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IMAGE CLASSIFICATION USING CONVOLUTIONAL NEURAL NETWORK

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Abstract: MANET has shown to be very successful in remote sectors, such as emergency services, disaster management, military applications, and the automation sector. Our main goal is to evaluate the network's performance using both live video feeds and static graphics. We start this assessment with transfer learning using image datasets on the networks. The next action is to assess the prediction accuracy for the same object in still images and live video streams. A range of accuracy percentages are identified, documented, and displayed in subsequent sections. Verifying if prediction accuracy varies for each CNN that is chosen is a crucial performance evaluation criterion. As an alternative to the existing distance finding approaches and semantic-based methods, the implementation of the Quadratic Assignment Problem (QAP) optimization strategy provides a novel approach to enhance document analysis and categorization. By extracting textual content from image data, the algorithm's accuracy is significantly increased. When processing a variety of photos, including ones with a wide range of features and complexity, the GSA technique proved to be robust. Moreover, contrasting the GSA's performance with other state-of-the-art optimization techniques would enable us to better understand its effectiveness in image classification.

Index Terms: Convolutional Neural Network (CNN), Gravitational Search Algorithm (GSA), Mobile ADHOC Network (MANET), Quadratic Assignment Problem (QAP).

I. INTRODUCTION

An alternative to conventional wireless networks is provided by MANETs. They have a limited node lifespan, operate in a dynamic manner, and show sudden topological changes [1]. As a result, nodes join or exit the network without warning, frequently changing the configuration of the network. Nodes route traffic independently without user intervention. MANET has shown to be very successful in remote sectors, such as emergency services, disaster management, military applications, and the automation sector [2]. Nonetheless, one significant worry is how vulnerable MANET is to malicious intrusions that employ a variety of attack techniques. Because of its complete reliance on wireless links, wireless transmission's communicative nature, dynamic topology, lack of infrastructure, and use of multi-hop routing, MANET is susceptible to malware activities [3].

Recently, Convolutional Neural Networks (CNNs) have become popular in image and pattern recognition applications, greatly advancing the field's potential to achieve state-of-the-art performance in a wide range of classification tasks [4]. An intriguing area of research for CNNs is predicting classification performance, or more specifically, assuming neural networks would be successful in accurately classifying data instances across a range of domains. This study is motivated by the need for robust predictive models that can assist practitioners in determining the chances of success of a CNN-based categorization system before it is implemented [5]. Predicting how successfully a CNN will classify new, unknown data is tremendously helpful, especially for applications such as medical image processing and autonomous systems.

This inquiry covers the intricate relationships between training, CNN architecture design, data preparation, and comprehensive evaluation. Using CNNs' automatic learning of hierarchical features from input data, the goal is to develop a method that not only improves classification accuracy but also provides insights into the model's potential for generalization [6].As we look at the details of Classification Performance Prediction. The purpose of this work is to investigate the possibility of employing CNNs to forecast the efficacy of these neural networks.

These days, the internet is overflowing with pictures and videos, which is encouraging the development of search strategies and applications targeted at closely examining the semantic analysis of such visual content. The goal is to improve user experience by providing summaries and search results that are more refined. Researchers from all over the world have made significant contributions to the fields of scene categorization, object identification, and picture labeling. This development makes it possible to develop novel solutions for problems pertaining to scene classification and object detection.

Considering the notable improvements in performance that artificial neural networks more specifically, convolutional neural networks have shown in the domains of object detection and scene categorization, the goal of this research is to identify the optimal network for both uses. A key component of these methods is feature extraction, in which a small number of features representing a significant amount of object or scene information is extracted from the values of the image's low-level pixels. To distinguish distinctions between the different object classes involved, this technique is essential.

1.1 Need for the Study

The need for the study on post-prediction with object images using a CNN approach is highlighted by the aim of improving prediction accuracy, the accomplishment of notable results, the emphasis on engaging attributes, the practical application of real-world datasets, and the comparison with the current techniques. In particular, object image analysis and predictive modeling as a whole will benefit from our work.

