Department of Electronics and Communication Engineering

Vasavi College of Engineering (Autonomous)

ACCREDITED BY NAAC WITH 'A++' GRADE

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CERTIFICATE

This is to certify that the Mini Project titled **"OBJECT CLASSIFICATION USING MATLAB"** submitted by

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Students of Electronics and Communication Engineering Department,Vasavi College of Engineering in partial fulfillment of the requirement of the award of the Degree of Bachelor of Engineering in Electronics and Communication Engineering is a record of the bonafide work carried out by them during the academic year 2022-2023.

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1.ABSTRACT

The objective of the "Object Classification using MATLAB" mini project is to develop a system that can accurately classify different objects based on their visual features. In today's era of increasing automation and artificial intelligence, object classification plays a crucial role in various applications such as image recognition, autonomous navigation, and surveillance systems.

This project utilizes the power of MATLAB, a versatile programming language and environment for numerical computing, to implement the object classification system. The project involves the collection of a diverse dataset comprising images of various objects from different categories. These objects may include everyday items, animals, vehicles, or any other relevant objects.

The trained model is capable of analyzing and classifying unseen images based on the learned patterns and features. Given a new image, the system applies the trained model to predict the object class with high accuracy. The project also focuses on evaluating the performance of the classification system by measuring metrics such as precision, recall, and accuracy.

The successful completion of this mini project will demonstrate the effectiveness of MATLAB in implementing object classification systems. It will showcase the ability to train models that can accurately identify and categorize objects based on visual features. The project outcomes can have practical applications in various domains, including computer vision, robotics, and intelligent systems.

2.LITERATURE SURVEY

In various fields, there is a necessity to classify the target objects and also track them effectively while handling occlusions and other included complexities. Many researchers attempted for various approaches in object classification.

A researcher Yingni Duan have published a paper named "An object recognition method based on deep learning" in IEEE Conference. Based on the traditional CNN convolutional neural network, this paper constructs a new network model, in which the 9 linear stacked inception modules are embedded. The use of inception modules reuses more features, improves the width of feature tensors, optimizes the training speed and improves the detection accuracy.[3]

An article "Deep Learning for Generic Object Classification: A Survey" by Mohammed J. Islam and Muhammad S. Khan (2018) provides an overview of deep learning techniques for generic object classification, including various architectures and methodologies. It covers both the fundamentals and recent advancements in the field.

3.PROBLEM STATEMENT

Object classification plays a crucial role in various domains and applications.So with the help of growing machine learning and deep learning algorithms,we can classify objects into various categories.In this project, we have created a convolutional neural network based on deep learning algorithms. Later an input test image is provided to the network and then classified output is displayed.

4.WORKING

We considered our objects of interest as Tiger,Balloon and Drone.With the help of deep learning algorithms,we have developed an object classification system, i.e, a convolutional neural network that can analyze the visual features of the objects and accurately assign the corresponding labels or categories .We aimed to achieve high accuracy and reliability in object classification, ensuring that the system can generalize well to unseen or new images.We tried to address a few challenges like variations in object appearance, potential ambiguity in object classes and memory issues in uploading datasets used to train the network.

5.SOFTWARE USED

We have used only one software in the implementation of our project i.e,MATLAB. MATLAB is a high-level programming language and environment that provides extensive support for numerical computing and data analysis. MATLAB provides a comprehensive environment for numerical computing. It offers a wide range of functions and tools for implementing machine learning and deep learning algorithms. However we didn't use any deep learning toolbox and pretrained models since we have created a Convolutional Neural Network(CNN). Also, we have used the App Designer Tool which is accessible in MATLAB to make a simple Graphical User Interface of our project. MATLAB's integration with other toolboxes and its extensive documentation and community support are additional advantages.

