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Ai Based Detection of Illegal Construction in Cities

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***ABSTRACT*-The growth of cities is happening fast and this has led to a lot of unauthorized building work in these cities. This kind of building work does not follow the rules. It is a big problem. It creates safety issues for people it hurts the environment. It causes problems with city planning.**
The old ways of keeping an eye on these things are not very good. They involve people going out to check and systems that rely on complaints. These methods take a lot of time. They cannot handle a lot of cases.

To deal with these problems this project is proposing a system that uses Artificial Intelligence to find building work that is not allowed. It uses pictures taken from satellites. The system uses algorithms, like YOLOv8 to find objects in real-time. It also uses Geographic Information Systems to check the location of things and municipal databases to check if something is legal.

The system is always looking at pictures, from satellites comparing them to pictures and maps of areas that have been approved. It finds things that are not supposed to be. When the system finds something that is not allowed it puts a tag on the location takes a picture as proof and tells the people in charge through a website and a mobile app. The Artificial Intelligence system makes cities better helps people enforce the rules efficiently and supports the idea of cities by making decisions based on facts. The city becomes a place to live because of the Artificial Intelligence system.

I. INTRODUCTION

Urbanization is a part of our world and it means we need more houses and roads. This growth has also led to a lot of construction like buildings that are not supposed to be there people taking over public land and buildings that do not follow the plans [4][6].
These unauthorized Urbanization developments cause a lot of problems:
They are not safe because they do not follow engineering rules [4]
They hurt the environment in areas that're very sensitive [6]
They use up much water, electricity and transportation which can be a big problem [4]
The way we monitor Urbanization now is not very good. We mostly just look at things every now and then or wait for people to complain. This way of doing things is slow, not efficient and different departments do not work well together [2][4].
Now we have technologies, like artificial intelligence, remote sensing and geospatial technologies that can help us with Urbanization. We can use these technologies to create a system that watches the city all the time [6][11]. The system we are talking about uses learning to find objects looks at maps to understand the space and uses satellite pictures to find construction as it happens [1][5][7].
This system changes the way we take care of our cities. Of just waiting for something to go wrong we can be proactive and make sure things are done correctly from the start. This means we can stop problems before they start and make sure people follow the rules [6]. Urbanization and the system we are talking about can help us make our cities better. Urbanization is an issue. We need to deal with Urbanization in a smart way.

II. LITERATURE SURVEY

The detection of construction has been studied a lot using computer methods.
Liu and his team proposed a detection model that's simple and very accurate. This model is based on the YOLO architecture [1]. The YOLO architecture is good at finding construction patterns. The detection model does not use a lot of computer power.
This work shows that deep learning is very good at identifying construction patterns. Deep learning is very good at identifying construction patterns because it can learn from a lot of data [1][5].
Some other people like Kondewar and his team made a system a time ago. They used image processing and old machine learning methods [2]. This system was the first to show that computers can detect construction. However it was not very good at doing it. It could not handle a lot of data.

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Kavana P used machine learning to detect buildings [3]. He used methods like Support Vector Machines and decision trees. He had some success with machine learning. Machine learning is good at detecting buildings.

Ding and his team said that using GIS and remote sensing is very important for watching cities and making decisions [4]. They showed that having information about where thingsre is very important. GIS and remote sensing are very important for cities.

Uzkent and his team used a method called segmentation to look at satellite pictures [7]. This method can classify every pixel in a picture. Find construction areas. The method called segmentation is very good at finding construction areas.

Schmitt and Zhu used networks to find buildings that are not documented [8]. They used data. They showed that deep learning is very good at finding buildings that are not documented. Deep learning is very good at this.

People also use satellite pictures to see how cities change over time [11]. This helps to identify what is different. Satellite pictures are very good, at showing how cities change.

With all these methods, systems that detect illegal construction are often not automatic. They do not work well with city databases. They are not easy to use [2][4]. This project wants to make these things better. The detection of construction is still a problem that needs to be solved.

The detection of construction is still a problem that needs to be solved. This project is trying to solve it by making a system that's automatic. The system will be integrated with city databases. The system will be easy to use. The detection of construction is the main goal of this project. The project wants to detect construction.

