Published by :
https://www.ijert.org/
An International Peer-Reviewed Journal

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 06 , June - 2026

AI Based Detection of Illegal Construction in Cities

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***ABSTRACT*- The rapid growth of cities has increased unauthorized construction activities, creating major safety, environmental, and urban planning problems [4]. Illegal constructions often violate zoning laws, building regulations, and municipal development plans, leading to unsafe structures and unplanned urban expansion [2][3]. Traditional monitoring methods mainly depend on manual inspections and public complaints, which are slow, inefficient, and difficult to manage in large urban areas [6].**

This survey paper reviews Artificial Intelligence (AI)-based approaches for detecting unauthorized construction using satellite imagery, Geographic Information Systems (GIS), and deep learning models such as YOLOv8 [5][9]. Various techniques including image processing [10], semantic segmentation [7], transfer learning [7], object detection [1][5], and GIS-based spatial verification [8] are studied and compared. The paper also discusses the use of remote sensing technologies [6][8] and satellite image change detection methods for identifying newly constructed or modified structures [11].

The survey highlights the importance of integrating Artificial Intelligence, Remote Sensing, Cloud Databases, and Web Technologies to improve monitoring efficiency, transparency, scalability, and real-time decision making [1][6]. Technologies such as Google Earth Engine [13], OpenCV [10], Firebase [12], Flask [14], and React.js [15] support automated data processing, visualization, and alert generation systems for smart city applications.

The study concludes that AI-powered urban monitoring systems can significantly reduce manual effort, improve detection accuracy, support sustainable urban development, and help authorities effectively manage unauthorized construction activities in modern cities [1][4][6][7].

I. INTRODUCTION

Rapid urbanization and population growth have significantly increased the demand for residential, commercial, and industrial infrastructure in modern cities [4]. As cities continue to expand, unauthorized and illegal construction activities have also increased at an alarming rate [2][3]. These constructions are often carried out without proper approval from municipal authorities and violate zoning regulations, environmental policies, and urban development plans [4]. Illegal constructions not only disturb planned urban growth but also create serious safety, environmental, and socio-economic problems [6].

Traditional methods used for monitoring illegal construction mainly depend on manual inspections, public complaints, and periodic surveys conducted by municipal authorities [4]. These methods are time-consuming, labor-intensive, and often inefficient in densely populated urban areas [6]. Human monitoring systems are prone to errors, delayed responses, corruption, and lack of coordination among different departments [3]. As a result, many unauthorized structures remain undetected until they become a major issue [2].

Recent advancements in Artificial Intelligence (AI), Deep Learning, Computer Vision, Remote Sensing, and Geographic Information Systems (GIS) have opened new possibilities for smart urban monitoring systems [1][6][7]. AI-powered systems can automatically analyze satellite images, identify construction-related patterns, and detect newly developed or modified structures in real time [1][7]. Deep learning algorithms such as YOLOv8 (You Only Look Once Version 8) provide high-speed and accurate object detection capabilities, making them suitable for monitoring large-scale urban environments [5][9].

Satellite imagery and remote sensing technologies play an important role in observing urban development over time

[6][11]. By comparing historical and current satellite images, change detection techniques can identify newly constructed buildings, land-use modifications, and suspicious urban activities [11]. GIS technology further improves the system by mapping detected structures with real-world coordinates and validating them against approved zoning maps and municipal records [8].
This survey paper reviews various AI-based approaches used for detecting unauthorized construction in cities. Different methodologies such as image processing [10], semantic segmentation [7], transfer learning [7], convolutional neural networks [1][8], GIS-based verification [6][8], and cloud-integrated monitoring systems [12][13] are studied and compared. The paper also discusses the advantages, limitations, tools, and technologies used in existing research works [1][6][7]. In addition, the study highlights the integration of cloud databases, web technologies, and real-time alert systems for improving monitoring efficiency and transparency [12][14][15]. Technologies such as Firebase Realtime Database [12], Flask [14], React.js [15], and Google Earth Engine [13] support scalable and intelligent monitoring platforms capable of handling large amounts of geospatial data.
The primary objective of this survey is to understand how Artificial Intelligence and modern geospatial technologies can help city authorities automatically identify illegal construction activities, reduce manual effort, improve urban governance, and support smart city development [1][4][6][7].