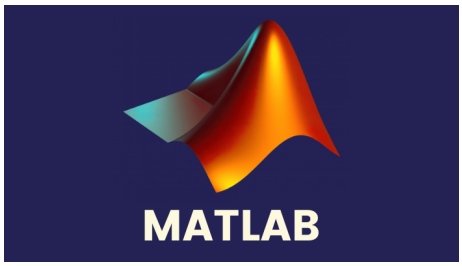

Figure 1: MATLAB

6.FLOW OF SOLUTION

Here are the few steps which we have followed inorder to approach towards the solution of the problem:

- **Deciding object classes**
- **Collection of object datasets**
- **Data preprocessing**
- **Network Design**
- **Network Training**
- **Network Testing**
- **Result Analysis**

By following these steps, the object classification system using MATLAB can provide accurate and reliable results, enabling various applications and domains that require object recognition and classification.

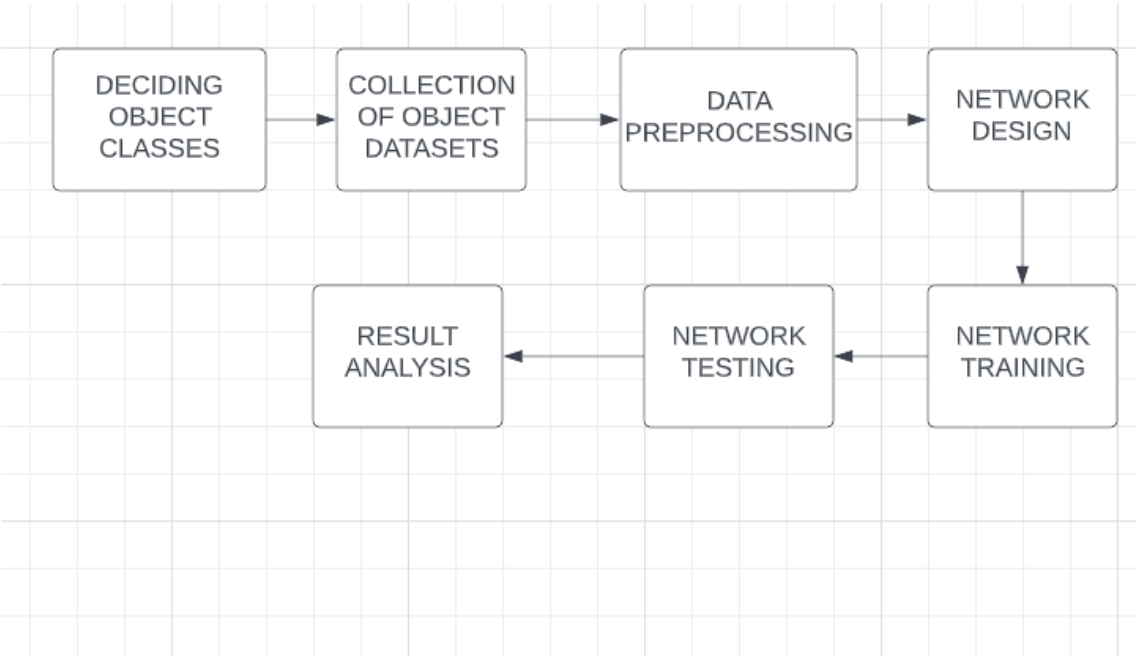

Figure 2: FLOW OF SOLUTION

6.1 DECIDING OBJECT CLASSES

Deciding object classes is a critical step because it establishes the foundation and framework for the entire object classification system.This step involves determining the specific categories or classes of objects you want to classify.the significance of deciding object classes lies in establishing a clear problem definition, focusing the task, guiding data collection efforts, enhancing model interpretability, ensuring practical relevance, and enabling iterative improvement.The Object classes that are chosen by us are:Tiger,Balloon,Drone.

6.2 COLLECTION OF OBJECT DATASET

Gathering a diverse and representative dataset is crucial for training an effective object classification model[1][2]. The dataset should include images or samples from each object class, covering a wide range of variations and perspectives. A comprehensive dataset helps the model learn the visual features and patterns associated with each class.Collecting datasets helps in Improved Model Generalization,Handling Class Imbalance,Robustness to Variations,Handling Rare or Challenging Cases,Avoiding Biases and Overfitting,Transfer Learning and Adaptability,addressing Domain-Specific Considerations.So we have gathered the datasets of the chosen object classes,i.e, Balloon,Tiger,Drone.

