

HERITAGE CATEGORIZATION OF MONUMENTS USING DEEP LEARNING

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Abstract- One of the most important tasks in the digital documentation of cultural heritage is the classification of the photos that are taken when measuring an architectural asset. Since many images are typically handled classifying them is a laborious process that takes a lot of time and is prone to error. Additionally properly categorizing the existing images enables more effective management and searches using particular keywords supporting the tasks of researching and analyzing the relevant historical asset. This articles primary goal is to classify photos of architectural heritage using deep learning-based techniques. By creating different pictures of the specific landmarks along with their geo-locations (latitudes longitudes and landmark coordinates) we can use this project to create a variety of landmarks that are present in a given monument.

Keywords: geolocations, prone to errors

1. INTRODUCTION

The only way to grasp a new country's culture and traditions is through visiting its historical monuments, which are always sought after whenever someone travels to a new location. India is a country with many historical sites. In 19 states, there are 116 ticketed monuments. So, with this, you can realise clearly that if you want to visit all of these destinations separately without any

suitable advice, it will take a lot of time to find the locations of those places. Use deep learning techniques for heritage identification of monuments to facilitate destination location for travelers. . You can easily find the locations of the places you like to visit by visiting the website we developed and uploading a photo of a monument. Modern definitions of computer vision go beyond optical image processing and barcode scanning. Machine learning is expanding to new heights thanks to advancements in the field. Recent advances in picture recognition have been accelerated by deep neural networks. One important component that generated these results was the convolution neural network. In a nutshell convolution neural networks are a particular kind of neural network that employs multiple copies of the same neuron to build a layered architecture of the image weights which can then be utilized with the deep learning technique. When trying to identify landmarks from photos one must take into account the intricacy caused by the contours of the landmarks and their shared characteristics with other structures. A large number of images taken from various angles must be grouped for a specific landmark before being fed into the database for training in order to meet the need for increased accuracy and efficiency in complex scenarios. However the most important component that produced these results is widely recognized as the Convolutional Neural Network (CNN). In essence a Convolutional Neural Network a member of the Neural Network family is a Deep Learning algorithm that receives an image as input assigns weights to various aspects of the objects in the image and attempts to distinguish and identify one from the other. Looking at the final 11 traits we can deduce that improved outcomes for Landmark/Monument recognition might also be possible with Convolutional Neural Networks.

The goal of deep learning a branch of machine learning is to automatically learn data representations by training multi-layered artificial neural networks. Hierarchical feature extraction is

a key component of Convolutional Neural Networks (CNNs) a popular deep learning architecture that has transformed image recognition tasks. CNNs are well-suited for tasks involving the recognition of monuments because they can be trained on vast amounts of data which enables them to recognize intricate patterns and structures in images. There are usually multiple steps involved in the deep learning process of identifying monuments. To give the network examples to work with a dataset of pictures of different monuments is first gathered and labeled. The deep learning models training set is the labeled dataset. The next step is to create and train a CNN architecture with the training data so that it can recognize various monuments based on their visual attributes. A CNNs ability to extract pertinent features from input images like edges textures and shapes is developed during training. Following that the photos are categorized into various monument groups based on these features. In order to minimize the discrepancy between the predicted and actual labels the networks parameters are iteratively adjusted during the training process. Gradient descent and other optimization techniques are frequently used in this process which helps the network become more accurate at recognition over time.

After training the CNN can be used for tasks involving the recognition of monuments. The trained model can identify the monument it represents by analyzing its visual characteristics when it is presented with a new image. In certain situations this forecast may include extra details about the monument like its architectural style or historical significance in addition to the monuments identification. There are various benefits to employing deep learning techniques for monument recognition. As a result less manual inspection or human expertise is required for the efficient and automated identification of monuments. Furthermore deep learning models are robust to various imaging conditions because they can manage changes in lighting perspective and occlusions. Monument recognition systems that make use of deep learning can improve tourism experiences support urban planning and development and help preserve cultural heritage.

