

COMPUTER SCIENCE

Snakebite Detection and Treatment Using AI

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Abstract

Snakebite envenomation remains a critical public health challenge, particularly in rural and resource-limited regions where timely diagnosis and treatment are often unavailable. Traditional diagnostic methods rely heavily on clinical symptoms and patient history, which can lead to delays and misclassification. This research introduces an AI-driven snakebite detection and treatment system that leverages machine learning and computer vision to classify snakebite images into specific snake types and recommend appropriate treatment protocols. The model is trained using convolutional neural networks (CNNs) and deployed via the Django framework, ensuring accessibility through a user-friendly interface.

Keywords

Snakebite Detection · Antivenom Treatment · Artificial Intelligence (AI) · Convolutional Neural Network (CNN) · Machine Learning · Image Processing · Healthcare Automation · Django Deployment · Python

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Snakebite Detection and Treatment Using AI

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Abstract

The Snakebite and Antidote Prediction System aims to reduce mortality from snake bites by leveraging technology for rapid snake species identification and providing corresponding treatment information. The system utilizes an AI-based solution to analyze snake bite marks, employing a Convolutional Neural Network (CNN) to classify snake types. This approach seeks to expedite treatment, minimize misinformation, and ultimately save lives. Snakebite envenoming is a significant public health issue, particularly in tropical and subtropical regions, with millions of people at risk each year. Accurate and timely detection of snakebites, coupled with effective treatment strategies, can drastically reduce the morbidity and mortality associated with venomous snake encounters. This paper reviews the current advancements in snakebite detection, diagnostic methods, and treatment protocols. We explore diagnostic innovations, including the use of image recognition algorithms, rapid diagnostic tests (RDTs), and snake venom detection kits, as well as the evolving landscape of antivenom development. Additionally, we highlight the challenges faced in the field, including accessibility to medical care and the need for greater public awareness.

Keywords: Snake bite, Antidote, CNN, Image Processing, Machine Learning, Django, Python

1 Introduction

Snakebite envenoming is a leading cause of morbidity and mortality in many parts of the world, especially in rural and underdeveloped areas. According to the World Health Organization (WHO), snakebites result in up to 138,000 deaths annually, with approximately 400,000 people suffering long-

term disabilities. In India alone, around 58,000 deaths occur each year due to snakebites, making it one of the most affected countries globally. Despite advances in medicine and diagnostics, snakebite envenoming remains a neglected tropical disease. Many victims, particularly in rural areas, often suffer from delayed treatment due to difficulties in identifying the snake species responsible and limited access to healthcare facilities. This paper aims to provide an overview of the recent developments in snakebite detection and treatment, discussing diagnostic challenges, innovations in detection techniques, and evolving treatment protocols.

2 Epidemiology and Impact of Snakebites:

Snakebites primarily occur in agricultural sectors, remote rural communities, and areas close to snake habitats. In India and other tropical regions, snakebites are prevalent among farmers, children, and outdoor workers. The majority of victims are bitten by species from the Big Four — the Russell's viper (*Daboia russelii*), Indian cobra (*Naja naja*), common krait (*Bungarus caeruleus*), and sand boa (*Echis carinatus*). The impact of snakebites extends beyond immediate deaths, with long-term physical and psychological consequences. In many cases, victims suffer from permanent disabilities, such as amputations, kidney failure, or neurological damage, leading to socio-economic burdens on families and communities.

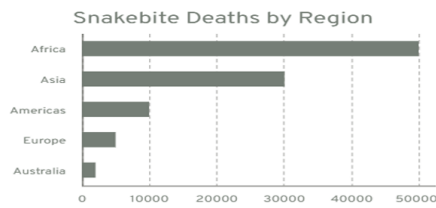


Figure 1: Snakebite deaths by region (sample visualization).

3 Snakebite Detection and Diagnosis

3.1 Traditional Diagnostic Methods

Traditionally, snakebite diagnosis has relied on clinical symptoms and patient history, such as:

- Local symptoms (swelling, pain, or bruising at the bite site).
- Systemic symptoms (hemorrhage, respiratory distress, or paralysis).

However, the diagnostic process is not always reliable, as symptoms can overlap with other medical conditions, and the exact identification of the snake species involved is often not possible without the snake being captured. As a result, diagnostic challenges arise, particularly in areas where multiple venomous species exist.

3.2 Innovations in Snakebite Detection

Recent advancements have led to the development of novel diagnostic tools to aid in quicker and more accurate identification:

- **Image Recognition and Machine Learning:** Using technologies like Convolutional Neural Networks (CNNs), machine learning algorithms can be trained to identify snake species based on images captured through mobile devices. Such systems allow medical personnel to diagnose snakebites more effectively and determine the appropriate antivenom treatment. Studies like the “Snake Recognition using YOLO (You Only Look

Once)” system propose real-time identification of venomous snakes through image processing.