6.3 DATA PREPROCESSING

Data preprocessing is significant in object classification as it improves data quality, extracts relevant features, normalizes the data, handles missing values, reduces dimensionality, augments the dataset, and prepares the data for model input[1][2]. These preprocessing techniques contribute to the overall performance and effectiveness of the object classification model, enabling it to learn from high-quality data and make accurate predictions. It helps in improved computational efficiency,Mitigating Variations in Image Scale,Reducing Computational Memory Requirements,Consistency in Model Input,Enhanced Generalization,Addressing Hardware Limitations,providing Compatibility with Pretrained Models.Hence, the input image is been resized by us.

6.4 NETWORK DESIGNING

The design of the network architecture is a critical step in object classification. It involves selecting the appropriate deep learning model or designing a custom architecture suited to the specific problem. The network should have the capacity to learn complex patterns and features from the input data and extract relevant information for classification[1][2].The significance of this step is that it helps in model selection,learning complex patterns,feature extraction,transfer learning,scalability and efficiency,Regularization and Generalization,Interpretability and Explainability. However, we have created our own convolutional neural network with the help of deep learning algorithms without any pretrained models and toolboxes.

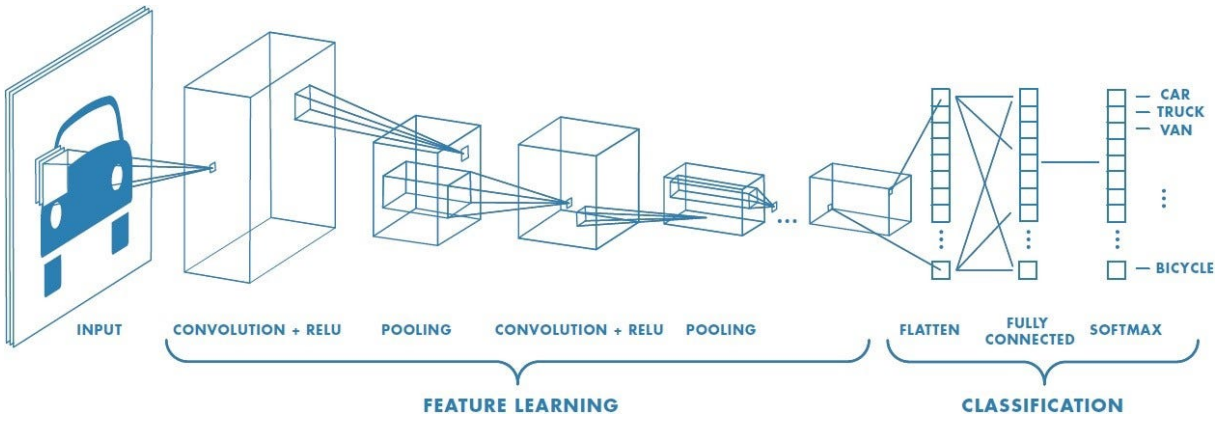

Figure 3: CONVOLUTIONAL NEURAL NETWORK

6.5 NETWORK TRAINING

In this step, the designed network is trained using the prepared dataset. During training, the model learns to recognize and differentiate between different object classes by adjusting its internal parameters. The training process involves optimization techniques such as gradient descent and backpropagation to minimize the error between the predicted and actual labels.It involves optimization algorithms,loss functions,defining batch size,learning rate and maximum iterations of training,training data augmentation,early stopping and model regularisation,monitoring and visualization,fine tuning few layers of network,transfer learning.
So we have defined the training options such as InitialLearnRate,MaxEpochs,etc in this step[1][2].