II. LITERATURE SURVEY

The integration of AI with GIS
and satellite-based monitoring systems can provide a costeffective, scalable, and reliable solution for maintaining sustainable urban growth and ensuring public safety.

Sr No.	Paper Title	Published Year	Details	Tools & Technologies
1	A New High-Precision and Lightweight Detection Model for Illegal Construction Objects Based on Deep Learning	2024	YOLOv4-based lightweight model for accurate illegal construction detection.	YOLOv4, Deep Learning, DenseNet
2	Illegal Building Construction Detection System	2014	System developed using image processing and ML techniques.	Image Processing, Machine Learning
3	Illegal Building Detection Using Machine Learning	2024	Applied ML algorithms for detecting illegal buildings.	SVM, Decision Trees, ML
4	Monitoring and Governance of Illegal Urban Construction	2024	Focused on governance strategies and urban monitoring.	GIS, Remote Sensing
5	You Only Look Once: Unified, Real-Time Object Detection	2016	Introduced YOLO object detection framework.	YOLO, CNN, Deep Learning

COMPARISON OF EXISTING SYSTEM WITH PROPOSED SYSTEM

Parameter	Existing Systems	Proposed System
Monitoring Method	Mostly manual inspections and complaint-based monitoring	Fully automated AI-based monitoring system
Detection Technique	Traditional image processing and basic machine learning methods	Advanced Deep Learning using YOLOv8 and AI models
Data Source	Limited local survey data and static images	Real-time satellite imagery and GIS data
Accuracy	Lower accuracy and higher chances of human error	High accuracy with real-time object detection
Processing Speed	Slow processing and delayed reporting	Fast real-time detection and alert generation
Change Detection	Limited or unavailable	Automatic comparison of historical and current satellite images
GIS Integration	Minimal integration with urban planning systems	Full GIS-based spatial verification with zoning maps
Scalability	Difficult to scale for large cities	Highly scalable cloud-ready architecture
Data Storage	Local storage and manual records	Firebase Realtime Database with cloud integration

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User Interface	Limited visualization and reporting tools	Interactive dashboard with maps, heatmaps, and reports
Alert System	Manual reporting process	Automatic real-time notifications and geo-tagged alerts
Transparency	Prone to corruption and delays	Improved transparency through automated verification
Human Effort	Requires continuous human supervision	Reduced manual effort using AI automation
Technology Used	Traditional ML, image processing	YOLOv8, OpenCV, GIS, Flask , Firebase
Smart City Support	Limited support for smart city applications	Designed for smart city monitoring and governance

III. PROPOSED SYSTEMS

The proposed AI-based unauthorized construction detection system follows a systematic methodology that combines Artificial Intelligence, Deep Learning, Remote Sensing, Image Processing, and Geographic Information Systems (GIS) to automatically identify illegal construction activities in urban areas [1][2][6][7]. The methodology is designed to provide accurate, real-time, and scalable monitoring of construction activities using satellite imagery and geospatial data [4][11].

1. ta Acquisition

High-resolution satellite imagery is acquired using platforms such as Google Earth Engine [13], which provides access to real-time and historical satellite datasets. Historical images are important for identifying changes in urban structures over time [11]. Additional data sources include municipal zoning maps, approved building permits, land registry records, and urban planning datasets [4][8].

2. ta Preprocessing

Raw satellite images often contain noise, distortions, inconsistent brightness, and unnecessary information that may affect detection accuracy. Preprocessing is performed using OpenCV [10] and image enhancement techniques. This includes noise removal, normalization, resizing, contrast enhancement, and edge detection for better feature extraction [1][7].

