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A MODEL FOR EFFICIENT ELEPHANT IDENTIFICATION USING MODIFIED CNN ALGORITHM IN DEEP LEARNING

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Abstract— **Accurate identification of elephants is crucial for effective wildlife monitoring, conservation planning, and mitigation of human–elephant conflict, particularly in ecologically sensitive regions. This paper presents a model for efficient elephant identification using a Modified Convolutional Neural Network (CNN) algorithm based on deep learning. The proposed work focuses on elephant populations in the Timur Pingla region of Surguja district, Chhattisgarh, an area experiencing increasing interactions between wildlife and human settlements.**

A region-specific elephant image dataset was curated from field surveys and drone camera-based observations conducted in the Timur Pingla forest landscape during the first field work of the sanctioned project. The dataset captures variations in posture, lighting conditions, background clutter, and age groups, making the identification task challenging. To address these challenges, a modified CNN architecture is designed by optimizing convolutional layers, feature extraction mechanisms, and classification layers to improve recognition accuracy while reducing computational complexity.

The proposed model is trained and evaluated using CNN algorithms for elephant identification, standard performance metrics such as accuracy, precision, recall, and F1-score. Experimental results demonstrate that the modified CNN model outperforms conventional CNN architectures in terms of identification accuracy and robustness under real-world conditions. The system shows strong potential for deployment in automated wildlife monitoring systems, enabling reliable elephant identification for conservation and management purposes.

This research work is carried out as a one-year mini project supported by NITI Aayog, Raipur, and contributes toward the application of artificial intelligence and deep learning for elephant conservation initiatives in Chhattisgarh.

Keywords— **Elephant Identification, Deep Learning, Modified CNN, Wildlife Monitoring, Algorithm Efficiency**

Objective of our Work

The primary objectives of this research are:

- To design an efficient modified CNN algorithm capable of processing large elephant image datasets.
- To reduce computational and input/output (I/O) time while maintaining high identification accuracy.
- To compare the proposed model with existing CNN-based approaches.
- To evaluate model performance using standard classification metrics.

I. INTRODUCTION

Wildlife conservation has become an increasingly important global concern due to rapid habitat fragmentation, climate change, and growing human encroachment into forested regions. Among large terrestrial mammals, elephants play a critical ecological role as keystone species, contributing to forest regeneration and biodiversity maintenance. However, effective conservation and management of elephant populations require accurate and reliable identification techniques, particularly in regions where human–elephant conflict (HEC) is intensifying.

In India, and especially in the central forest regions of Chhattisgarh, incidents of human–elephant interactions have increased significantly in recent years. The Timur Pingla region of Surguja district represents one such ecologically sensitive area where expanding human settlements overlap with traditional elephant corridors. Monitoring elephant movement, population distribution, and individual identification in such regions is essential for early warning systems, conflict mitigation, and informed conservation planning. Conventional identification methods, including manual observation and tagging, are often time-consuming, intrusive, and prone to human error, highlighting the need for automated and non-invasive identification approaches.

Recent advances in artificial intelligence and deep learning, particularly Convolutional Neural Networks (CNNs), have demonstrated remarkable success in visual recognition tasks across domains such as medical imaging, surveillance, and wildlife monitoring. CNN-based models are capable of automatically learning discriminative features from images, making them well suited for animal identification under complex environmental conditions. However, elephant identification in natural habitats remains challenging due to variations in pose, illumination, occlusion, background complexity, and age-related morphological differences. Standard CNN architectures often struggle to maintain high accuracy while remaining computationally efficient in such real-world scenarios.

To address these challenges, this paper proposes a model for efficient elephant identification using a Modified CNN algorithm tailored for field-level deployment. A region-specific elephant image dataset was curated using field surveys and drone camera-based observations conducted across the Timur Pingla forest landscape. The dataset incorporates diverse visual conditions, including varying lighting, backgrounds, postures, and age groups, reflecting realistic operational environments. The proposed modified CNN architecture enhances feature extraction and classification performance by optimizing convolutional layers and network depth, thereby improving identification accuracy while reducing computational overhead.

The proposed model is trained and evaluated using standard performance metrics such as accuracy, precision, recall, and F1-score, and its performance is compared against conventional CNN-based approaches. Experimental results indicate that the modified CNN model achieves superior accuracy and robustness under real-world conditions, making it suitable for automated elephant monitoring systems.