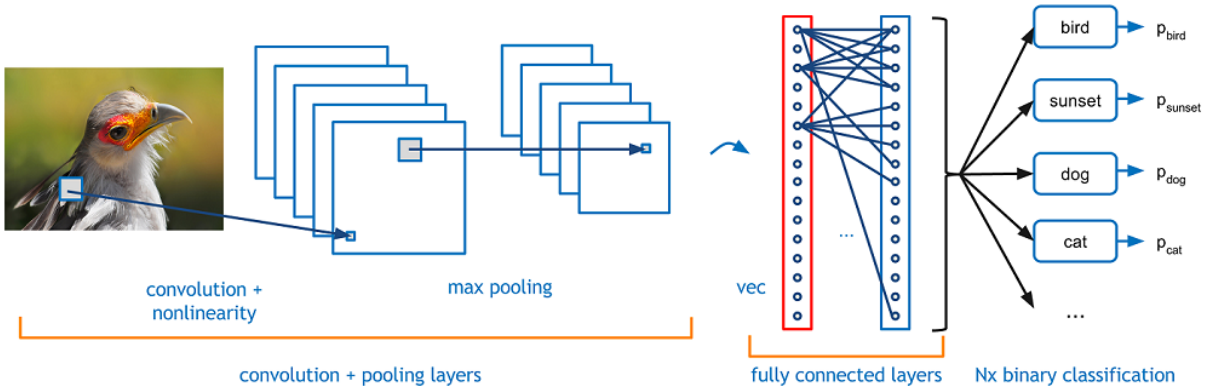

Figure 4: TRAINING OF CONVOLUTIONAL NEURAL NETWORK

6.6 NETWORK TESTING

Once the model is trained, it is evaluated using a separate test dataset that was not used during training. The testing phase assesses the model's performance by measuring metrics such as accuracy, precision, recall, and F1 score. It helps to validate the model's ability to classify objects correctly and provides insights into its generalization capabilities.This step plays an important role in Model Evaluation,Generalization and Overfitting,Error Analysis,Performance Comparison,Robustness Assessment,Confidence Estimation,Real world performance of the model,changes in training process.[1][2]
We have created Graphical User Interface which include Train and Test Buttons using MATLAB App designer.[4]

