepared to evacuate. Monitoring flood warnings near any flood-prone area can provide important information about the situation and help protect property and save lives. In this work, we propose a rapid flood monitoring system using Internet of Things (IoT) water sensors powered by Raspberry Pi boards.

3- METHODOLGY

BLOCK DIAGRAM

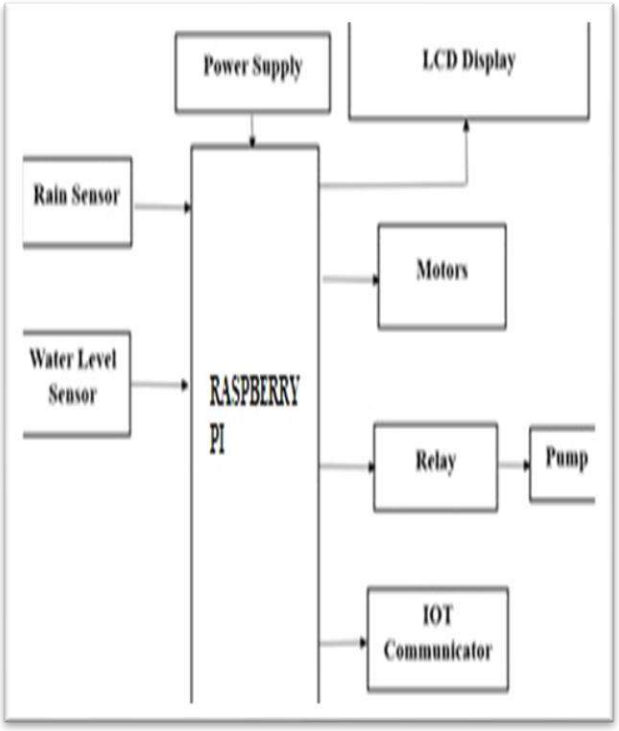

Figure 3.1.1 : Block Diagram Underpass Water Logging Detection and Safety Solutions.

The underpass monitoring concept uses Raspberry Pi as a device equipped with sensors and communication modules to detect water levels in the underpass and monitor traffic by communicating with the nearest traffic lights. The aim is to prevent water accumulation in underpasses and to divert traffic during periods of low water levels, thus preventing injuries or delays. For the system to operate efficiently, a Raspberry Pi microcontroller, a water level sensor, a Zigbee communication module, and a signal control module are used. The following is a detailed description of the 1 process. Monitors and controls the water level. When the water level exceeds a predetermined level, indicating a flood, the sensor sends a signal to the Raspberry Pi. Underground passages to other roads. Operation Water Level Meter: When the water level in the ground exceeds a predetermined point, the water meter detects this and sends a signal to the Raspberry Pi. The Raspberry Pi then processes the data to determine whether the water below is completely submerged or still suitable for traffic. Manual Control: The system can be designed with control options in case a problem occurs, or manual intervention is required. If the system is not working or needs to be replaced, officers can check the traffic signals. Testing and Calibration Sensor Calibration: Calibrate the water level sensor to ensure it is testing the water level accurately. Calibration involves adjusting the sensitivity of the sensor to match the actual water level in the groundwater. This prevents the system from detecting floods and disrupting traffic.

4-HARDWARE AND SOFTWARE REQUIREMENTS

HARDWARE REQUIREMENTS

- Raspberry Pi
- Lcd Display.
- Rain Sensor.
- Water Level Sensor.
- DC Motor/Servo motor.
- Relay.
- Water pump.
- Power Supply.

Software Requirements

4.3.1 Raspbian OS

Although the Raspberry Pi's operating system is closer to the Mac than Windows, it's the latter that the desktop most closely resembles It might seem a little alien at first glance, but using Raspbian is hardly any different to using Windows (barring Windows 8 of course). There is a menu bar, a web browser, a file manager and no shortage of desktop shortcuts of pre-installed applications. Raspbian is an unofficial port of Debian Wheezy arm hf with compilation settings adjusted to produce optimized"hardfloat"codethatwillrunontheRaspberryPi.Thisprovides

- Although Raspbian is primarily the efforts of Mike Thompson (MP Thompson) and Peter Green (plug wash), it has also benefited greatly from the enthusiastic support of Raspberry Pi community members who wish to get the maximum performance from their device.
- Raspbian is a Debian-based computer operating system for Raspberry Pi. There are several versions of Raspbian including Raspbian Stretch and Raspbian Jessie. Since 2015 it has been officially provided by the Raspberry Pi Foundation as the primary operating system for the family of Raspberry Pi single-board computers. Raspbian was created by Mike Thompson and Peter Green as an independent project. The initial build was completed in June2012. The operating system is still under active development. Raspbian is highly optimized for the Raspberry Pi line's

5-RESULT

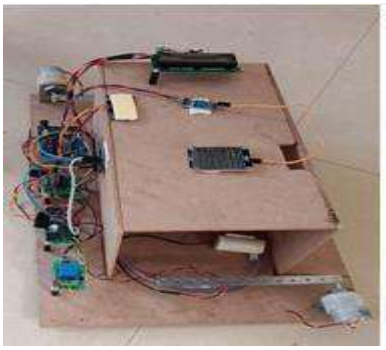

Figure 5.1 Model of Underpass Water Logging Detection and Safety Solutions.

