A Synopsis on

AI for Sustainable Drainage System to Prevent Waterlogging

Proposed to be submitted in

partial fulfilment of the requirements for the award of degree of

Bachelor of Engineering

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PIMPRI, PUNE – 411 018.

2025-2026

1. Abstract

Urban flooding and waterlogging are persistent challenges in rapidly growing cities, often caused by heavy rainfall, poor drainage capacity, and unplanned urbanization. Traditional drainage monitoring systems rely mainly on sensors and rainfall data, which provide limited insights and delayed responses. To address this, our project proposes an AI-powered urban drainage management system that integrates multi-source data, including IoT water-level sensors, rainfall APIs, CCTV image analysis, and citizen-reported crowdsourced data. The system preprocesses this data and applies machine learning models for predicting waterlogging risks and identifying vulnerable hotspots in advance. Computer vision techniques are employed to analyze road and drain images for real-time waterlogging detection. A decision-support engine then generates early warnings, maintenance recommendations, and traffic rerouting suggestions, which are visualized through dashboards and sent as alerts to authorities and citizens. Unlike existing approaches, our solution emphasizes data fusion, predictive modeling, and actionable insights, making it scalable, cost-effective, and practical for smart city integration. The project demonstrates how AI and IoT can together contribute to resilient, sustainable, and smarter urban infrastructure by minimizing the socio-economic impact of waterlogging.

2. Introduction

Urban flooding and waterlogging have become recurring issues in many cities across the world, especially in rapidly developing nations like India. Increasing urbanization, reduced green cover, encroachment on natural water channels, and inadequate drainage infrastructure have worsened the situation. Even moderate rainfall events often result in traffic congestion, property damage, health hazards, and disruption of daily life. Hence, efficient and intelligent urban drainage management has become a pressing need.

Traditional flood monitoring and drainage systems rely mainly on manual inspections, limited sensors, or rainfall measurements. These methods provide reactive solutions, where authorities respond only after waterlogging has already occurred. The lack of real-time predictive capability and integration of multiple data sources makes existing approaches insufficient to handle the growing complexities of modern cities. Therefore, there is a need for a smarter, data-driven, and proactive solution.

Artificial Intelligence (AI), combined with the Internet of Things (IoT), provides a promising pathway to improve drainage management. IoT sensors can continuously collect water level and rainfall data, while AI models can analyze patterns, detect anomalies, and predict waterlogging events in advance. Moreover, integrating data from CCTV footage, weather APIs, and crowdsourced citizen reports enables a more holistic understanding of urban flooding scenarios. This allows authorities not only to monitor but also to take preventive and corrective actions efficiently.

This project proposes an AI-enabled urban drainage system that combines real-time sensor data, computer vision, and machine learning for predictive waterlogging management. The system generates early warnings, identifies high-risk areas, and provides actionable insights such as maintenance alerts and traffic diversion strategies. By merging technology with urban infrastructure, the project aims to support smart city initiatives and contribute to sustainable urban living, ensuring reduced waterlogging impacts and improved resilience to extreme weather events.

3.Problem Statement

Urban areas are increasingly facing the challenge of frequent waterlogging and flooding due to rapid urbanization, inadequate drainage infrastructure, and unpredictable rainfall patterns. Existing monitoring systems are mostly reactive, relying on limited sensors, manual inspections, or post-incident reports, which delays response and fails to prevent damage. These traditional methods often lack real-time data integration, predictive analysis, and actionable insights, making it difficult for authorities to identify high-risk zones, plan timely interventions, and minimize disruptions.

4.Objective

1. To develop an AI-driven system for predicting and preventing urban waterlogging.
2. To integrate real-time data from IoT sensors, weather forecasts, CCTV, and citizen reports.
3. To design machine learning and computer vision models for risk detection and analysis.
4. To provide early warning alerts and decision support for authorities and the public.
5. To support smart city initiatives by improving urban resilience and sustainable drainage management.

5. Scope

The project focuses on developing an AI-powered urban drainage management **sys**tem to address the issue of waterlogging in cities. The scope includes designing a framework that integrates data from multiple sources such as IoT water-level sensors, rainfall and weather APIs, CCTV feeds, and citizen-reported information. This ensures that the system captures both environmental and human-centric perspectives for a more accurate assessment of flooding risks.

The system aims to leverage machine learning models to analyze historical and real-time data for predicting waterlogging hotspots. Additionally, computer vision techniques will be applied to CCTV and street-level images to identify actual on-ground flooding conditions. This predictive and detection capability will enhance the accuracy and reliability of the proposed solution compared to traditional methods.

In terms of functionality, the project will provide a decision-support platform for city authorities. This includes early warning alerts, risk mapping, and maintenance recommendations for drainage systems. Moreover, the system will support traffic management by identifying areas where waterlogging may disrupt mobility, thereby reducing public inconvenience and economic loss.

The scope also extends towards long-term benefits by contributing to smart city initiatives. The framework developed can be scaled to multiple cities and adapted to different environmental conditions. Furthermore, by incorporating crowdsourced data and citizen participation, the system promotes community involvement, making urban drainage management more inclusive, sustainable, and resilient.

6. Application

The AI-based urban drainage system can be applied in multiple real-life scenarios to improve city resilience and management. It can help predict and prevent waterlogging by analyzing real-time and

historical data, allowing authorities to take early preventive measures. The system can also be integrated into smart city platforms, making urban infrastructure more intelligent and sustainable.

In traffic management, the solution provides alerts on flooded roads, enabling rerouting and reducing congestion during rainfall events. It also supports disaster management and emergency response by offering real-time insights to authorities for rescue operations and efficient resource allocation. For the public, the system enhances safety by sending alerts and notifications about waterlogged zones, ensuring safer commuting and reducing risks.

Additionally, the system assists in drainage system maintenance by identifying blocked drains and high-risk locations, allowing timely cleaning and repair activities. In the long run, it supports urban planning by providing data-driven insights to design better drainage networks and allocate resources effectively. Overall, the project has strong applications in minimizing the socio-economic impacts of flooding while contributing to sustainable and smart city development.

7. Project plan with timeline

Table 1: Proposed detailed activity and sub activity plan

Year ⇨		2024						2025					
Activity	**Sub Activity**	**M1**	**M2**	**M3**	**M4**	**M5**	**M6**	**M7**	**M8**	**M9**	**M10**	**M11**	**M12**
Design	Literature review												
	Requirement analysis												
	Model/Algorithm Selection												
	User Interface/Experience Design												
Development & Integration	AI Model Training & Tuning												
	Accessibility Features (TTS, Audio/Haptics)												
	Backend-Frontend Integration												

Testing & Validation	Usability & Accessibility Testing												
	Field Feedback Collection												
	Optimization & Debugging												
	Preparing framework and writing research paper												
Writing and finalization of Report													

8. Conclusion

Urban waterlogging continues to be a major challenge due to rapid urbanization and inadequate drainage systems. Existing methods are mostly reactive and fail to provide timely solutions. Our project proposes an AI-driven approach that integrates IoT sensors, weather forecasts, CCTV analysis, and citizen data to predict and prevent flooding effectively. The system uses machine learning and computer vision to identify high-risk areas and generate early alerts for authorities and the public. This not only helps in traffic management and public safety but also guides long-term urban planning. Overall, the project contributes to smart city initiatives by offering a proactive, sustainable, and scalable solution for resilient urban drainage management.

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