3. Object Detection Using YOLOv8

The YOLOv8 deep learning model is applied for detecting construction-related objects in satellite images [5][9]. YOLOv8 is chosen for its high detection speed, lightweight architecture, and real-time processing capability [1]. The model is trained on datasets containing buildings, rooftops, foundations, construction sites, and excavation areas [2][3].

4. Change Detection

Change detection compares current satellite images with historical ones to identify newly constructed or modified structures [11]. Techniques include pixel-based comparison, image differencing, temporal analysis, and structural variation detection [6].

5. S-Based Spatial Verification

Detected structures are verified using GIS mapping, which converts object locations into real-world coordinates [8]. The system overlays detected structures onto zoning maps, approved layouts, land-use records, and municipal planning maps to classify unauthorized construction [4][6].

6. Alert Generation System

Unauthorized construction triggers automatic alerts for municipal authorities [2][4]. Each alert contains GPS coordinates, timestamps, annotated satellite images, and verification results, enabling immediate action [6].

7. atabase and Cloud Storage

All detected data, reports, and alerts are stored using Firebase Realtime Database [12]. Cloud storage ensures synchronization, secure management, and scalability for smart city monitoring applications [1][6].

8. Visualization and Reporting

A web-based dashboard developed using Flask [14] and React.js [15] provides interactive maps, heatmaps, real-time alerts, and construction activity reports [6]. This enables efficient monitoring through a user-friendly interface.

9. Notification and Decision Support System

Real-time notifications are sent via web and mobile platforms, assisting authorities in decision-making and law enforcement [4][6].

Advantages of the Proposed Methodology

- Fully automated detection system [1][2]
- Real-time monitoring capability [5][9]
- High accuracy using YOLOv8 [1][5]
- Integration with GIS and satellite imagery [6][8]
- Reduced human effort and operational cost [4][6]
- Cloud-based scalable architecture [12][13]
- Faster alert generation and reporting [2][6]
- Improved transparency and urban governance [4][7]

IV CONCLUSION

Unauthorized construction has become one of the major challenges faced by rapidly growing urban areas [2][3][4]. Illegal buildings not only violate municipal regulations and zoning laws but also create serious risks related to public safety, environmental sustainability, infrastructure management, and planned urban development [4][6]. Traditional monitoring approaches based on manual inspections and complaint-based systems are often slow, inefficient, and unable to handle the increasing complexity of modern cities [2][6].

The proposed AI-based unauthorized construction detection system provides an intelligent and automated solution for addressing these challenges. By integrating advanced technologies such as Artificial Intelligence, Deep Learning, Geographic Information Systems (GIS), Remote Sensing, and Cloud Computing [1][6][7], the system can efficiently monitor urban areas and identify illegal construction activities in real time. The use of YOLOv8 deep learning models enables accurate and fast object detection from satellite imagery [5][9]. Change detection techniques further improve the system by identifying newly developed or modified structures through comparison of historical and current satellite images [11]. GIS-based spatial verification ensures that detected constructions are validated against approved zoning maps and municipal records, reducing false detections and improving reliability [8].

The integration of cloud technologies such as Firebase Realtime Database [12] allows secure storage and real-time synchronization of alerts, reports, and metadata. Web technologies including Flask [14] and React.js [15] provide interactive dashboards for visualization, reporting, and administrative monitoring [6]. These features improve operational efficiency, reduce manual effort, and increase transparency in urban governance systems [4][7].

This survey concludes that AI-powered urban monitoring systems have the potential to transform the way municipal authorities manage construction activities. The integration of Artificial Intelligence, GIS, satellite imagery, and cloud-based technologies can significantly improve the detection and management of unauthorized construction activities while supporting sustainable urban development and smart city initiatives [1][6][7].

In the future, the system can be enhanced by integrating drone-based surveillance, predictive analytics, edge AI processing, Internet of Things (IoT) devices, and advanced real-time monitoring frameworks [1][6]. These advancements can further improve detection accuracy, reduce processing delays, and provide more intelligent urban management solutions for modern cities.

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