IMPROVED PRECISION RATE IN OBJECT DETECTION AND CLASSIFICATION USING NOVEL REGION-BASED CONVOLUTIONAL NEURAL NETWORKS OVER SUPPORT VECTOR MACHINE

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Abstract

Aim: To improve the precision rate in Object Detection and Classification and to identify the objects based on Novel Region-Based Convolutional Neural Networks (RCNN) and Support Vector Machine algorithms.
Materials and Methods: Classification is performed by Novel Region-Based Convolutional Neural Networks (N=10) over Support Vector Machine (N=10). The sample size is calculated using GPower with pretest power as 0.8 and alpha 0.05.
Result: Mean accuracy of Novel Region-Based Convolutional Neural Networks (96.9%) is high compared to Support Vector Machine (90.00%). The significance value for accuracy and loss is 0.339 ($p>0.05$).
Conclusion: The mean accuracy of the object detection and classification in Novel Region-Based Convolutional Neural Networks (RCNN) is better than the Support Vector Machine algorithm.

Keywords: Novel Region-Based Convolutional Neural Networks, Support Vector Machine, Classification, Precision, Detection, Object Recognition.

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1. Introduction

The process of doing object detection in real-time with quick inference and a minimal level of accuracy is known as object detection (Jiang et al. 2018). An image is given as input to detect and classify the objects. This detection system uses a database of objects and compares it with the image data and predicts its output (Brosch and Elshaarany 2019). In this paper, research is implemented with two different algorithms and finally, algorithms are compared to find out the best performing one (D, Triphena, and Karunakaran 2021). A portion of the application's object location and characterization are PC vision, including picture recovery, security, reconnaissance, robotized vehicle framework, and machine assessment. To recognize or locate the shifting object in the frame, Object detection is the first degree in tracking. After that, detected items can be classified as motors, humans, birds, and other transferring items (Brownlee 2019). Applications for object detection and categorization include image retrieval, security, surveillance, automated vehicle systems, and machine inspection. Object detection is used in retail shops, railways, airports, and transportation for security purposes (Stojmenovic 2018).

In this research work, the advancement in the field of deep learning for extracting objects of interest from an image is implemented (Kaul 2017). Object detection has been carried out by researchers and 40 related research articles in IEEE Digital Xplore and 123 articles are published in google scholar. The research work focuses on training Faster Novel Region-Based Convolutional Neural Networks to recognize objects of interest using custom-based datasets (Song et al. 2011). This article looked at the most recent and most exceptional Convolutional Neural Networks-based item recognition calculations. All of the organizations were prepared with the open-source dataset by Microsoft, to guarantee a homogeneous benchmark (Yang and Wang 2021). Multiclass object detection is implemented and improves the precision rate in classifying objects (Creusere and Dahman 2001). Profound learning structures and administrations accessible for object discovery are additionally examined in this paper. It mainly created a tiny dataset for everyday item detection. The dataset is then used to train a variety of object detection models, with successful everyday object detection outcomes (Peng 2019).

Our institution is passionate about high quality evidence based research and has excelled in various domains (Vickram et al. 2022; Bharathiraja et al. 2022; Kale et al. 2022; Sumathy et al. 2022; Thanigaivel et al. 2022; Ram et al. 2022; Jothi et al. 2022; Anupong et al. 2022; Yaashikaa, Keerthana Devi, and Senthil Kumar 2022; Palanisamy et al. 2022).The existing system of object detection and classification has some drawbacks related to large variations in viewpoints, poses, occlusions, and lighting conditions. It is difficult to detect object detection with additional localization tasks. Though much research has been carried out in this field there exists a gap to formulate the accuracy when it comes to detecting and classifying the object automatically. Therefore a detection system is required to detect and classify the objects. The study aims to detect the object and classify the object present in the video using Novel Region-Based Convolutional Neural Networks, thereby improving the precision rate and reducing the false detection rate.

