ADVANCED IOT AND MACHINE LEARNING SOLUTIONS TO MONITOR UNDERPASS WATER LOGGING

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Introduction:

In today's rapidly evolving technological landscape, ensuring road safety and public awareness has become increasingly paramount. To address this, innovative solutions leveraging advanced technologies such as Internet of Things (IoT), cloud computing, automation, and machine learning are being explored and implemented. One critical aspect of road safety is regulating the types of vehicles permitted to traverse certain routes. To address this, a system is proposed to display alert information to road users regarding the types of vehicles allowed to pass through specific areas. This system aims to mitigate the risk of accidents and congestion by providing real-time guidance to drivers, ensuring compliance with regulatory restrictions.

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.

Objectives:

1. To display alert information to the road user which type of vehicle can pass in

A system alerts road users about permitted vehicle types in specific areas, enhancing compliance and reducing accidents. Real-time guidance ensures adherence to regulatory restrictions, promoting safer and smoother traffic flow.

2. To upload warning messages to the cloud and make the status available to the public.

Warning messages are uploaded to the cloud for public access, ensuring real-time dissemination of crucial road information. Cloud-based status updates enable informed decision-making and enhance overall road safety awareness.

3.To remove the collected water automatically using water pump.

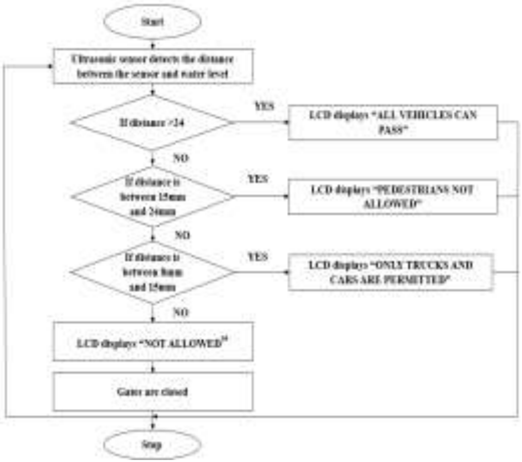
Automated water pumps efficiently clear collected water from roadways, reducing hydroplaning risks and ensuring safer travel. This automated system minimizes response times, enhancing road accessibility during inclement weather conditions.

4. To detect the human beings in underpass flood area using YOLO algorithm (Machine learning).

The YOLO algorithm detects human presence in underpass flood areas, aiding in timely rescue efforts and ensuring safety. Utilizing machine learning, it enhances flood response by swiftly identifying individuals in critical situations.

Methodology:

Objective 1 To display alert information to the road user which type of vehicle can pass in



The fig 1 shows the flowchart to display alert information to the road user which type of vehicle can pass in.The system described integrates multiple sensors and output devices to manage water levels in an underpass. An Arduino Mega serves as the central control unit, receiving input from a Ultrasonic sensor. The water level sensor, initialized as an analog input, measures the distance between water and sensor, ensuring non-negative readings. Should the sensor output zero, indicating a lack of data or malfunction, the system loops back to collect accurate measurements. Based on the water level data, the Arduino Mega determines the underpass status. If the distance between water and sensor is 24 mm, the LCD display indicates all vehicles can pass. If it's between 15 and 24 mm, pedestrians are barred. For distances ranging from 8 to 15 mm, only trucks and cars are permitted, while anything less than 8 mm prohibits all vehicle traffic and gates is closed.

Objective 2 To upload warning messages to the cloud and make the status available to the public.

Set up a Telegram bot through BotFather on the Telegram platform and obtain the API token. BotFather will guide you through the process of creating a new bot and provide you with a unique API token. This token will serve as the authentication key for your bot when communicating with the Telegram API.Arduino code is written to read Ultrasonic sensor data.code is implemented to establish communication with the Arduino Mega receive sensor data, and then use the Telegram API to send this data to your Telegram bot.set up the NodeMCU to connect to Wi-Fi. Define the SSID and password of your Wi-Fi network in the NodeMCU code. Then, implement code to connect to the Wi-Fi network using the provided credentials. and the messages is sent.

Objective 3 To remove collected water automatically using water pump

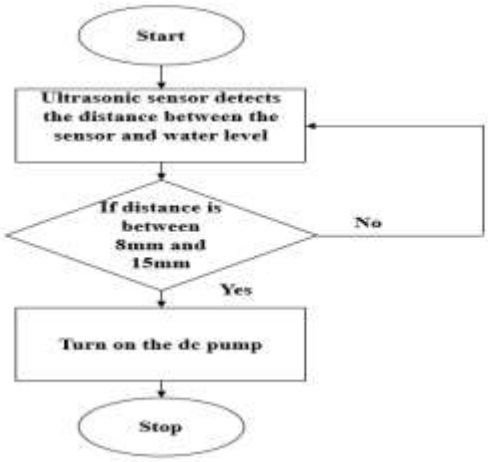


Fig 2 Flow chart to remove collected water automatically using water pump

The fig 2 shows flow chart to remove collected water automatically using water pump. When the water level exceeds the threshold, a DC pump activates instantly. A relay serves as the switch for the pump, toggling its operation. This setup enables efficient management of water levels, ensuring timely activation of the pump to mitigate flood risks and prevent damage in affected areas.

Objective 4 To detect the human beings in underpass flood area using YOLO algorithm (Machine learning).

Fig 3 Flow chart for creating a trained model

The fig 3 shows the block diagram for creating a trained model. The process begins with data gathering, labeling, and annotating, followed by preprocessing using Roboflow to ensure data consistency and quality. YOLOv5 training is then conducted to develop a robust model for object detection. The trained model is stored for future use. Performance analysis is subsequently carried out using Google Colab, enabling thorough evaluation of the model's accuracy and effectiveness in detecting human presence in underpass flood areas. This comprehensive approach ensures the reliability and efficiency of the system in providing timely alerts and facilitating proactive responses to potential hazards.

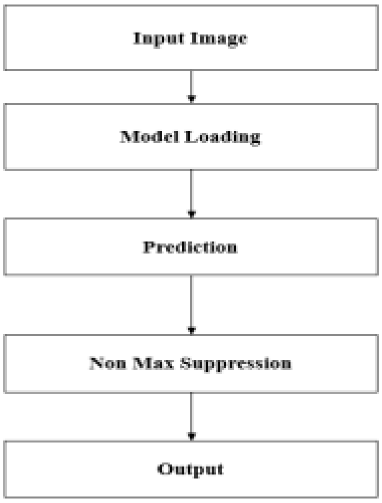


Fig 4 Flow chart for testing the model

The fig 4 shows the block diagram for testing the model.In the live detection process, input images captured from a camera are fed into the trained model for prediction. The model compares the input image with its learned features to identify human presence. Non-maximum suppression is then applied to refine the detection results. If a human is detected, an immediate rescue ladder is deployed, and a message containing the detected location is transmitted to the rescue team. This technical workflow ensures efficient real-time detection of humans in flood-prone areas, enabling swift rescue operations and enhancing overall emergency response capabilities.

Conclusion:

The integrated system presented offers a multifaceted approach to improving road safety and public awareness during flood events. By combining alert systems for motorists, cloud-based warning dissemination, automated water removal mechanisms, and advanced human detection algorithms, it effectively mitigates flood risks, enhances traffic management, and ensures timely responses to potential hazards. This comprehensive solution underscores the importance of leveraging technology to safeguard public safety and mitigate the adverse impacts of inclement weather conditions on road infrastructure and user welfare. Further research and implementation of such systems hold promise for bolstering resilience and emergency preparedness in the face of natural disasters.

Scope for 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.