

HERITAGE IDENTIFICATION OF MONUMENTS USING DEEP LEARNING TECHNIQUES

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ABSTRACT

India is a nation with a plethora of cultural landmarks, including notable architectural masterpieces, 37 of which are UNESCO World Heritage master pieces. We must protect cultural heritages because they bind successive generations together over time. Architectural Designers, researchers, and travellers, etc. visit numerous historical locations, where it is frequently challenging for them to recognise and learn more about the historical significance of the monument in which they are interested. Due to the size and dependability of the information, the work of archiving, recording, and sharing the knowledge of these cultural assets is difficult. Modern machine learning and deep learning algorithms, as well as high processing computational resources, offer practical answers. The classification of Monument satellite images or photographs can be atomized by utilising the Convoluted Neural Network techniques. During our project implementation, monuments images dataset was created with the help of images. We have applied various pre-processing techniques and from pre-processed images we extracted features using feature extraction techniques such as Mean Standard Deviation (MSD). A model was developed using deep learning algorithms such as the Convoluted neural network (CNN). The results of our project are discussed in this paper. Initially we upload the monument satellite image, then the system recognizes the monument first then predicts whether the monument is heritage or not and displays the monument image along with information of the monument.

Keywords: Convolutional Neural Networks (CNN), Heritage Identification, Image Classification, Mean Standard Deviation (MSD), Monument Recognition.

I. INTRODUCTION

Heritage of a monument has prominence as the people belonging to the various cultures, castes, creeds and religions take pride in their culturally rich heritage bestowed upon them in the form of monuments. There is a need to digitally recognize and archive the monuments as an important historical and cultural heritage site. This poses an impactful feature not only for tourists but also for the local people in order to gain knowledge regarding their own cultural heritage. Over a period of time as the generations change, the architecture styles of the buildings also change. Monuments are the buildings or structures famous for their architectural and cultural heritage. They are durable and famous symbols of the past. We get a lot of historical and political information from monuments. They are like a treasure for a nation and a symbol of pride in their civilization. They help us to appreciate our past and the level of development, knowledge and thoughts. In a way, they provide life to our past. They serve as important sources / evidence of history and they enhance tourism. It is important to conserve, preserve and protect monuments. International bodies like UNESCO have taken important initiatives to preserve them. UNESCO has a world heritage mission which encourages international cooperation in the conservation of our world's cultural and natural heritage. There are 1,157 World Heritage Sites in all, spread across 167 nations as of January 2023 (900 cultural, 218 natural, and 39 combined properties). Countries are required to nominate their heritage sites. Sites must have exceptional global importance and fulfil at least one of ten selection criteria in order to be listed on the World Heritage List of UNESCO (<https://whc.unesco.org/en/criteria/>) World Heritage sites were selected on the basis of six cultural and four natural criteria they are [1]: (i) To represent a masterpiece of human creative genius; (ii) To exhibit an important interchange of human values, over a span of time or within a cultural area of the world, on developments in architecture or technology, monumental arts, town-planning or landscape design; (iii) To bear a unique or at least exceptional testimony to a cultural tradition or to a civilization which is living or which has disappeared; (iv) To be an outstanding example of a type of building, architectural or technological ensemble or landscape which illustrates (a) significant stage(s) in human history; (v) To be an outstanding example of a

traditional human settlement, land-use, or sea-use which is representative of a culture (or cultures), or human interaction with the environment especially when it has become vulnerable under the impact of irreversible change; (vi) To be directly or tangibly associated with events or living traditions, with ideas, or with beliefs, with artistic and literary works of outstanding universal significance. (The Committee considers that this criterion should preferably be used in conjunction with other criteria); (vii) To contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance; (viii) To be outstanding examples representing major stages of earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features; (ix) To be outstanding examples representing significant on-going ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals; (x) To contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation. A World Heritage Site must be an unusual landmark that is easily recognized geographically and historically and has outstanding cultural or physical importance in order to be chosen. It encourages participation of the local population in the preservation of their cultural and natural heritage [2]. The need for classification of the images taken during the survey of an architectural asset during the digital documentation of cultural heritage is an essential task. This paper discusses the classification of the satellite images of architectural heritage, specifically through the use of convolutional neural networks. Our work provides reliable information on the state of landmarks, monuments and buildings, thus facilitating their conservation, maintenance and rehabilitation. Various types of Deep Learning architectures have been used to recognize monuments and achieve a good performance. Our method leverages the rich visual features extracted from satellite images to automatically detect and classify monuments. We highlight the importance of using CNNs for heritage identification, as they can learn complex patterns and representations from large amounts of data, making them well-suited for handling the diverse and intricate visual characteristics of heritage sites. We also discuss the potential benefits and applications of our proposed approach, including assisting archaeologists, cultural heritage experts, and policy makers in heritage preservation and management. Eventually, our project strives to state the importance of preserving and maintaining information for a cultural heritage digitally. The results of the applied architectures are analyzed to give the technique with the high performance.