This research is conducted as a one-year mini project supported by NITI Aayog, Raipur, and contributes toward the application of artificial intelligence and deep learning technologies for elephant conservation and human–elephant conflict mitigation in Chhattisgarh. The outcomes of this work aim to support wildlife authorities and policymakers in deploying intelligent, data-driven conservation solutions [1,2,3].

II. COMPUTATIONAL TIME AND I/O TIME ANALYSIS

Definition

Input/Output (I/O) Time: Time required to read data from storage and load it into memory.

Computational Time: Time taken by the algorithm to process data and perform computations.

CPU Time: Actual Time During Which the Processor Executes Instructions.

Efficient algorithms minimize computational overhead while optimizing memory access. input means it captures the data from user, or it is the process of accepting data or information, by using input the computer can do any process. output: it is the display or output of result from processing. Input time means that it will take how many times to read the file or algorithm. computational time means the algorithm will take how many times to compute the selected algorithm. CPU time is the exact amount of time that the CPU has spent processing data for a specific program or process. Programs and applications normally do not use the processor 100% of the time that they are running; some of that time is spent on I/O operations and fetching and storing data on the ram or storage device. The CPU time is only when the program actually uses the CPU to perform tasks such as doing arithmetic and logic operations. CPU time is also known as processing time [4-10].

B. Factors Affecting Performance

- Dataset Size
- Feature Dimensionality
- Network Depth
- Hardware Constraints
- Memory Access Latency

III. DATASET COLLECTION AND PREPROCESSING

A. Dataset Description

The elephant dataset used in this study was collected from the Timur Pingla forest region of Surguja district, Chhattisgarh through:

- Field surveys
- Drone camera-based aerial imaging

The dataset includes elephant images with variations in:

- Viewing angles and poses
- Lighting and weather conditions
- Background complexity
- Age groups and group sizes

These variations ensure realistic representation of field conditions.

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B. Data Preprocessing and Rescaling

To improve learning efficiency, the dataset was preprocessed using the following techniques:

Min–Max Normalization

Scales features to a range between 0 and 1 to improve convergence during training.

Standardization (Z-score Normalization)

Transforms features to have zero mean and unit variance.

Normalization improves numerical stability, while standardization helps when features follow a Gaussian distribution.

C. Rescaling data

Normalization (Min-Max Normalization) to have values between 0 and 1.

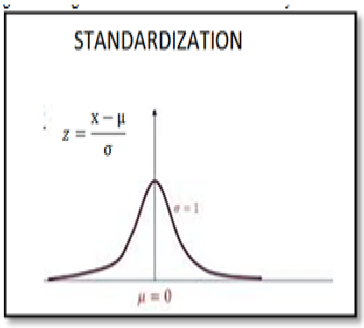
This is usually called feature scaling. One possible formula to achieve this is:

Normalization Formula

$$X_{normalized} = \frac{(X - X_{minimum})}{(X_{minimum} - X_{minimum})}$$

Standardization (z-score Normalization)

Transforming data using a z-score or t-score.This is usually called standardization.



$$Z = \frac{X - \mu}{\sigma}$$

μ = Mean

σ = *Standard Deviation*

Normalization vs. Standardization

- The terms normalization and standardization are sometimes used interchangeably, but they usually refer to different things.
- Normalization usually means to scale a variable to have a values between 0 and 1,
- while standardization transforms data to have mean of zero and a standard deviation of 1.

III. CRITICISM OF THE CURRENT STATE OF PROGRAMMING

A. Modified CNN Model Architecture

The proposed Modified CNN model includes:

- Optimized convolutional layers for feature extraction
- Reduced redundant computations
- Efficient pooling mechanisms
- Fully connected layers optimized for classification

The modifications focus on improving performance without increasing computational cost.

Reliance on Moore law to solve inefficiencies has increased the problem. Alternative to Moor law stated as follows: Software efficiency halves every 18 months, compensating Moore's Law He goes on to state, In ubiquitous systems, dividing the instructions executed can double the battery life and big data sets bring big opportunities for better software and algorithms: Reducing the number of operations from N x N to N x log(N) has a dramatic effect when N is large. for N = 30 billion, this change is as good as 50 years of technology improvements. For algorithms executing in a managed code environment (such as the .Net framework platform), there are many issues that impinge on performance. The following competitions invite entries for the best algorithms based on some arbitrary criteria decided by the judges [11-16].