This thesis aims to recognize landmarks and monuments through the implementation and deployment of a Deep Convolutional model for image recognition.

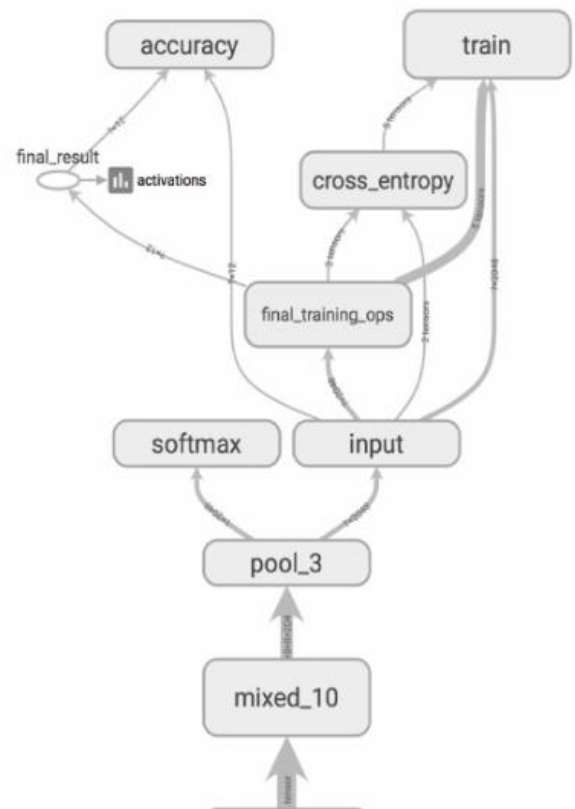


Fig.1. System Architecture

2. LITERATURE SURVEY

1. "Monument Recognition using Deep Neural Networks" was published in 2017 by Siddhant Gada, Viraj Mehta, Karan Kanchan, Chahat Jain, and Prof. Purva Raut.

Chahat Jain Viraj Mehta Karan Kanchan Siddhant Gada and Prof. published an article titled Monument Recognition using Deep Neural Networks [5] in 2017. Purva Raut. In the process they classify popular Indian monuments located in the Golden Quadrilateral using the Inception v3 deep learning architecture model. With its unique ability to continuously analyze the dataset and produce a better model this architectural design is made up of many different layers. A key element of the neural networks successful train is the

activation function in this case the Rectified Linear Unit (ReLU) which offers smooth performance and shorter training times. Additionally they introduce the concept of pooling more especially max pooling a well-known machine learning method that strengthens a model by summarizing the features present in an input image [8]. Using a retrained model and 400–600 photos for each landmark they were able to achieve a cross-entropy close to 0.067 a training accuracy of 99.4 percent and a comparable testing accuracy estimated from 96–99 percent after 4000 iterations. Two years have passed since V. With A Monument Recognition Mobile App Palma made an attempt to develop a smartphone app that could recognize and identify monuments [6]. Deep learning techniques and convolutional neural networks are the foundation of the applications concept. The program uses convolutional neural network algorithms to identify architectural objects. To elaborate the aforementioned mobile application consists of two main sections: the first lets you upload the desired document along with any relevant data and the second provides information on monuments that are kept in an online database using 21 machine learning software. He develops two unique apps one for Apple iOS and the other for Android OS.