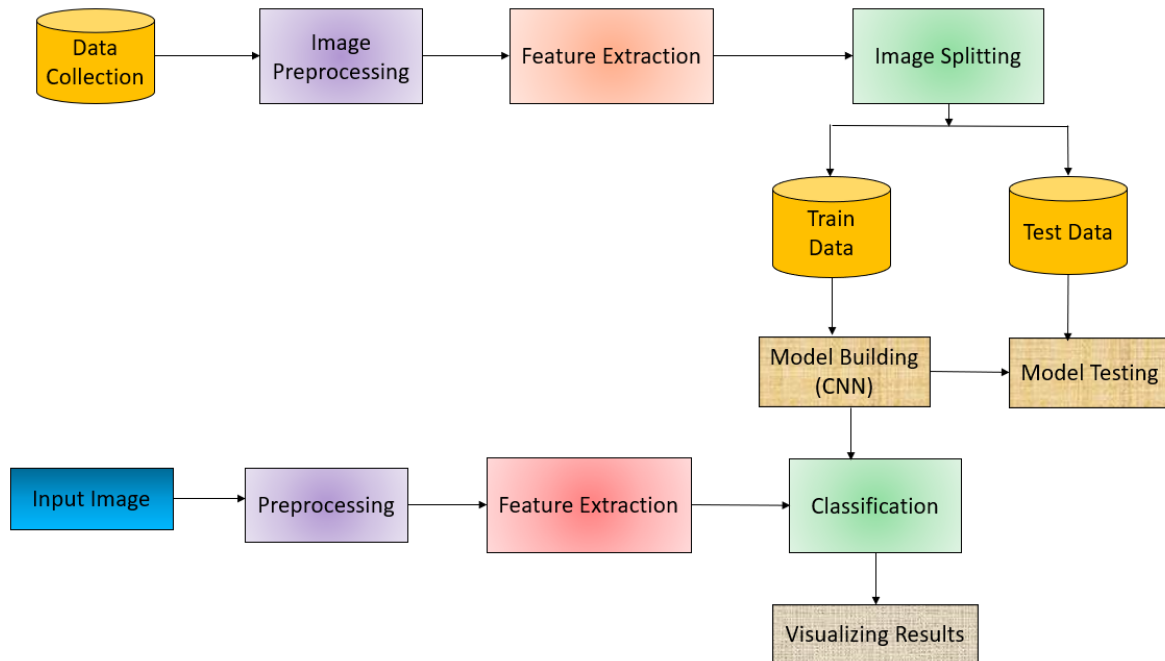
II. METHODOLOGY

Heritage identification of monuments is an important task in the field of cultural heritage preservation. Deep learning models such as convolutional neural networks (CNNs) are effective for image processing. The methodology for image recognition and classification using a Convolutional Neural Network (CNN) typically involves several key steps, such as

- 1) Dataset Preparation: Collect and preprocess a dataset of labelled images for training and validation.
- 2) Feature Extraction: Extract the features from the preprocessed images using LBP (local Binary Pattern) and MSD (Mean standard deviation) techniques.
- 3) Architecture Design: Define the architecture of the CNN, including the number and type of convolutional, pooling, and fully connected layers, as well as the activation functions. The architecture should be designed based on the specific requirements of the image recognition task and the characteristics of the dataset.
- 4) Model Training: Train the CNN using the prepared dataset. Training is typically performed for multiple epochs (iterations over the entire dataset) to allow the model to learn from the data and converge towards optimal weights.
- 5) Model Evaluation: Evaluate the trained CNN using the validation dataset to assess its performance. The evaluation results provide insights into the model's performance and help identify potential areas for improvement.
- 6) Model Optimization: Fine-tune the CNN based on the evaluation results. This may involve adjusting hyper parameters such as learning rate, batch size, and regularization strength. The optimization process is typically iterative, involving multiple rounds of training, evaluation, and adjustment to achieve the best possible performance.

