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Smart Detection of Wild Animals in Residential Area

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Abstract

In recent years, wild animals have been increasingly spotted in residential areas, posing risks to both humans and animals. The presence of these animals can cause accidents, damage to property, or even harm to the animals themselves. Therefore, it is important to have an effective method to detect wild animals in residential areas and ensure safety for everyone involved. This research focuses on creating a smart detection system that can identify wild animals in urban settings using sensors and advanced technology. The system uses a combination of cameras, motion sensors, and artificial intelligence (AI) to detect and track animals. When an animal enters a residential area, the sensors send a signal to a central monitoring system, which processes the data to identify the species and the location of the animal. The smart detection system can be integrated with existing security systems to provide real-time alerts to residents, allowing them to take precautionary actions. For example, the system can send notifications to homeowners' smartphones, informing them of the animal's presence and suggesting steps to keep safe, such as staying indoors or calling animal control. The use of AI ensures accurate identification of animals, even in difficult weather or lighting conditions. Additionally, this system can learn over time, improving its ability to detect animals in different environments. Overall, the smart detection system aims to reduce human-animal conflicts in residential areas by providing timely and reliable information. This approach not only helps protect residents but also contributes to the safe relocation of animals to their natural habitats.

Keywords: Wild animal detection, IoT, ultrasonic sensors, camera module, residential

INTRODUCTION

Wild animal incursions into residential areas pose increasing risks, including property damage and safety threats. Traditional response methods are often ineffective, leading to conflicts that endanger both humans and animals. To address this issue, we propose a smart detection system that integrates the Internet of Things (IoT) with YOLO-based image recognition for real-time wildlife monitoring. This system enables continuous surveillance of forested or protected areas using networked sensors and cameras. The YOLO algorithm ensures fast and accurate object detection, while IoT facilitates seamless data transmission. Together, they provide an efficient, automated solution for tracking wildlife movement, preventing poaching, and supporting conservation efforts in remote and vulnerable ecosystems [1].

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The system employs strategically positioned sensors and cameras to monitor forest-adjacent areas for the presence of wild animals. Using real-time image processing and species recognition algorithms, it accurately identifies the detected animals. Once an

animal is detected, the system immediately sends alerts to nearby residents, forest officials, and local authorities. This rapid notification mechanism allows for quick and coordinated responses to prevent human-wildlife conflicts. The approach not only helps protect communities but also ensures that animals are not harmed or unnecessarily provoked. Additionally, the collected data can aid in wildlife tracking, behavior analysis, and conservation planning. By integrating technology with ecological awareness, the system enhances both human safety and wildlife preservation, creating a balanced coexistence between rural settlements and surrounding ecosystems. As urban expansion reduces natural habitats, wildlife is forced into human settlements, increasing the need for such solutions. By combining AI, IoT, and real-world data analysis, this system provides an effective and humane approach to mitigating human-animal conflicts, improving security, and supporting safe wildlife management [2–5].

RELEVANT LITERATURE

Wild animal detection in residential areas is a crucial aspect of ensuring safety and reducing human-wildlife conflicts. Several studies have explored various technologies, including sensor-based monitoring, AI-driven image recognition, IoT integration, and real-time alert systems, to address this issue.

Use of Sensors and Camera-Based Monitoring

Studies highlight the effectiveness of motion sensors, infrared (IR) cameras, and ultrasonic detectors in monitoring wildlife activity. These devices help in detecting movement, especially during nighttime, when many wild animals are most active. High-resolution camera modules, coupled with computer vision algorithms, have been employed to identify and classify species based on physical characteristics [6].

AI-Based Image Recognition and YOLO Framework

Recent advancements in machine learning and deep learning have improved the accuracy of animal detection systems. YOLO (You Only Look Once), a state-of-the-art object detection algorithm, is widely used for real-time classification of wild animals. Research shows that AI-powered detection models trained on large datasets can differentiate between humans, domestic animals, and wildlife, significantly reducing false alarms. These models continuously learn and adapt to improve accuracy under different weather and lighting conditions [7].

Acoustic Detection for Wildlife Monitoring

Besides visual detection, sound-based monitoring has been explored as an alternative method. Audio sensors capture animal calls and movement noises, which can be analyzed using spectrogram-based AI models. This method is particularly useful for detecting nocturnal or hidden wildlife that may not always be visible on cameras.