1.2 Significance of Study

At first, we were fascinated by the notion of teaching a computer to carry out tasks such as image classification. We also investigated Image Classification because of the concept's many real-world implications. Thankfully, the scientific community has thoroughly investigated this topic, which removes any obstacles to locating pertinent educational materials. As a result, we read a great deal of research articles on picture categorization, each with a unique viewpoint. After that, we decided to use the minimal hardware available to us to implement picture categorization on a small scale. It was clear that our first findings had extremely high accuracy, which was mainly caused by the limited quantity of the dataset. We used data augmentation techniques to overcome this constraint, thereby increasing the size of our dataset by over three times. Eventually, this investigation led us to investigate CNNs, or neural networks. On the same dataset, we were able to obtain an astounding accuracy of 93.57% after successfully deploying CNN. This achievement demonstrates the greater potential of DL approaches over more conventional ML techniques.

1.3 Research Gap

- While certain optimization techniques have been applied to enhance CNN performance, the exact application and effectiveness of gravitational suction analysis in the context of image classification have not received as much attention. Thorough research into the impact of Gravitational SA on CNN training and performance in image recognition tasks is needed.

- Most of the existing literature focuses on individual optimization methods such as Gravitational SA and QAP.

- The robustness of CNN-Gravitational SA-QAP frameworks to noisy and imperfect data still has to be investigated.

II. RESEARCH METHODOLOGY

The research Classification Performance Prediction Using Convolutional Neural Network and improving the accuracy with the suggested algorithm Gravitational Search Algorithm are included in the proposed research technique.

2.1 Design of Research

In order to solve the issue of high computation and accuracy it is necessary to do a geotagging analysis of Meta data based on QAP (Quadratic assignment problem optimization). With more options for analysis, this technique aids in more reliable data analysis. The utilization of the quadratic assignment optimization strategy in lieu of the current distance finding technique and other semantic-based approaches are some of the elements that are taken into consideration for the proposed work approach.

2.2 Tools for conducting research

This study is an empirical investigation. A questionnaire is the instrument used in the study to collect data. The completed study was divided into several divisions. Using NLP and the quadratic assignment optimization technique, assess the CNN classification performance prediction.

2.3 Dataset Collection

You can take pictures from a dataset from the UCI machine learning repository that has many categories. Five-image classes were included in the digital image dataset representing the various image types for the purpose of classification analysis. The flowchart begins with the input of sets of photographs, which include different types: bus, building, beach, dinosaur, and Africa. With its central role in many facets of visual identification, image classification has become a basic field of study in computer vision.

2.4 CNN

The pooling layer, convolutional layer, nonlinear activation layer, and fully connected layer are the fundamental parts of a convolutional neural network (CNN). Before the image enters the network through the input layer, it usually goes through preprocessing. After that, it passes through a sequence of convolutional and pooling layers that are organized alternately until the fully connected layer classifies it.

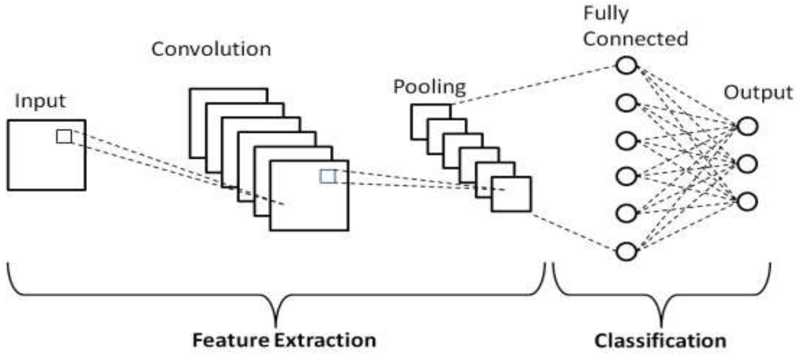

Figure 1: CNN Architecture

In image classification, the complete image is often characterized by hand-extracting features or by using feature learning techniques. The object category is then determined by using a classifier. Therefore, the process of extracting features from the image is especially important. The Bag of Words model was frequently used for object classification prior to the deep learning era. This model's basic structure consists of three stages: feature coding, feature extraction, and classifier creation. These three phases were part of the traditional picture classification process before 2012. Nonetheless, a number of procedures are typically involved in the thorough development of an image classification model, such as low-level feature learning, feature coding, spatial constraint, classifier design, and model fusion.

2.5 GSA classification

The Gravitational Search Algorithm (GSA), which is a population-based stochastic search technique commonly used to solve optimization issues, is based on Newton's theory. GSA was first introduced by E. Rashedi and is intended to tackle nonlinear optimization issues. The foundation of the approach is the concept that gravitational force, which is derived from Newton's equation of gravity, attracts all particles to one another. This force directly relates to the product of their masses and is inversely proportional to the square of their separation. This software interprets particles as objects and uses their masses to determine how well they behave.