III. METHODOLOGY

- **Data Acquisition** Collect multi-temporal satellite images (e.g., Google Earth Engine).
- **Preprocessing** Use OpenCV to clean images: noise removal, contrast enhancement, normalization.
- **Feature Detection (YOLOv8)** Identify construction objects (buildings, foundations, roofs, excavation areas).
- **Change Detection** Compare current vs. past images to spot modifications.
- **GIS Verification** Cross-check with zoning maps, land registry, and permits to flag violations.
- **Alert Generation** Produce GPS coordinates, timestamps, and annotated evidence.
- **Visualization & Reporting**

A. ARCHITECTURE MODEL

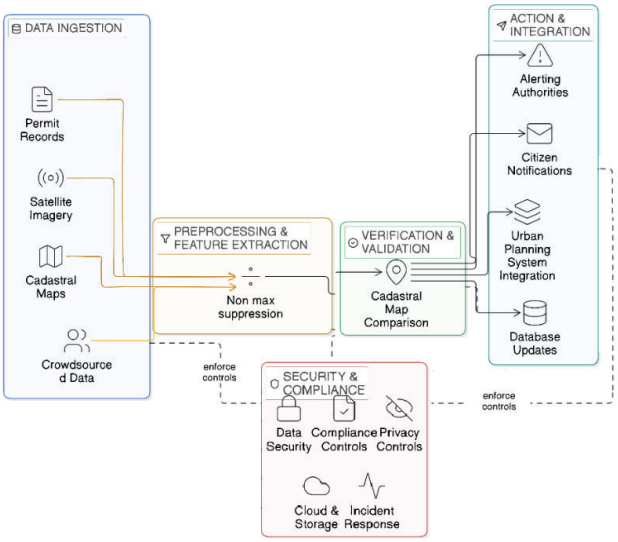

Fig. 3.1 Architecture Diagram For detection of illegal construction in cities

The proposed system is made up of layers and is very flexible. This way of designing it helps make sure the system can handle a lot of data and works efficiently and the system can detect construction activities as they happen [1][6].

The system has some parts: the system is divided into sections that work together to make the system work properly and the system has many important components that make up the system.

1. Data Acquisition Layer

This part collects data from many sources:

• Satellite images with high resolution from Google Earth Engine [13]

• Old satellite data to compare with current data

• Maps and records from municipalities, including zoning maps and approved construction records [4]

2. Data Preprocessing Layer

The raw satellite images are cleaned up to make them better for analysis:

• Removing noise using techniques

• Normalizing images so the brightness is consistent

• Resizing and formatting images so they work with AI models

• Making edges and features clearer using OpenCV [10]

3. Detection Layer (AI Model)

• It uses the YOLOv8 AI model for detecting objects in real-time [1][9]

• The model is trained on data that includes construction-related features

• It detects things like buildings, rooftops and construction sites

4. Change Detection Layer

This part finds changed constructions by comparing:

• Current satellite images

• Old satellite images

It uses techniques like:

• Comparing pixels

• Looking at image differences

• Analyzing changes over time [11]

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5. GIS Verification Layer
In this part the system checks detected constructions using data:
• It overlays detected structures on maps
• It checks against approved building plans and zoning rules [4]
• It finds differences between detected and approved structures
6. Database and Storage Layer
All processed data is stored safely:
• The system uses Firebase Realtime Database to store alerts, logs and metadata [12]
• It stores location coordinates, timestamps and images
• It allows real-time updates across systems
7. Application Layer (User Interface)
This part lets users interact with the system:
• A web dashboard made using Flask and React.js [14][15]
• It displays:
• Interactive maps
• Heatmaps of violations
• Alerts and reports
• It provides access levels for administrators and officials
8. Alert and Notification System
• It generates real-time alerts for detected violations
• It sends notifications through the dashboard and mobile interface
• It includes:
• Location
• Timestamp
• Evidence

B. MATHEMATICAL MODEL

1. **Image Representation** Satellite image = matrix of pixel values $I(x, y)$.

2. **Object Detection (YOLOv8)**
- Predicts bounding boxes (x, y, w, h), confidence score, and class (construction/non-construction).
- Score = $P(Object) \times P(Class \mid Object)$.

3. **Bounding Box Localization** Each detected structure is enclosed in $B = (x, y, w, h)$.

4. **Change Detection** Compare current vs. past images:
$$D(x, y) = I_{current}(x, y) - I_{previous}(x, y)$$
If $D(x, y) > T \rightarrow$ new construction detected.