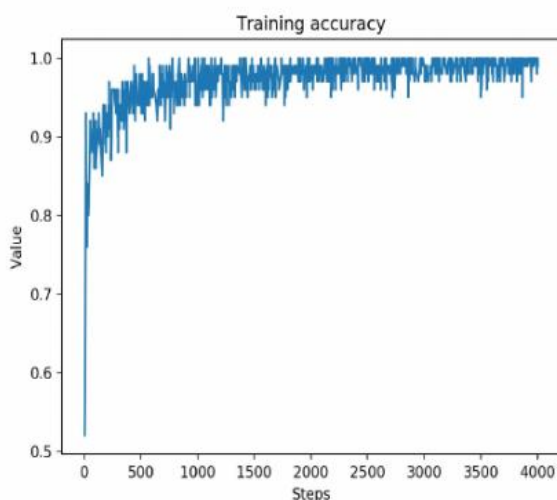


Fig.2. Training Accuracy

Using 50–100 images for each of the 46 distinct monuments—500 images per monument—and data augmentation techniques to expand the dataset the model can identify the intended monument with an accuracy of 95 percent or more.

2. NU-LiteNet: Mobile Landmark Recognition using Convolutional Neural Networks"

Chakkrit Termritthikun, Surachet Kanprachar, and Raisarn Muneesawang

At the 2018 conference NU-LiteNet: Mobile Landmark Recognition using Convolutional Neural Networks Chakkrit Termritthikun Surachet Kanprachar and Raisarn Muneesawang significantly improved the recognition of monuments and landmarks [7]. They understand that latency remains an issue even with our capacity to achieve human-level precision. They build a novel convolutional neural network model in their study which they refer to as NU-LiteNet based on the SqueezeNet [9] development concept. To accomplish their goal they build two different versions of NU-LiteNet called NU-LiteNet-A and NU-LiteNet-B each with two extra convolutional filters measuring 5x5 and 7x7 to increase the accuracy score but with a different depth level. This experiment made use of two datasets: the first included 4060 photos of 50 Singaporean landmarks and the second included 6412 photos of 12 French monuments in Paris. The dataset is divided into training and test halves at 90% and 10% respectively and their results are compared with those of AlexNet GoogLeNet and SqueezeNet. Using both the top-1 and top-5 accuracy to gauge performance they outperform GoogLeNet achieving 7.4–10.46 percent higher accuracy for the Singapore dataset and 6.7–96.1 percent higher accuracy for the Paris dataset. The models size was 2 points-6 times smaller than SqueezeNets at the same time. To further accomplish their aim they develop an Android OS application and feed it the models. The best performing model was found to be NU-LiteNet-A which processed each image in 637 ms and only needed 1.07 MB. Ajay Kumar Mallicka Aniket Ninawe Vikash Yadav Hifzan Ahmad Dinesh Kumar Sah and Cornel Barna try to solve the 22 image classification problem of classifying whether an architectural structure or monument belongs to the Cathedral or the Indian

Mughal in their paper Cathedral and Indian Mughal Monument Recognition using Tensorflow from the same year. An open-source machine learning framework called Tensorflow constructs a convolutional neural network using a deep learning technique. They use a thousand monuments of Indian Mughal and cathedral architecture in their research in order to successfully train the algorithm to recognize possible differences between monuments of the same class. They surpass Gupta et al. by employing convolutional neural networks to extract general features and derive the train weights resulting in an accuracy of eighty percent. [14] by a margin exceeding 7%.

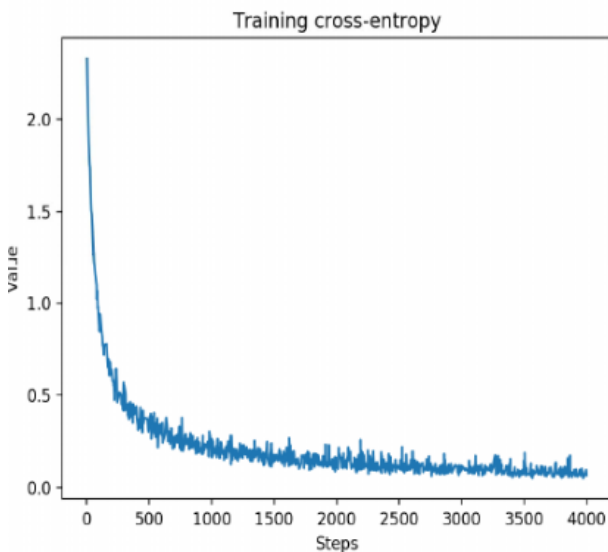


Fig.3. Training Cross entropy

3. Image based Indian Monument Recognition using Convolved Neural Networks" by Aradhya Saini, Tanu Gupta, Rajat Kumar, Akshay Kumar Gupta, Monika Panwar, and Ankush Mittal