Internet of Things (IoT) and Real-Time Alert Systems

IoT integration has revolutionized wildlife monitoring by connecting multiple sensors and devices to a centralized network. Smart detection systems use Wi-Fi, GSM, or LoRa networks to transmit real-time data to monitoring centers. Upon detecting a wild animal, automated alerts are sent to residents and local authorities via mobile applications, SMS, or emails. Some systems even integrate automated deterrents, such as flashing lights and ultrasonic sound emitters, to prevent animals from entering human settlements [8].

Data Analytics for Behavioral Insights

Researchers use big data analytics and pattern recognition to study wildlife movement trends. By analyzing past detection logs, authorities can predict high-risk zones and migration patterns, allowing for preventive measures such as wildlife corridors and fencing solutions.

Ethical and Safety Considerations

Technological interventions in wildlife detection must also consider animal welfare and ethical concerns. Studies emphasize the importance of non-invasive detection methods that prevent unnecessary

harm to animals. Eco-friendly deterrents, such as odor-based repellents and non-lethal sound systems, are gaining traction as humane solutions for managing wildlife intrusion [9].

BLOCK DIAGRAM AND FLOW CHART OF THE SYSTEM

Explanation of Block Diagram (Figure 1)

Camera Module

- This is the first step, where cameras are set up around the residential area to monitor and capture images of the surroundings.
- The cameras take photos or videos to watch for any unusual activity, like wild animals entering the area.

Motion Sensor

- These sensors are installed to detect any movement in the area. If an animal or person moves near the sensor, it triggers the system.
- The motion sensor works in tandem with the camera to make sure that only when movement happens, the camera activates and starts capturing footage.

Image Processing

- The captured images from the camera are sent to an image processing system, which uses special algorithms to identify if there are any wild animals (like a bear, deer, etc.).
- The system can recognize animals using pre-trained models, so when it detects one, it can send a signal that an animal is present.

Alert System

- Once an animal is detected, the alert system gets activated.
- This sends notifications to the residents (via mobile apps or alarms) or local authorities, letting them know there is a wild animal in the area.
- This is important to ensure that residents stay safe and appropriate measures are taken.

A flow diagram is illustrated in Figure 2. For maximal energy generation, the system ensures that the solar panels are clean. The components and how they function are illustrated below:

1. *The user*
   a. The user operates the cleaning system.
   b. To initiate the cleaning, the user sends the order or provides permission.

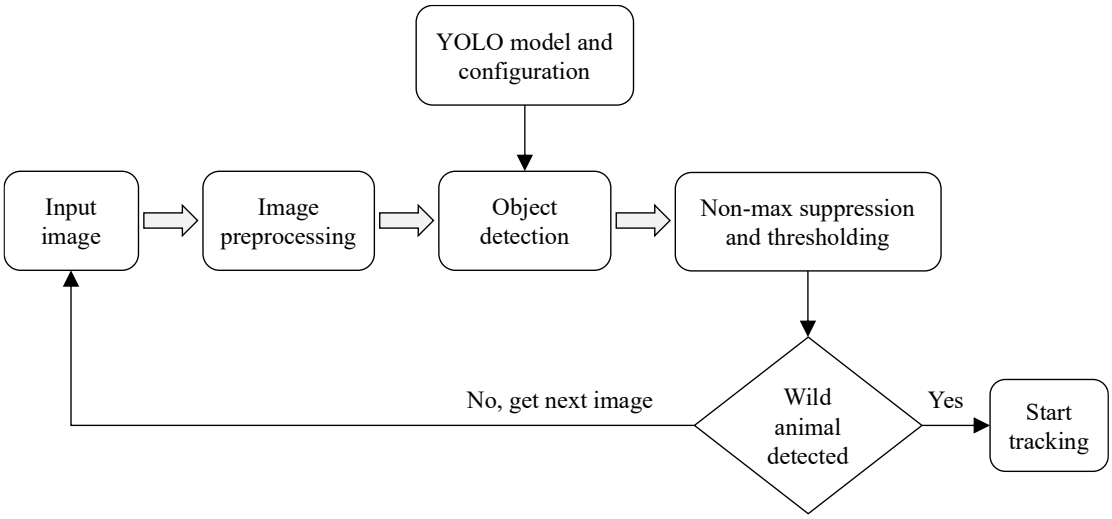

Figure 1. Block diagram.