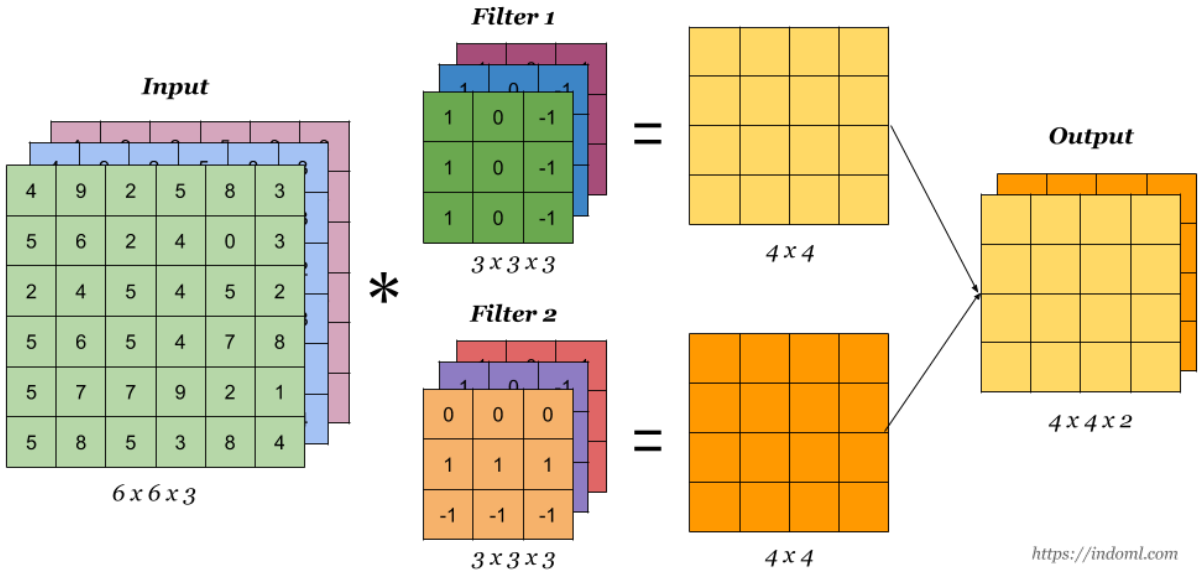

Figure 5: TESTING OF CONVOLUTIONAL NEURAL NETWORK

6.7 RESULT ANALYSIS

After testing, the results are analyzed to understand the performance of the object classification system. This analysis may involve examining the confusion matrix, visualizing misclassified samples, and identifying areas of improvement. It helps in fine-tuning the model, refining the dataset, or adjusting the network design to enhance the classification accuracy. As a part of result analysis,the code is being written in such a way that the bar graphs and the probabilities of each object class is displayed along with the image and the detected classname. If the probability of all classes is below 0.5, then it means that no object is recognised of our interest.So in that case, the result is displayed in this way:'No Object Recognised'.If two objects of our interest are present in the test image then the object class with higher probability is recognised.

Figure 6: RESULT OF CONVOLUTIONAL NEURAL NETWORK

7.OBSERVATIONS

Figure 7: GRAPHICAL USER INTERFACE[4]

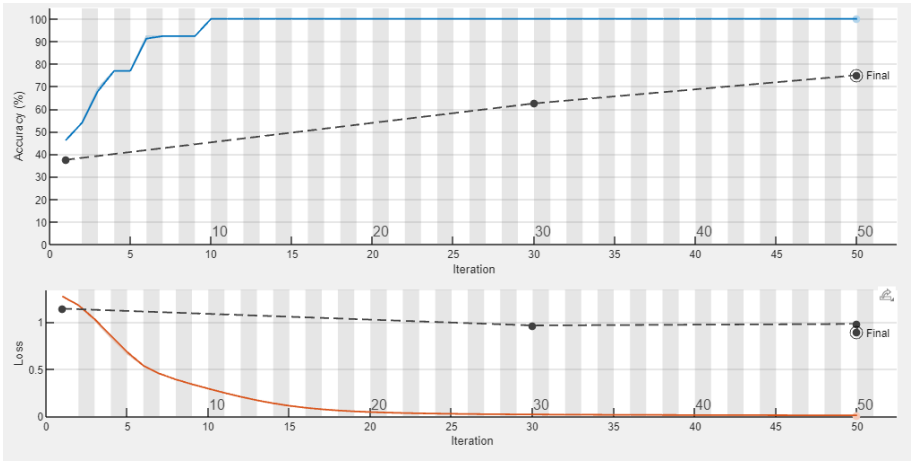

Figure 8: TRAINING REVIEW

Figure 9: RESULT FOR TEST INPUT 1

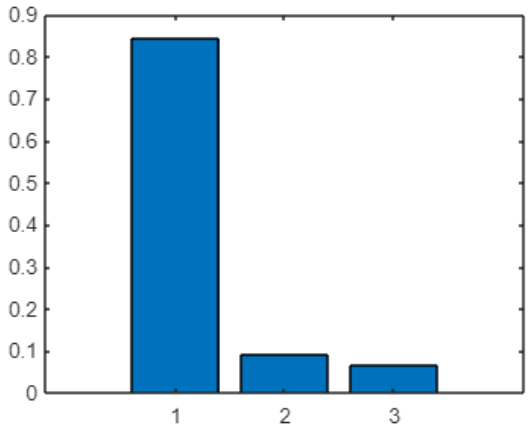

Figure 10: CLASS PROBABILITIES FOR TEST INPUT 1

As seen in the above image, as Balloon have higher probability, and the test input image is clearly Balloons, the output is shown as Balloon.