2. Materials and Methods

This study set was done in the Data Analytics Lab, Department of Information Technology, Saveetha School of Engineering. The sample size for this project is 20 (Group 1=10, Group 2=10). In object detection and classification, to modify the problem of low precision rate Novel Region-Based Convolutional Neural Networks and Support Vector Machine algorithms were used. To categorize the provided objects into any of the required classes, a model with many layers was developed using Region-Based Convolutional Neural Networks. Support Vector Machines effectively detect an object from its background with minimum training data. The mean accuracy of Novel Region-Based Convolutional Neural Networks is 96.6%. The mean accuracy of the Support Vector Machine algorithm is 90.00%. The dataset for this article is collected from https://github.com/howl0893/custom-object-detection-datasets website with 8 attributes and 528 rows (Chen 1991).

The Novel Region-Based Convolutional Neural Networks algorithm generates some boxes in the image and determines which of them are filled with objects. These boxes are extracted from a picture using selective search using Novel Region-Based Convolutional Neural Networks. Using an algorithm like Edge Boxes, the novel Novel Region-Based Convolutional Neural Networks detector creates region recommendations initially. The image is cropped and scaled to exclude the proposal parts. The cropped and resized regions are then classified by Convolutional Neural Networks. The algorithm starts with a convolutional neural network that has already been trained. The model is then retrained. The amount of classes that need to be discovered is used to train the network's last layer. The third stage is to determine each image's Region of Interest. Then restructure all of these regions to meet the CNN input size. To train and categorize objects and backgrounds when the areas are acquired. Finally, for each recognized object in the image, train a linear regression model to build narrower bounding boxes (Farkhodov, Lee, and Kwon 2020). Pseudocode for Novel Region-Based Convolutional Neural Networks is described in Table 1. The Support Vector Machine is a common Supervised Learning method that can be used to address classification and regression problems. But it's largely used in machine learning to solve classification problems. The goal of the Support Vector Machine algorithm is to determine the best line or decision boundary for classifying n-dimensional space so that future additions of data points can be quickly assigned to the appropriate group. The algorithm aims to effectively detect an object from its background with the minimum training data. It demonstrates high generalization capabilities in the object recognition problem. Support Vector Machines are techniques for regression analysis and classification. The Support Vector Machine can solve both linear and nonlinear and work well for many practical problems. It transforms data using a method known as the kernel trick, and then it determines the best separation between the outputs. These work well in high-dimensional spaces and also when there are more dimensions involved than there are samples. The pseudocode for the Support Vector Machine algorithm is described in Table 2.

Statistical Analysis

The analysis was done by IBM SPSS version 21. In SPSS, datasets are prepared using 10 as the sample size for both the algorithm Novel Region-Based Convolutional Neural Networks and Support Vector Machine algorithms. Group id is given as 1 for Novel Region-Based Convolutional Neural Networks and 2 for Support Vector Machine, group id is given as a grouping variable, and accuracy is given as a testing variable. The attributes are objects, camera, color, shape, pattern, and texture. Dependent variables are color, shape, texture, and pattern. Independent variables are objects. An Independent t-test is carried out in this research work.

3. Result

In statistical tools, the total sample size used is 20. This data is used for the analysis of Novel Region-Based Convolutional Neural Networks and Support Vector Machines. Statistical data analysis is done for both the algorithms namely Novel Region-Based Convolutional Neural Networks and Support Vector Machines. The group and accuracy values are calculated for given detection systems. These 20 data samples used for each algorithm along with their loss are also used to calculate statistical values that can be used for comparison. Table 3, shows that group, accuracy, and loss values for two algorithms Novel Region-Based Convolutional Neural Networks and Support Vector Machines are denoted. The Group statistics table shows the number of samples that are collected. The mean and the standard deviation is obtained and accuracies are calculated and entered.

Table 4, shows group statistics values with mean, standard deviation and standard error mean for the two algorithms that are also specified. Independent sample T-test is applied for data set fixing confidence interval as 95%. Table 5, shows independent t-sample tests for algorithms. The comparative accuracy analysis and mean of loss between the two algorithms are specified. Figure 1 shows the comparison of the mean accuracy and mean loss between Novel Region-Based Convolutional Neural Networks and the Support Vector Machine algorithm.