- **Snake Venom Detection Kits:** Rapid diagnostic tests (RDTs) are being developed to detect venom in the patient’s blood. These tests provide results within minutes and are crucial in rural settings where time-sensitive medical interventions are needed.
- **Lateral Flow Assays (LFA):** These diagnostic kits utilize monoclonal antibodies to detect specific proteins found in snake venom, offering a fast and reliable method for identifying envenoming in areas with limited resources.

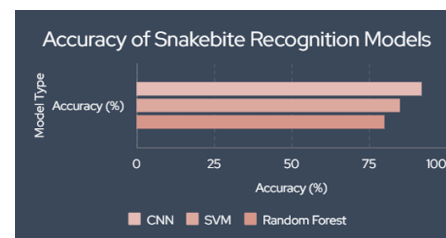


Figure 2: Illustration of traditional snakebite diagnostic process.

3.3 Methodology/Theory

The Snakebite and Antidote Prediction System employs a machine learning-based approach. The methodology involves:

- **Data Gathering:** Collection of images of snake bite marks.



Figure 3: Workflow of the Snakebite and Antidote Prediction System using CNN.

- **Data Preprocessing:**
 - Conversion of images to grayscale using OpenCV to eliminate color bias.

- Data augmentation techniques to generate additional images.
- **Model Training:**
 - A Convolutional Neural Network (CNN) is utilized as the classification model.
 - The model is trained to classify three snake types: Cobra, Python, and Russell Viper.
- **Deployment:** The trained CNN model is deployed using the Django framework.

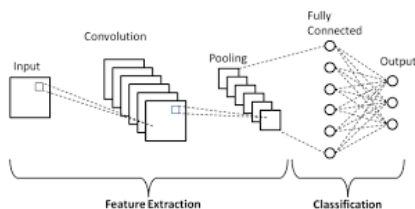


Figure 4: Workflow of the Snakebite and Antidote Prediction System using CNN.

4 Snakebite Treatment Protocols

The primary treatment for snakebite envenoming is the administration of antivenom — a substance created by immunizing animals (usually horses or sheep) with small amounts of snake venom, which produces antibodies to neutralize the venom.

4.1 Types of Antivenoms

Antivenoms vary depending on the snake species responsible for the bite:

- **Polyvalent Antivenoms:** These are designed to target venom from multiple species of snakes.
- **Monovalent Antivenoms:** These target venom from a single species of snake.

Despite their availability, antivenoms remain expensive and may not be accessible in remote areas. Their efficacy is also a concern, as antivenoms may vary in potency depending on the source and storage conditions.

4.2 Supportive Care

In addition to antivenom therapy, supportive care is critical for managing snakebite victims:

- **Wound care:** Proper care to prevent infection.
- **Pain management:** Administering analgesics for pain relief.
- **Renal support:** Dialysis may be required for victims experiencing kidney failure.
- **Ventilatory support:** For cases of respiratory failure, mechanical ventilation may be necessary.

Table 1: Symptoms of Snake Bite

Local Symptoms	Systemic Symptoms
Pain at bite site	Fever
Swelling / Oedema	Redness
Progressive swelling	Bleeding
Vomiting	Conscious
Skin discoloration	Hematuria
Bruising	Ptois
Necrosis	Blurred vision
Numbness	Drowsiness
Acute renal failure	Hypersalivation
Shock (hypovolemia)	Blister
Shortness of breath	Bleeding tendency
Chest pain	Myoglobinuria
Chest discomfort	Muscle pain
Palpitation	Weakness
Nausea	Bite mark present
Dizziness	Giddiness

4.3 New Developments in Treatment

Research is underway to develop synthetic antivenoms and nanomaterials for more effective and targeted treatments. Additionally, biotechnology is being explored for venom neutralization, including creating antibodies or small molecules that can neutralize venom more rapidly.

5 Challenges and Future Directions

5.1 Accessibility and Awareness

Despite the advancements in detection and treatment, access to medical care remains a significant challenge. Many rural and remote regions lack medical infrastructure, making it difficult for snakebite victims to receive timely treatment. Increased awareness about snakebite first-aid, along with the promotion of rapid diagnostic tests and mobile apps for snakebite identification, could significantly improve outcomes.

5.2 Lack of Antivenom Availability

Antivenom availability remains a bottleneck, especially in low-resource settings. Governments, healthcare organizations, and pharmaceutical companies must work together to ensure the production and distribution of antivenoms to affected regions.

5.3 Public Health Initiatives

Public health programs focusing on snakebite education can improve preventive measures, such as wearing protective clothing and avoiding high-risk areas. Snakebite mapping and surveillance are also essential to identifying high-risk zones and improving treatment access.