5. **GIS Validation** Map detected objects to coordinates.
- If overlap with approved area → authorized.
- If no overlap → unauthorized.

6. **Decision Function** Final classification:
$$U = f(O, D, G)$$
Where U= unauthorized construction, based on object detection (O), change detection (D), and GIS verification (G).

C. ALGORITHM

Algorithm: AI-Based Detection of Unauthorized Construction
Input: Satellite images, GIS data
Output: Unauthorized construction alerts
Step 1: Data Collection
- Acquire satellite images from sources like Google Earth Engine [13]
- Retrieve GIS data and approved construction records

Step 2: Preprocessing
- Normalize and resize images
- Enhance quality using OpenCV [10]

Step 3: Object Detection
- Apply YOLOv8 model [5][9]
- Detect construction-related objects
- Generate bounding boxes and confidence scores

Step 4: Change Detection
- Compare current and historical images [11]
- Identify newly constructed or modified areas

Step 5: Location Mapping
- Convert detected object positions into GPS coordinates

Step 6: GIS Verification
- Cross-check detected structures with approved zoning data [4]

Step 7: Classification
- If structure matches approved records → Legal
- Else → Unauthorized

Step 8: Alert Generation
- Generate alert containing: Geo-coordinates ,Timestamp ,Annotated image

Step 9: Data Storage
- Store results in Firebase Realtime Database [12]

Step 10: Visualization
- Display results on dashboard using Flask and React.js [14][15]

Step 11: Notification
- Send alerts to authorities for action

IV. RESULTS AND ANALYSIS

A. EXPECTED RESULT

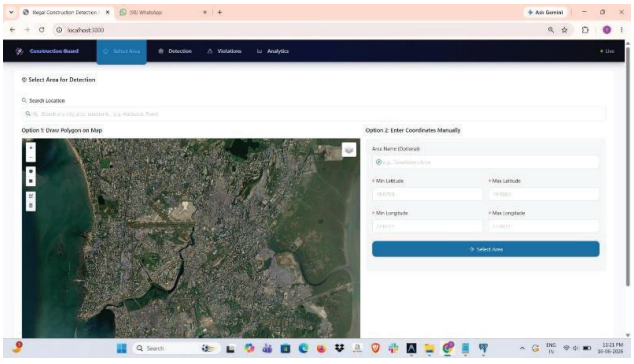

Fig.4.1 Detection Workflow- Area Selection And Data Loading

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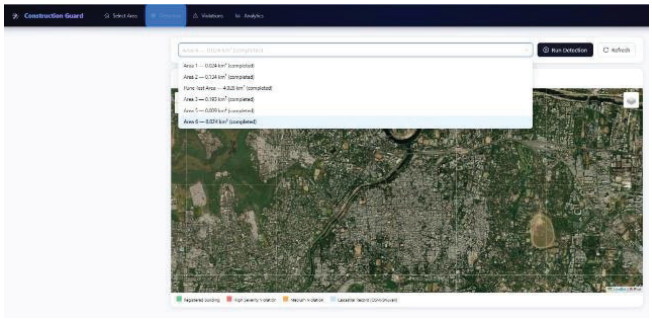

Fig. 4.1.Area Selection And Satellite View

The system is expected to achieve:

- It sends out alerts that have a location so we know where the rules are being broken.
- It shows us satellite pictures with notes so we can see what was found.
- It compares things from before and after so we can see what has changed.
- It gives us dashboards so we can look at the information and make reports.
- These things help the people, in charge do something about it.