Another interesting technique was published in the 2017 paper Image based Indian Monument Recognition using Convolved Neural Networks by Aradhya Saini Tanu Gupta Rajat Kumar Akshay Kumar Gupta Monika Panwar and Ankush Mittal [10]. The vast variations and different orientations

of the structures make it difficult to identify monuments they observe. Their goal is primarily driven by the characteristics that the monuments may yield. Using manual and convolutional neural network techniques they extract information to identify the monuments. The basic concept behind the classification of monuments based on hand-crafted features is the Histogram of Oriented Gradients (HOG) Local Binary Patterns (LBP) and (GIST) features methodologies. For the experiment every one of Indias 100 distinctive monuments was represented by 50 images. Various approaches were combined with well-known classification algorithms like Random Forest k-Nearest Neighbor (KNN) and Support Vector Machine (SVM). Results show that convolutional neural models outperform handcrafted examples with an estimated accuracy of 92. 7%. Additionally they introduce the concept of Graph-Based Visual Saliency (GBVS) a method that achieves better results and accurately assesses the salience of an image [11] [12]. 23 In recent years there has been a great deal of interest in monument recognition using deep learning techniques. Scholars have investigated a range of methods and structures to address this difficult undertaking. An overview of some noteworthy studies in the field can be found here:.

Monument to be Classified	Location 1	Location 2	Location 3	Ground Truth
	India Gate (score=0.98516)	Gateway Of India (score=0.01386)	Qutub minar (score=0.0006)	India Gate
	Howrah Bridge (score=0.98717)	Worli SeaLink (score=0.00629)	India Gate (score=0.00243)	Howrah Bridge
	Victoria Memorial (score=0.97572)	Red fort (score=0.00703)	St.Thoma's Basilica (score=0.00576)	Victoria Memorial
	Worli Sea Link (score=0.93792)	Howrah Bridge (score=0.02034)	Gateway of India (score=0.01330)	Worli Sea Link

Fig.4. Table of expected accuracies

A deep learning framework for landmark recognition was proposed in this groundbreaking work. The groundbreaking dataset which included millions of geotagged photos from well-known photo-sharing websites was unveiled by the writers. They used a sizable dataset to train deep CNNs to identify landmarks and they got encouraging results. The study showed how deep learning can be used to recognize monuments.

4. Monument Recognition mobile app using Deep Learning. Chollet, F., Omran, M., Ramos, S., Rehfeld M., Benenson

This project presents a still-to-be-developed research stream that will examine CNN techniques in the field of architectural heritage. In this paper a multidisciplinary teams efforts to use AI technologies for image recognition in the field of architectural heritage are presented. In order to facilitate the localization of sites of architectural interest an automated image recognition system is

suggested. By storing vast volumes of data online that can be retrieved when needed it contributes to the systems increased scalability. By simply pointing the camera at an object this paper developed a mobile application that provides access to data about buildings or works of art. The outcome has the ability to link the actual city to set documents including texts images and 3D outcomes [4].