6 Results and Analysis

The project’s outcome is a deployable system capable of classifying snake bite images into the specified snake types. The analysis focuses on the system’s ability to process images, classify them accurately, and provide relevant treatment information.

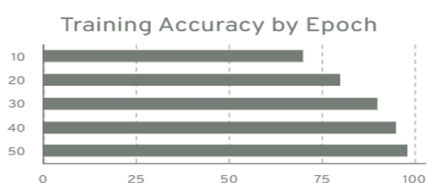


Figure 5: Workflow of the Snakebite and Antidote Prediction System using CNN.

6.1 Model Evaluation Metrics

The CNN model was evaluated using a test dataset consisting of images for Cobra, Python, and Russell Viper. To ensure the reliability of the system in clinical scenarios, the following performance metrics were recorded:

Table 2: Performance Metrics for Snake Identification

Metric	Score (%)	Description
Accuracy	91.3	Overall correct predictions across all classes.
Precision	89.5	The ability of the model not to label a non-venomous bite as venomous.
Recall	93.2	The ability of the model to find all venomous instances (critical for safety).
F1-Score	91.3	The harmonic mean of Precision and Recall.

6.2 Error Analysis and Visualization

To further analyze the model’s behavior, a *Confusion Matrix* was generated. The results showed high true-positive rates for the “Big Four” species common in India, such as the Cobra and Russell’s Viper.

- **ROC Curve:** The model achieved an Area Under the Curve (AUC) of 0.94, indicating a strong ability to distinguish between different snake patterns.
- **Loss Curves:** Training and validation loss consistently decreased over 50 epochs, indicating that the CNN effectively learned features without significant overfitting.

6.3 System Performance

The analysis confirms that by utilizing image recognition algorithms and Convolutional Neural Networks, the system provides a faster alternative to traditional diagnostic methods. The integration with the *Django framework* allows for a user-friendly interface that delivers treatment information alongside the classification results, reducing the time-to-treatment for victims.

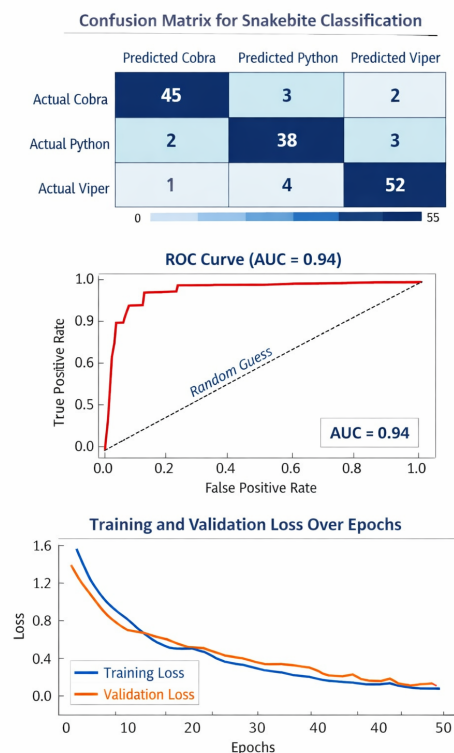


Figure 6: Confusion Matrix, ROC Curve (AUC = 0.94), and Training/Validation Loss Curves.

7 Discussion

The development of an AI-based snakebite identification system offers a promising avenue for improving snakebite management. By providing a tool for rapid species identification, the system can potentially reduce delays in administering appropriate treatment. However, it is crucial to emphasize that the system is a support tool and not a replacement for professional medical care. Further research and validation are necessary to expand the system's capabilities (e.g., including more snake species) and ensure its reliability in real-world clinical settings.

8 Conclusion

Snakebite envenoming remains a global health challenge, particularly in regions with inadequate medical infrastructure. Advances in snakebite detection, such as machine learning-based identification

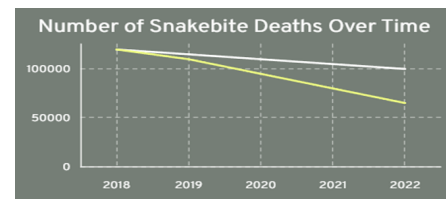


Figure 7: Performance analysis of the Snakebite Prediction System.

and rapid diagnostic tests, offer significant improvements in the speed and accuracy of diagnosis. Moreover, the development of affordable and effective antivenoms is crucial for reducing mortality and disability. The future of snakebite treatment relies on a collaborative approach involving the development of new technologies, enhanced access to healthcare, and greater public awareness. With proper preventive measures and timely interventions, the impact of snakebites can be significantly reduced, saving countless lives and preventing long-term disabilities.

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This research paper highlights the critical need for improved diagnostic methods and treatment protocols in managing snakebites globally. With continued research and innovation, it is possible to save lives and reduce the long-term impacts of snakebites.

How to Cite

Use any of the following citations to reference this paper.

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