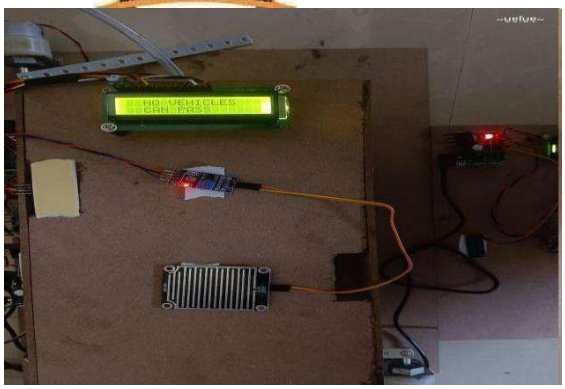

Figure 5.1.2 Alert Messages Displayed

6- DISCUSSION

Result Explanation of Underpass Water Monitoring System Using Raspberry Pi

The underpass water monitoring system using Raspberry Pi is designed to address the recurring problem of waterlogging in underpasses, ensuring real-time water level detection and alerting mechanisms. The system's results validate its effectiveness in improving safety and mobility in flood-prone areas.

The system utilizes a Raspberry Pi microcontroller as its central processing unit. It connects with ultrasonic sensors to measure water levels and other components like cameras for visual monitoring. The ultrasonic sensor, placed at a fixed height, accurately detects water depth in the underpass by calculating the time taken for sound waves to reflect back from the water surface. The sensor data is processed by the Raspberry Pi to determine whether the water level is within safe, warning, or critical thresholds.

Results show that the system effectively classifies water levels into three zones:

- **Safe Zone:** Indicates no or minimal water accumulation.
- **Warning Zone:** Triggers caution for potential flooding.
- **Critical Zone:** Initiates immediate alerts and activates countermeasures, such as closing the underpass or sending notifications.

The system also integrates real-time alerts using IoT platforms. Notifications, including water level status and live camera feeds, are sent to municipal authorities or displayed on public boards. The alerts ensure timely action, minimizing risks to commuters.

Testing in controlled and real-world environments demonstrates the system's reliability, with high accuracy in detecting water levels under various conditions. Its low-cost and scalable design make it suitable for wide- scale deployment.

In conclusion, the underpass water monitoring system using Raspberry Pi provides an efficient, automated solution to monitor and manage waterlogging, ensuring public safety while reducing response time for disaster management.

Future scope

- Integration with Smart City Initiatives: Integration with smart city initiatives to create a comprehensive urban flood management system.
- Artificial Intelligence (AI) and Machine Learning (ML) Integration: AI and ML integration to improve predictive analytics, enabling proactive measures to prevent water logging.
- Internet of Things (IOT) Sensor Fusion: Combining data from various IOT sensors (e.g., water level, temperature, humidity) to create a more accurate and comprehensive picture of underpass conditions.
- Real-Time Video Analytics: Integration of real-time video analytics to detect water logging, monitor traffic, and enhance safety.
- Autonomous Systems: Development of autonomous systems, such as drones or robots, to inspect and maintain underpass infrastructure.
- 5G and 6G Connectivity: Leveraging 5G and 6G connectivity to enable faster data transfer rates, lower latency, and greater connectivity.

7- ADVANTAGES AND DISADVANTAGES

Advantages

- Real-time monitoring and alerts ensure road user safety.
- Automated water removal reduces manual effort.
- Cloud-based alerts provide wider public awareness.
- Integrated rescue system enhances emergency response.
- Predictive maintenance.
- Reduced Damage.
- Data-Driven decision making.

Disadvantages

- Initial installation cost may be high.
- System depends on stable internet connectivity for cloud updates.
- Regular maintenance of sensors and pumps is required

Applications

- Urban infrastructure to manage underpass flooding.
- Highway and road safety management.
- Smart city initiatives to improve public safety.
- Disaster management for flood-prone areas.
- Emergency response systems for stranded individuals.
- Smart traffic management system

8- CONCLUSION

The project proposes a simple water level monitoring system with different levels indicated. It also signifies when the water level is below and above then the requirement. Future Work can involve the analysis of water level in a particular area so that the wastage of water is prevented. We can also include the SMS- based system where the message will be sent to the actual authorized person when the water level is below the specified level. The advancement of innovation made ready to increment in originations like WSN, IoT, and 5G and numerous others. In this paper, we've made programmed water utilization checking framework dependent on cloud in a lake which lets in plunging the consumption of the water.

future work:

The future scope of the underpass waterlogging project includes further advancements in automation and machine learning algorithms for improved flood detection and response. Integration with smart city infrastructure could enable proactive measures such as preemptive road closures based on predictive analytics. Collaborations with weather forecasting agencies may enhance the accuracy of real time alerts, minimizing the impact of extreme weather events. Implementation of sensor networks could provide granular data for better flood monitoring and management. Additionally, exploring renewable energy sources to power water removal systems can enhance sustainability. Augmented reality interfaces for drivers could offer intuitive navigation during flooded conditions. Public-private partnerships may accelerate innovation and deployment, fostering a more resilient urban infrastructure. Continued research into materials and designs for flood-resistant underpasses can enhance long-term durability. Community engagement initiatives can raise awareness and promote citizen participation in flood response efforts. Overall, the project's future lies in embracing emerging technologies and collaborative approaches to create safer and more resilient urban environments.

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