8.VALIDATIONS

Figure 11: RESULT FOR TEST INPUT

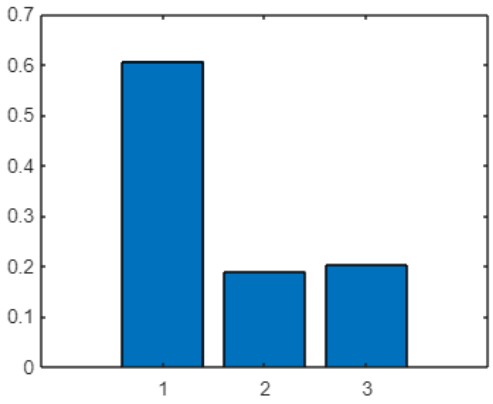

Figure 12: CLASS PROBABILITIES FOR TEST INPUT

As seen in the above image, even though there are two objects of our interest, the output can be seen as only one object is recgnised. This is due to the higher class probability of Balloon than Tiger.
Except for few exceptional test inputs like the above one,on a whole, around 70-80 percent accuracy have been acheived.

9.DIFFICULTIES IN THE PROCESS

1)Unable to give large amount of datasets to train the network as MATLAB have limited space,and if the space gets exceeded, an error is thrown displaying that memory is full.
2)Unable to get same perfect accuracy everytime we train the network.
3)Only one object having higher probability is being recognised when the test image is consisting of two objects of our interest.
4)Lot of problems are been faced while designing and writing the code of Graphical User Interface. Lot of errors have been thrown regarding callbacks of functions.However, we finally rectified them.

10.APPLICATIONS

1)Autonomous Systems: Object classification is vital for autonomous systems, such as self-driving cars or drones. It helps these systems recognize and classify objects in their surroundings, enabling them to make informed decisions and navigate safely. This includes identifying pedestrians, vehicles, traffic signs, obstacles, and other relevant objects.
2)Agriculture: Object classification can assist in agricultural applications by identifying and classifying crops, weeds, or pests. This can aid in crop management, disease detection, and optimizing pesticide use. It allows farmers to take timely actions to enhance crop yield and reduce losses.
3)Environmental Monitoring: Object classification can aid in environmental monitoring efforts, such as identifying and tracking wildlife species or monitoring land use changes. It can analyze satellite imagery or data collected from drones to identify and classify objects of interest, helping researchers and conservationists in their work.

4)Security and Surveillance: Object classification helps in security and surveillance systems by automatically identifying and classifying objects or individuals in real-time. It can detect suspicious activities, recognize specific objects (e.g., weapons, bags), or track the movement of people or vehicles. This improves overall security and facilitates quick response to potential threats.
5)An object classification model combined with a speaker or text-to-speech functionality can be extremely helpful for blind people. For example, Facial recognition capabilities can be integrated into the model, allowing blind individuals to recognize and identify people they know.

11.FUTURE SCOPE

We have done a simulation project.So by exploring Domain-Specific Applications, our model can be extended to be deployed to those applications on real time.For example, we could investigate applying your model to medical imaging tasks, industrial inspection, or agricultural applications.Applying our model to real time scenarios can be implemented by using FPGA connected to camera.
We could investigate options for integrating voice commands, gesture recognition, or tactile feedback to facilitate interaction with the system and consider designing a user-friendly interface or exploring accessibility standards, such as incorporating support for screen readers or Braille displays.
Also,we could investigate the possibility of deploying our object classification model on edge devices, such as smartphones, IoT devices, or embedded systems and Optimize the model size and computational requirements to ensure efficient execution on resource-limited devices.

12.CONCLUSION

In conclusion,the use of deep learning techniques such as CNNs shows a greater impact in classifying the objects. We have created the desired CNN and trained it with the object class datasets,added a Graphical User Interface to facilitate easy sharing execution of code file by others.And finally, we obtained the desired output by achieving the accurate classification of objects. We will explore the possibilities of deploying our model to real time applications using hardware elements like FPGA or GPU,TPU,etc.

13.REFERENCES

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5)Latex Basics
https://www.overleaf.com/learn/latex

14.TEAM MEMBERS

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