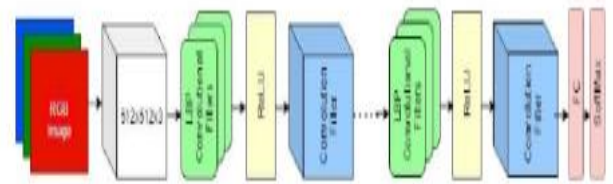


Fig.5. Structure of CNN

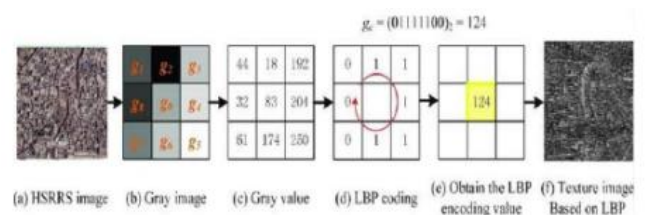


Fig.6. Feature Extraction

The caliber and volume of data used for training has a major impact on how well deep learning models perform. In the case of heritage identification we used a variety of public open sources including Google Earth to obtain satellite imagery of 15 monuments. To create the dataset using Google Earth we must first visit the site search for the necessary information and then take screenshots of the monuments by navigating around the screen and zooming in and out. We have gathered a sample set of 300 images for every monument to fit the system configuration because the size will be larger.



Fig.5. Satellite Images

3. METHODOLOGY

Data Collection: Gather a comprehensive dataset of images or other relevant data representing various heritage monuments. This dataset should cover a wide range of architectural styles, historical periods, and cultural contexts to ensure the model's robustness.

Preprocessing: Clean and preprocess the collected data to ensure consistency and remove noise. This may involve standardizing image sizes, adjusting lighting and color balance, and removing irrelevant background elements.

Model Selection: Choose an appropriate deep learning architecture for the task. Convolutional Neural Networks (CNNs) are commonly used for image classification tasks due to their effectiveness in extracting features from visual data.

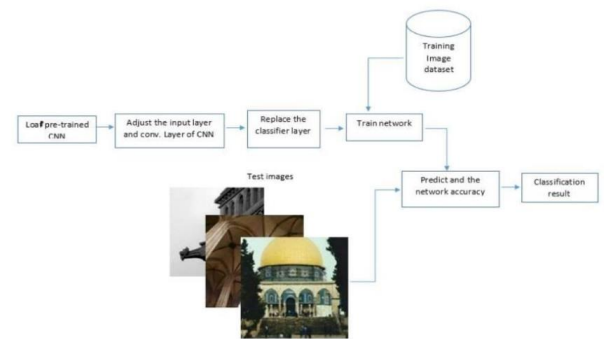
Training: Divide the preprocessed dataset into training, validation, and testing sets. Train the deep learning model using the training set, adjusting the model's parameters to minimize the loss function and improve classification accuracy. Use the validation set to tune hyperparameters and monitor the model's performance.

Evaluation: Evaluate the trained model's performance on the testing set to assess its accuracy, precision, recall, and other relevant metrics. Fine-tune the model if necessary to improve its performance.

Categorization: Once the model is trained and evaluated, use it to categorize heritage monuments based on predefined criteria such as architectural style, historical period, cultural significance, or