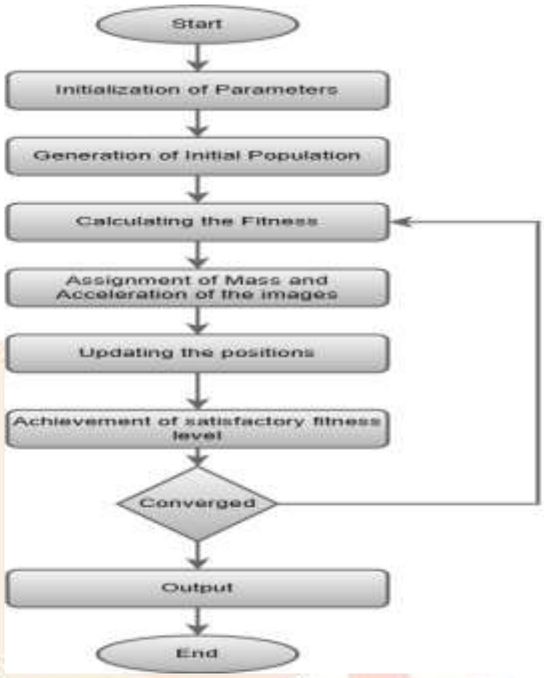

Figure 2: Proposed GSA Algorithm

Four categories of specifications passive gravitational mass, active gravitational mass, inertial mass, and particle position are used to describe each particle in GSA. Particle positions are solutions to the issue, and the gravitational and inertial masses are computed using the fitness function.

2.6.QAP Algorithm

The 1957 mathematical model known as the Quadratic Assignment Problem (QAP) is one of the most well-researched combinatorial optimization problems. Allocating a set of facilities to designated locations with the goal of decreasing flow and distance between the allotted pairs is the main goal of the QAP. Exact techniques become unfeasible when tackling many instances of the QAP because of its NP-hardness. As such, this poses a significant challenge to academics working with (meta-)heuristics. Numerous meta-heuristics (MHs), such as Genetic Algorithms, Robust Tabu Search, and Iterated Local Search, have shown efficacy in handling QAP situations.
Although various MHs have yielded good results, there are differences in their biases, suggesting that some algorithms might work better than others for particular situations. It is established that no single algorithm can consistently outperform others in accordance with the No Free Lunch Theorem.

III. RESULTS AND DISCUSSION

Pre-processing and feature extraction are crucial steps in the picture classification process, especially when utilizing CNN. By incorporating the Gravitational Search Algorithm, this procedure gains an optimization component. Normalization, noise reduction, image scaling, and data augmentation using neural networks (CNNs) trained on feature extraction can improve the performance of picture classification models. GSA can be used to detect texture and color features in images that are essential for classification, or to optimize the parameters of these networks or fine-tune them for a specific picture classification task. GSA can be used to estimate the weights of various features in order to improve classification accuracy.

3.1 Image Accuracy

Africa is represented by the photos in figure 3 below. CNN classifies the photos using a graphical user interface (GUI) with a 95% accuracy rate after optimizing the algorithm with QAP and GSA to produce better results.

Figure 3: Image classification of Africa using proposed algorithm

The beach photographs are displayed in figure 4 above. CNN employs a graphical user interface (GUI) to classify the images, achieving a 95% accuracy rate following algorithmic optimization through the use of QAP and GSA to enhance output.

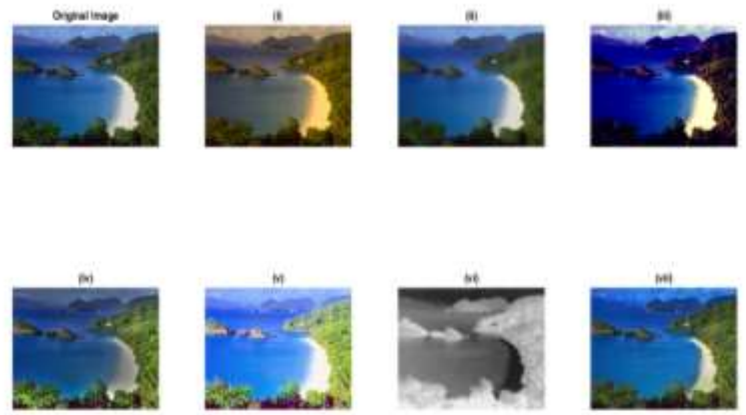

Figure 4: Image classification of beach using proposed algorithm

The increased 95% accuracy rate shows the strength of the used neural network models as well as the impact of algorithmic optimization with QAP and GSA for better results. This adjustment likely enhanced the classification results by improving pattern detection and feature extraction. The graphical user interface plays a crucial role in promoting user involvement and understanding of the classification process. In order to help users examine and confirm the data, it provides a visual representation of the classification results. Thanks to the GUI's seamless integration, a larger audience may now utilize the classification system, which enhances the user experience overall.