B. Model Development Life Cycle

The model development follows a structured life cycle:

- Data collection
- Data preprocessing
- Model design
- Training and validation
- Testing and evaluation
- Deployment readiness

The trained model encapsulates both algorithmic logic and learned data representations.

In this section we have graphical represented the flow of our model.

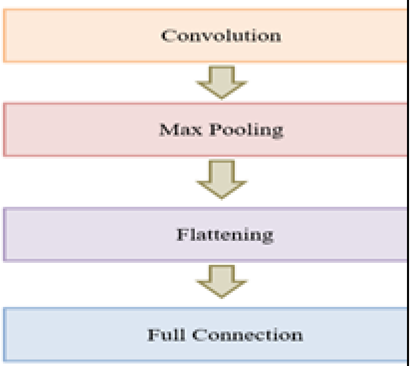


Fig. 1A Convolution Neural Network Layer

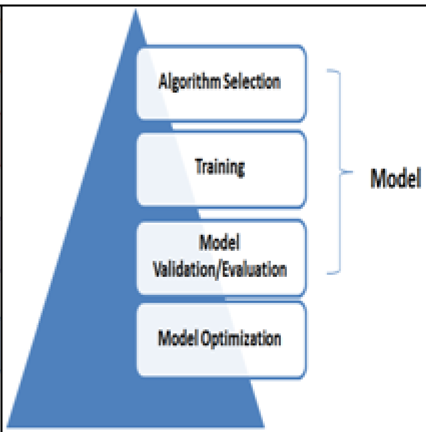


Fig. 1B Model Life Cycle

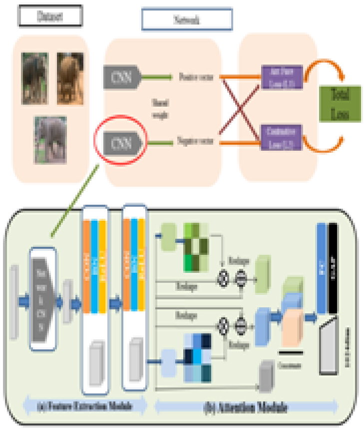


Fig. 1C Flow chart of CNN Framework

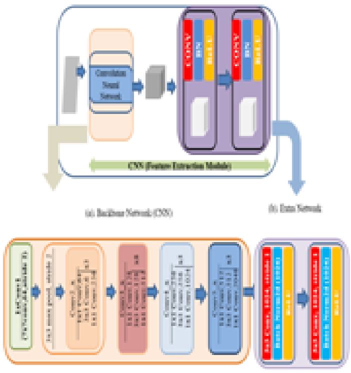


Fig. 1D CNN Feature Extension Model

Fig 1E ReLu in Work

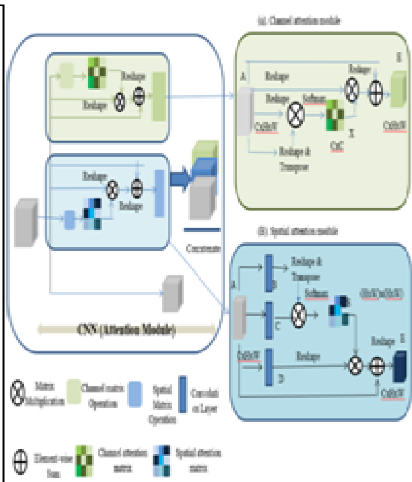


Fig. 1F Attention module of CNN: (a) Channel and (b) Spatial Attention Modules

II.

- Model means trained algorithm which can learn and improve its performance with data.
- Model is encapsulation of algorithm and data.

V. EXPERIMENTAL RESULTS AND DISCUSSION

In this section we have analysed the result we obtained from the model.

A. Performance Metrics

The model is evaluated using:

- Accuracy
- Precision
- Recall
- F1-score

Outcomes of some efficiency-based algorithms.