4. Discussions

The accuracy of the Support Vector Machine algorithm is 90.00% whereas Novel Region-Based Convolutional Neural Networks have higher accuracy of 96.9% with $p = 0.339$ which shows that the Novel Region-Based Convolutional Neural Networks are better than Support Vector Machines algorithms. Mean, standard deviation and standard mean values for Novel Region-Based Convolutional Neural Networks are 95.0790, 2.32084, and 0.73391 respectively. Similarly, for Support Vector Machines algorithms mean, standard deviation, and standard mean values are 85.1420, 3.00722, and 0.95097 respectively.

This research increases the accuracy and precision rate of detecting and classifying objects in accordance with the data. With a hybrid database, the chances for correct detection are also increased (Christofi 2010). This model has a slow processing rate with better accuracy (Kurilová et al. 2021). The slow processing rate is due to the usage of a large database but in the case of a smaller database, both the processing and accuracy are faster and better. The above problem's complexity will be reduced once a model is built (Wang 2005). Despite the various facts that many researchers have discovered various prediction models, many of them are unable to accurately perform better algorithms (Chew 2013). Many applications can be developed to predict accurately sensitivity from various platforms. The Novel Region-Based Convolutional Neural Networks algorithm has the drawback of not being user-friendly and is very time-consuming. This means that the Novel Region-Based Convolutional Neural Networks algorithm is not easy to use and processing the data requires a lot of time. In the future, this object detection system can be further improved by developing the Novel Region-Based Convolutional Neural Networks algorithm.

5. Conclusion

From this study of object detection and classification, the mean accuracy of the Support Vector Machine algorithm is 90.00% whereas Novel Region-Based Convolutional Neural Networks have a higher mean accuracy of 96.9%. Hence it is inferred that Novel Region-Based Convolutional Neural Networks appear to be better in precision when compared to the Support Vector Machine algorithm.

DECLARATIONS

Conflicts of Interest

No conflict of interest in this manuscript.

Authors Contribution

Author GP was involved in data collection, data analysis, and manuscript writing. Author RK was involved in the conceptualization, data validation, and critical reviews of the manuscript.

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TABLES AND FIGURES

Table 1. Pseudocode for object detection and classification based on Novel Region-Based Convolutional Neural Networks

INPUT: Training dataset for object detection and classification
Step 1: for i<- 1 to num of scales in pyramid of images do Step 2: Downsample image to create image$_i$ Step 3: Compute integral image, image $_{ii}$ Step 4: for j<-1 to num of shift steps of sub-window do Step 5: for k<-1 to num of stages in cascade classifier do Step 6: for l<- 1 to num of filters of stage k do Step 7: Filter detection sub-window Step 8: Accumulate filter outputs Step 9: formula for Novel Region-Based Convolutional Neural Networks $L= 1/N_c\ \Sigma\ L_c(P_k, P^*_k) + \lambda / N_r\ P^*_k\ L_t(t_k, t^*_k)$ Step 10: end for Step 11: if accumulation fails per-stage threshold then Reject sub-window as object Break this k for loop Step 12: end for If sub-window passed all per-stage checks then Accept this sub-window as a face
OUTPUT: Image with object indicators as rectangles and obtain precision rate

Table 2. Pseudocode for object detection and classification based on Support Vector Machine Algorithm

INPUT: Training dataset for object detection and classification

Step 1: for y in 1 to height
Step 2: for x in 1 to width
Step 3: {
If (image(x,y)>threshold) and (At least 1 adjacent pixel<threshold)
match_found=0
For n in 1 to (No of objects found)

```
                    If (x,y) falls within a small distance of object n
                          match_found =1
                     Break;
                     Endif
            Endfor
            If match_found==1
                    Increase the boundaries of object n to include (x,y)
            Else
                      Add a new op[object with centre as (x,y)
            Endif
        Endif
    }
    Endfor
    Endfor
Step 4: formula for Support Vector Machine
```

$K(X,Y) = \sum_{1=1} \lambda_i \phi_i(x) . \phi_i(y) \lambda_i > 0$

OUTPUT: Image with object indicators as rectangles and obtain precision rate.