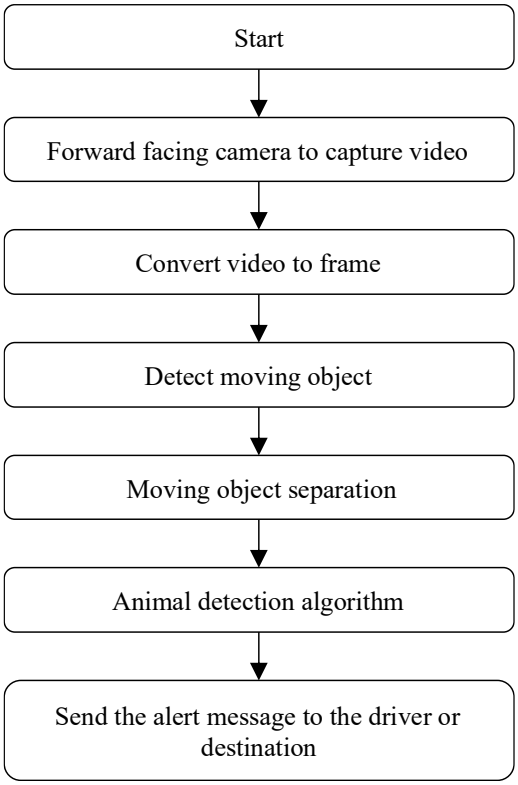

Figure 2. Flow chart.

2. *The ESP microcontroller*
   a. The user provides the command to the ESP Microcontroller.
   b. It controls the request and governs the Relay Module as the main controller.
3. *Relays module*
   a. The relay module runs the cleaning process.
   b. Its two main roles are:
      i. Activating the water motor starts the cleaning process.
      ii. *Ending the cleaning process:* Once the cleaning is over, the motor is switched off.
4. *The water motor*
   a. The water motor pumps water through the system.
   b. It ensures that water is supplied with full pressure to clean the solar panels effectively [10].

METHODOLOGY

This methodology focuses on utilizing smart technologies, including IoT, sensors, and AI, to detect wild animals in residential areas and provide real-time alerts to residents and authorities.

Data Collection

- *Camera-based monitoring*: Deploy CCTV, night vision, and thermal cameras at key locations to capture real-time visuals.
- *Motion and infrared sensors*: Install motion sensors and infrared detectors to track movement efficiently, even in low-light conditions.
- *Sound sensors*: Use acoustic sensors to recognize animal noises, improving detection accuracy [11].

Real-Time Alerts

- *Instant notifications*: Send alerts via mobile applications, SMS, or sirens when an animal is detected.
- *Coordination with authorities*: Notify wildlife control units and local authorities for immediate response.

Automated Response Systems

- *Smart deterrents*: Activate lights and sound-based repellents to discourage animals from entering residential areas.
- *Drone surveillance*: Deploy drones for aerial monitoring and tracking of detected animals.

Continuous Improvement

- *User feedback integration*: Collect feedback from residents and officials to enhance system accuracy.
- *AI model updates*: Improve detection by retraining AI models with new data for better recognition [12].

RESULT AND DISCUSSION

Furthermore, Figures 3–5 illustrate the working model, circuit diagram, and sensor placement of the proposed system, respectively.

DISCUSSION

- *Sensors and cameras*: Sensors and cameras are installed in strategic locations around the residential area. These sensors and cameras can detect movement, heat, and other signs of animal activity.
- *Data analysis*: The data from the sensors and cameras is analyzed using machine learning algorithms. These algorithms can identify patterns and anomalies in the data, allowing the system to detect wild animals.