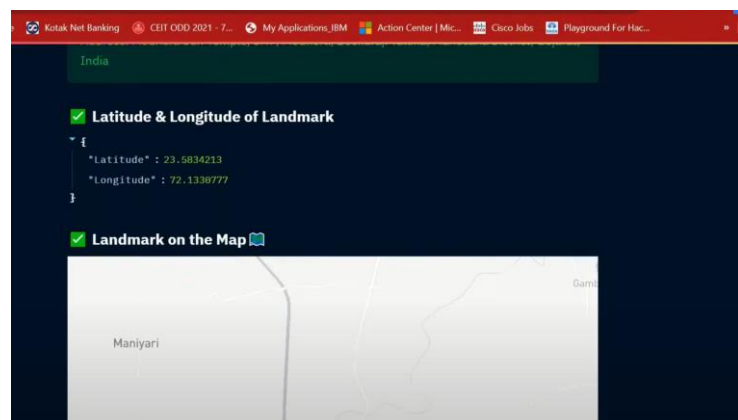
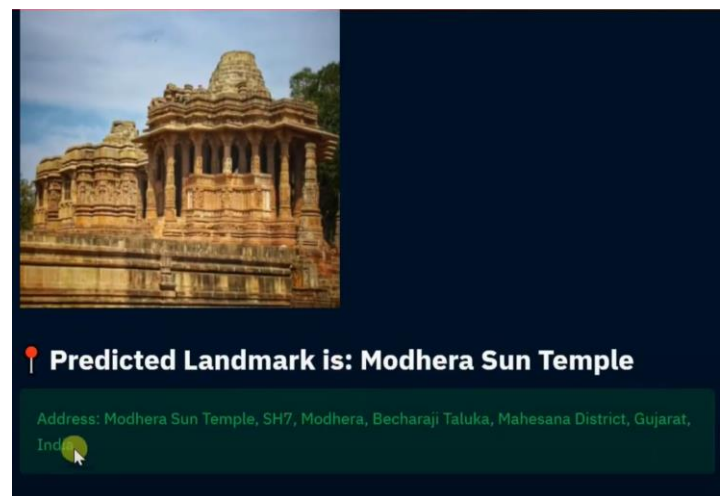
geographical location. Apply the model to new data to categorize previously unseen monuments.

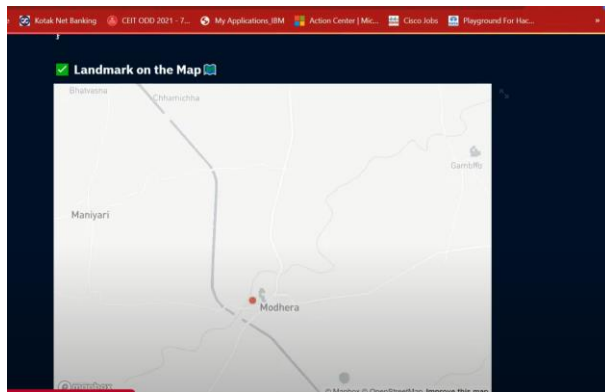
Validation and Refinement: Validate the categorization results against expert knowledge or existing classification systems to ensure accuracy and consistency. Refine the model as needed based on



feedback and additional data.

4.RESULTS





5. CONCLUSION

The deep learning model for classifying photos of architectural heritage is based on convolutional neural networks and is provided by this research. In this model CNN utilizes a pre-trained structure. ResNet-18 ResNet-101 and GoogleNet. They each performed three separate iterations of tests on the dataset. The classification outcomes of GoogleNet surpassed those of other methods and other CNN for the small version of the dataset. ResNet-18 produced better classification results than other pre-trained CNNs. The datasets ResNet-101-based subimages had the best accuracy 95 point 47 percent. Along with providing the monuments name full address latitude and longitude values (directions) and map coordinates the model also indicates the monuments location. In conclusion it has been shown that RESNET101 is a very effective and efficient method for monument recognition. Deep convolutional neural network architecture RESNET101 has been extensively used for image recognition applications such as object detection and classification. The variety of monument types altered lighting occlusions and disparate viewing angles make monument recognition a difficult task. But in terms of precisely recognizing and categorizing monuments from photos RESNET101 has demonstrated outstanding performance. To extract meaningful representations of monuments RESNET101 uses millions of trainable parameters and its deep architecture to learn complex features and patterns from training data. The network can then successfully identify and classify various monument types by making precise predictions on unseen images.

High accuracy resilience to changes in illumination and viewpoint and ease of handling complicated and cluttered backgrounds are some of the advantages of utilizing RESNET101 for monument recognition. Additionally RESNET101 can be adjusted on particular monument datasets to enhance its functionality and 77 adjust to particular recognition tasks. Overall the use of RESNET101 for monument recognition has shown how effective it is at automating the identification process which makes efficient cataloging assistance for tourists and preservation efforts possible. It is an invaluable resource that helps tourists researchers historians and cultural heritage organizations comprehend and value the worlds architectural treasures.

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