Table 3. Group, Accuracy and Loss value uses 8 columns with 8 width data for object detection and classification

SI.NO	Name	Type	Width	Decimal	Columns	Measure	Role
1	Group	Numeric	8	2	8	Nominal	Input
2	Accuracy	Numeric	8	2	8	Scale	Input
3	Loss	Numeric	8	2	8	Scale	Input

Table 4. Group Statistical analysis for Novel Region-Based Convolutional Neural Networks and Support Vector Machine Algorithm Mean, Standard Deviation, and Standard Error mean are determined

	Group	N	Mean	Std Deviation	Std.Error Mean
Accuracy	Region-based convolutional neural networks	10	95.0790	2.32084	0.73391
	Support vector machine	10	85.1420	3.00722	0.95097
Loss	Region-based convolutional neural networks	10	4.9210	2.32084	0.73391
	Support vector machine	10	23.8300	3.02765	0.95743

Table 5. Independent sample T-test t is performed on two groups for significance and standard error determination. P value is greater than 0.05 (0.339) and it is considered to be statistically insignificant with 95% confidence interval

	Levene's	T-Test for equality of mean

		Test for Equality of variance		t	df	Sig(2-tailed)	Mean difference	Std.Error Difference	95% confidence of Difference	
		F	**Sig**						**Lower**	**Upper**
Accuracy	**Equal variances assumed**	0.591	0.452	8.272	18	0.000	9.93700	1.20123	7.41330	12.46070
	Equal variances not assumed			8.272	16.914	0.000	9.93700	1.20123	7.40163	12.47237
Loss	**Equal variances assumed**	0.964	0.339	-15.674	18	0.000	-18.90900	1.20636	-21.44346	-16.37454
	Equal variances not assumed			-15.674	16.862	0.000	-18.90900	1.20636	-21.45577	-16.36223

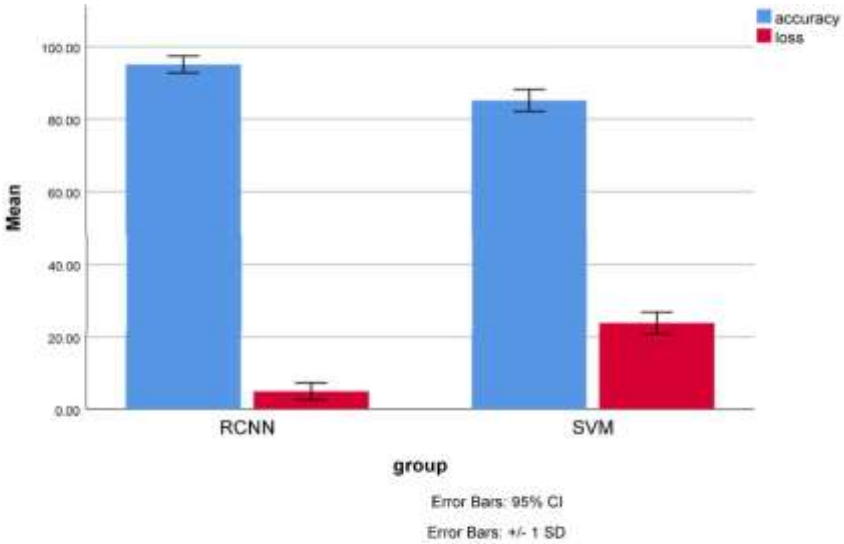

Fig. 1. Comparison of Novel Region-Based Convolutional Neural Networks and Support Vector Machine algorithm in terms of mean accuracy. The mean accuracy of Novel Region-Based Convolutional Neural Networks is better than the Support Vector Machine algorithm. The standard deviation of Novel Region-Based Convolutional Neural Networks is slightly better than the Support Vector Machine algorithm (Mattausch et al. 2014). X-Axis: Novel Region-Based Convolutional Neural Networks vs Support Vector Machine algorithm. Y-Axis: Mean accuracy of detection ± 1 SD.