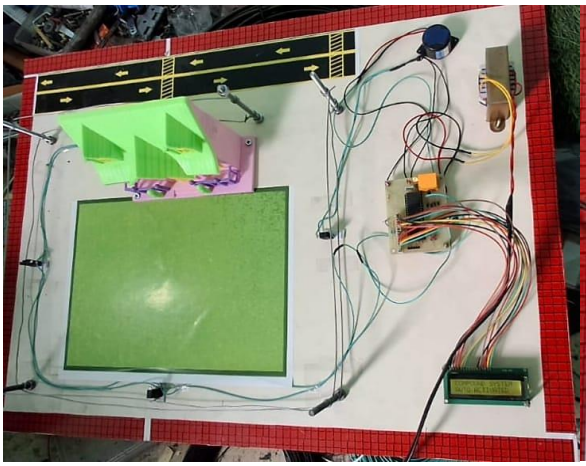

Figure 3. Working model.

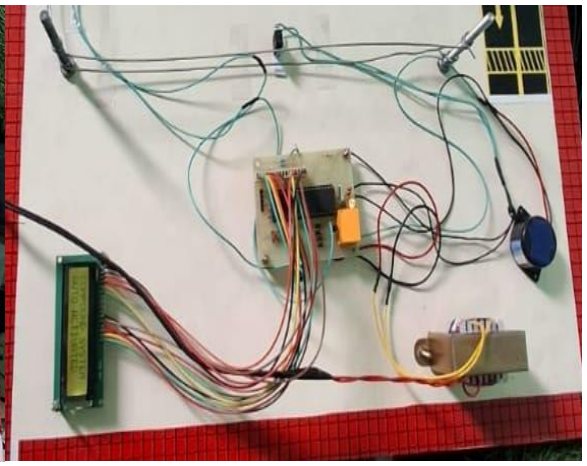

Figure 4. Circuit.

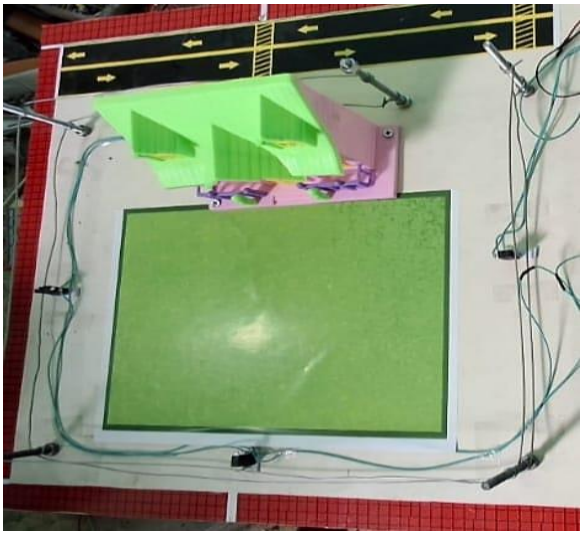

Figure 5. Sensors fixing.

- *Real-time alerts*: When a wild animal is detected, the system sends real-time alerts to residents, wildlife authorities, and other stakeholders.
- *Improved public safety:* By detecting wild animals in real-time, smart detection systems can help prevent conflicts between humans and animals [13].
- *Reduced property damage*: Smart detection systems can help prevent property damage caused by wild animals.
- *Enhanced wildlife conservation*: Smart detection systems can provide valuable insights into wild animal behavior, helping conservation efforts.
- *Increased community engagement*: Smart detection systems can engage residents in wildlife conservation efforts, promoting a sense of community and shared responsibility.
- *Integration with other smart city technologies*: Smart detection systems could be integrated with other smart city technologies, such as traffic management systems and energy management systems.
- *Use of artificial intelligence*: Smart detection systems could use artificial intelligence to improve their accuracy and effectiveness.
- *Expansion to other areas*: Smart detection systems could be expanded to other areas, such as national parks and wildlife reserves.

CONCLUSION

In conclusion, the smart detection of wild animals in residential areas represents a crucial step in enhancing both wildlife conservation efforts and human safety. By leveraging advanced technologies such as motion sensors, infrared cameras, and machine learning algorithms, communities can effectively monitor and identify wildlife activity. This system not only ensures a quicker response to potential threats or encounters but also helps in minimizing human-wildlife conflict. Moreover, it contributes to better understanding of animal behavior in urban environments, promoting coexistence between humans and wildlife. Ultimately, the adoption of such smart detection systems could lead to safer neighborhoods, more informed wildlife management practices, and a greater sense of environmental steward.

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