B. OUTPUT

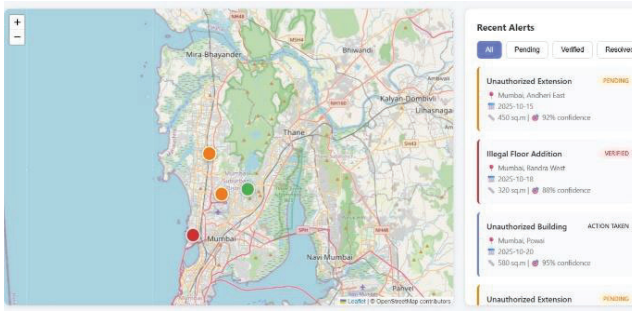

Fig 4.3 Violation Detection and Geotagging Interface

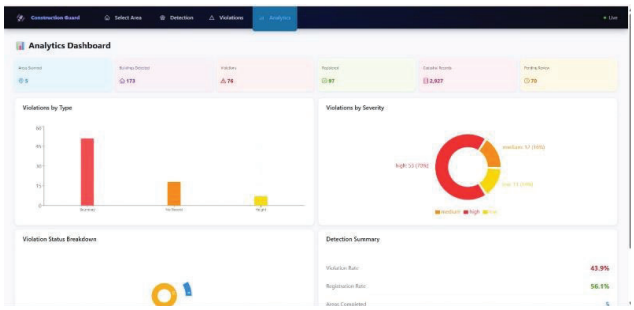

Fig.4.4 Analytics Dashboard

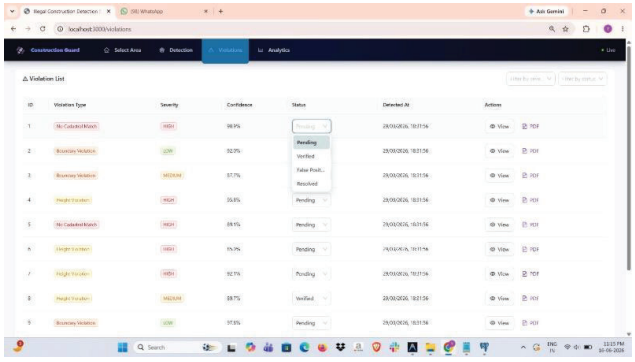

Fig: Violation Resolutions Status

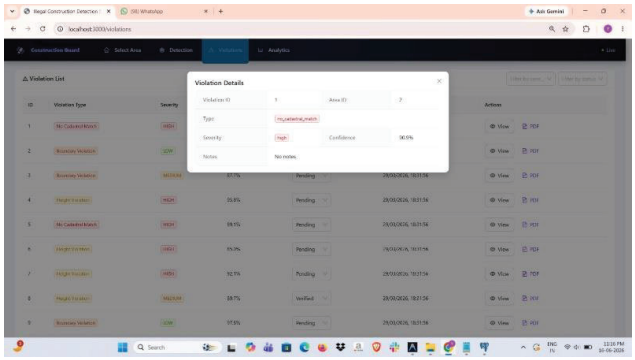

Fig: Violation Details

The system produces:
• Geo-tagged alerts that show where the rules are being broken
• Satellite pictures with notes that show the things that were found
• Comparing things before and after to see what has changed
• Interactive dashboards that let you filter and make reports
These things help the people in charge take action away.

V. CONCLUSION

The system we made to find construction using Artificial Intelligence is a new and efficient way to solve a big problem that cities are facing. By using techniques like YOLOv8, satellite pictures and GIS-based spatial validation the system can automatically find illegal construction activities [1][4][9].
This system is better than the way of doing things, which relied on people looking at things and reporting back slowly [2][4]. Our system looks at satellite pictures all the time finds changes and checks them against approved city records to find construction [11]. It can also see how things are changing over time.
The system uses technologies to find exactly where the unauthorized construction is happening. The dashboard is a way for the people in charge to see what is going on look at trends and take action. This makes things more efficient reduces the work people have to do and makes it less likely that there will be corruption or mistakes [6].
The system is also designed to be flexible. Can be used with existing city systems. It uses tools like Firebase for real-time

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data [12] and modern web technologies like Flask and React.js [14][15] to make sure it works well.

This project is part of a vision to make cities smarter by using data to make decisions being transparent and promoting sustainable development [6]. It helps the people in charge enforce construction laws protects resources keeps the environment safe and keeps citizens safe.

It uses techniques like YOLOv8, satellite pictures and GIS-based spatial validation to find these activities [1][4][9].

Our system is better than the way of doing things. The old way relied on people looking at things and reporting back slowly [2]. Our system looks at satellite pictures all the time. It finds changes. Checks them against approved city records to find construction [11]. It can also see how things are changing over time with construction.

The system uses technologies to find where unauthorized construction is happening. The dashboard helps people in charge see what is going on. They can look at trends. Take action. This makes things more efficient. It reduces the work people have to do. It also makes it less likely that there will be corruption or mistakes with construction [6].

The system is designed to be flexible. It can be used with existing city systems. It uses tools like Firebase for real-time data [12].

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