3.2 Performance Matrix

This approach produced a trained model that demonstrates CNN's capacity to handle challenging image recognition tasks. MATLAB was the programming language of choice for this entire study, which is noteworthy. This decision was influenced by MATLAB's smooth integration with the CNN framework, which provided a unified and comprehensive environment for the system's design and deployment and featured MATLAB throughout. Table 1 and Figure 5 provide the performance metrics and values for the different image parameters.

Table 1: Performance Matrix of Images

Parameters	**Values**
Accuracy	95%
Error Rate	5%
Sensitivity	95%
Specificity	98.75%

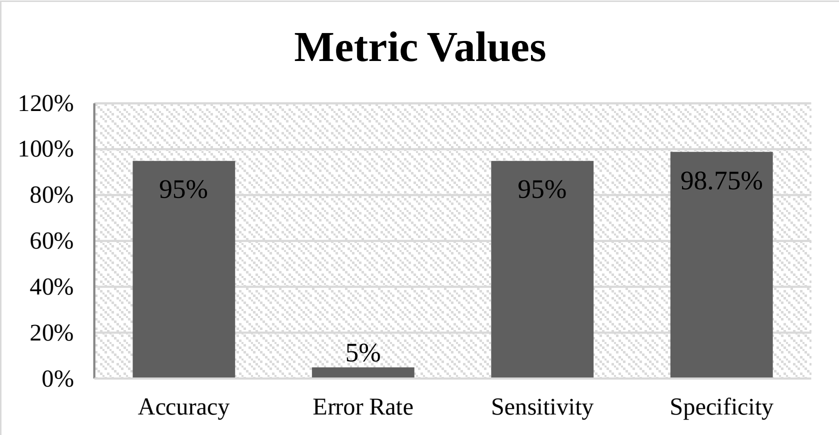

Figure 5: Performance metrics of image classification by CNN using GSA

The CNNframework is utilized in the execution of the suggested approach. The assessments are carried out on a system that uses MATLAB to run the images. Three measurements are used for the evaluation metrics: confusion matrix, average accuracy, and 95% confidence interval. The ratio of correctly identified samples to the total number of samples in each of the five tasks is known as average accuracy. With a 95% confidence level, the 95% confidence interval shows the likelihood that the images' classification accuracy falls within this range. With a few photos per experiment group, the confusion matrix arranges actual classifications in rows and expected categories in columns.

IV. LIMITATIONS OF STUDY

- Big and varied datasets are necessary for CNN training to be effective. When a model is over fitted, it performs well on training data but has trouble generalizing to new or untested data because of incomplete or skewed datasets.

- For both training and inference, CNNs demand a significant amount of processing resources, particularly when utilizing deep architectures. Because optimization techniques like GSA and QAP increase computational complexity, real-time applications or their deployment on devices with restricted resources may become challenging.

- Given their well-known noise sensitivity, CNNs may classify data erroneously even when there are only slight disturbances in the input data.

V. CONCLUSION

In conclusion, the use of the Quadratic Assignment Problem (QAP) optimization strategy, as an alternative to the existing distance finding techniques and semantic-based methods, provides a new avenue for enhancing document analysis and classification.
By extracting textual content from image data, the algorithm's accuracy is significantly increased. One essential component is optimizing the relational function between users and accessed components. By using Natural Language Processing (NLP) for comprehensive data processing and eliminating the time limits associated with questionnaire-based techniques, text detection cycles can be greatly decreased.

Furthermore, the GSA approach showed its robustness in handling many image types, including those with a broad range of characteristics and complexity. The algorithm's ability to efficiently search the solution space and dynamically adjust gravitational forces is what makes it so good at expediting the image classification process. When compared to other optimization techniques, the GSA performed competitively, showing that it has potential as a practical optimization technique for picture classification applications. The results suggest that applying gravitational principles to optimize picture classification model parameters can be a useful approach, and they also point to a promising avenue for future research in this field.

VI. ACKNOWLEDGMENT

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