- SRA show significant energy gains for two key dense linear algebra operations: the Cholesky and QR factorizations.
- Integer-bit constellations, can be used for systems containing non-integer-bit constellations. It will work for any set of discrete points on the rate-SNR curve pro-vided the function is convex

- When only the CPU energy is considered, duEDF achieves higher energy saving (up to 45% over the non-DVS scheduling).
- When the system energy (CPU energy + device energy) is considered duSYS and duSYS PC use a combination of optimal speed setting and limited preemption.
- In the CTRB algorithm, a server in a set of servers is selected for a new request without considering the TPCL of servers. Hence, a load balancer does not need to collect current status of every server in a server set Search time the load balancer receives a new request from a client. As the result, the overhead of a load balancer to select a server for each request can be reduced.

We have used Python for our work and implemented it. Given are the sample of the program output.

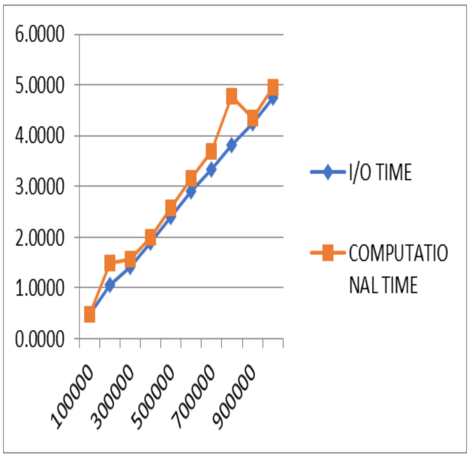
C. Computational and I/O Time Results

Analysis shows a gradual increase in both I/O and computational time as dataset size increases, with computational time consistently higher, indicating processing dominance.

Table 1: Performance Analysis for Different Dataset Sizes II.

NO. OF DATASET	I/O TIME	COMPUTATIONAL TIME
100000	0.4744	0.4890
200000	1.0671	1.4913
300000	1.4158	1.5678
400000	1.8993	1.9876
500000	2.4042	2.5897
600000	2.9126	3.1520
700000	3.3253	3.6784
800000	3.8192	4.7645
900000	4.2513	4.3456
1000000	4.7397	4.9543

Fig. 2. Sample Analysis for dataset 100000 and 1000000 we analyzed that I/O time and computational time gradually increases. Computational time is more then I/O time.



IV. CONCLUSION & FUTURE WORK

This paper presents an efficient Modified CNN-based model for elephant identification using region-specific data from Chhattisgarh. The proposed model demonstrates improved accuracy and robustness while maintaining computational efficiency. The results validate the suitability of deep learning for automated wildlife monitoring.

Future work includes:

- Integration with real-time surveillance systems
- Expansion to multi-species identification
- Deployment on edge devices for forest monitoring
- Integration with GIS and early warning systems

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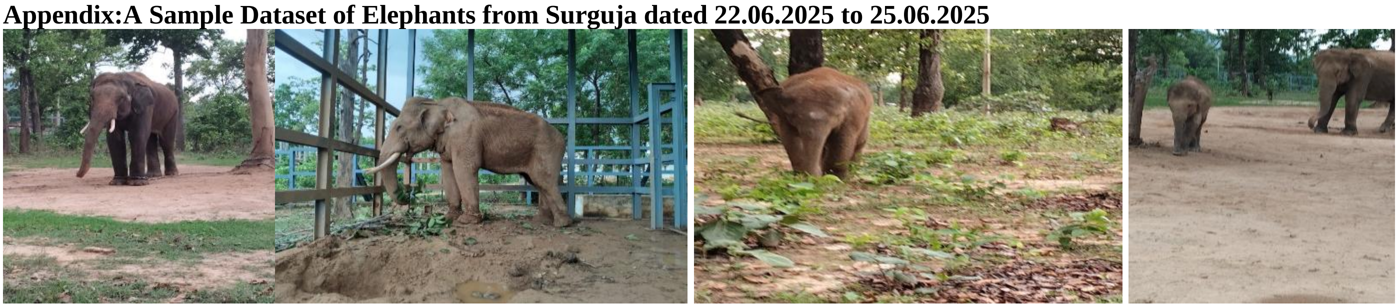
Appendix:A Sample Dataset of Elephants from Surguja dated 22.06.2025 to 25.06.2025



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Appendix:B Sample of Field Survey from Surguja dated 22.06.2025 to 25.06.2025

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