7) Model Testing: After optimizing the CNN, test its performance on a separate test dataset that was not used during training or validation. This provides a final assessment of the performance and its ability to accurately recognize images in real-world scenarios.

8) Deployment: Once the CNN has been trained and optimized, it can be deployed in a production environment for image recognition and identification tasks [7].



III. MODELING AND ANALYSIS

Step 1: Selection of images:

The dataset, Heritage dataset is implemented as input. The dataset is taken from dataset repository. The input dataset is in the format '.png', '.jpg'. In this step, we have to read or load the input image by using the `imread()` function. In our process, for selecting the input image tkinter file dialogue box can be used.

Step 2: Pre-processing of images:

As part of our procedure, we must downsize the image and turn it into grayscale. To resize an image, use the `resize()` method on it and supply a two-integer tuple parameter that represents the image's new width and height. The function returns another Image with the updated dimensions rather than altering the original image. For image conversion to grayscale in python, use Matplotlib Library and the Conversion Formula. We can also convert an image to grayscale using the conventional RGB to grayscale conversion formula.

$$\text{imgGray} = 0.2989 * R + 0.5870 * G + 0.1140 * B$$

Step 3: Feature Extraction:

Feature extraction is a critical step in convolutional neural networks (CNNs) for image processing tasks, including heritage identification of monuments using satellite images. The process involves automatically learning and extracting relevant visual features from input images, which are then used by the CNN model for classification or other tasks. Here, we extract the features in two methods:

- Local Binary Pattern (LBP)
- Mean Standard Deviation (MSD)

Step 4: Image Splitting:

Data splitting is the process of dividing a set of available data into two parts, typically for cross-validator needs. We divide the input dataset in half, using 30% for testing and 70% for training. One portion of the data is used to create a predictive model, and the other is utilised to assess the effectiveness of the model. Evaluation of data mining methods involves dividing data into training and testing sets. Typically, when we separate a data set

into a training set and testing set, most of the data is used for training, and a smaller portion of the data is used for testing.

Step 5: Classification:

A CNN is a kind of network architecture for deep learning algorithms and is specifically used for image recognition and tasks that involve the processing of pixel data. There are other types of neural networks in deep learning, but for identifying and recognizing objects, CNNs are the network architecture of choice.

Step 6: Generation of The Results

The Final Result will get generated based on the overall classification and prediction. The performance of this proposed approach is evaluated using some measures like accuracy of classifier refers to the ability of classifier. It predicts the class label correctly and the accuracy of the predictor refers to how well a given predictor can guess the value of a predicted attribute for a new data.

$$AC = (TP + TN) / (TP + TN + FP + FN)$$

TP : Number of true positive predictions

TN : Number of true negative predictions

FN : Number of false negative predictions

FP : Number of false positive predictions

Steps for Implementation are given as follows:

- Import all the required Libraries/packages (Numpy, Pandas, Tensorflow, Keras, CV2, Scikit learn, Matplotlib, streamlit).
- Create and Upload the dataset.
- Preprocess the dataset. In preprocessing we have to resize the image and convert the image into gray scale. To resize an image, we call the `resize()` method and we then use gray scale conversion on the resized image.
- Utilizing the LBP (local Binary Pattern) and MSD (Mean Standard Deviation) approaches, extract the features from the preprocessed images.
- Split the dataset into training and testing data. By using CNN a deep learning algorithm train and test dataset.
- Set the parameters for CNN in order to build a model.
- After developing the model, we must evaluate it. If the created model is acceptable, we go to the next phase; otherwise, we reset the parameters.
- Build UI for data input and results display using Streamlit framework.
- Run `Main.py` at the Anaconda prompt to start the streamlit server, and then we will be sent to our web server.
- Upload a satellite image of a monument, the system first recognizes the monument and then determines whether it is a heritage or not. It then estimates the accuracy of the Identification and presents the monument image and related information.

IV. RESULTS AND DISCUSSION

The identification and preservation of our cultural legacy could be revolutionised by the use of deep learning in heritage identification, which is a promising area of research. Our heritage monuments can be preserved for future generations with the aid of cutting-edge technologies and deep learning algorithms. However, there are still a number of issues that must be resolved, including the need for more diverse datasets and a lack of adequate documentation.

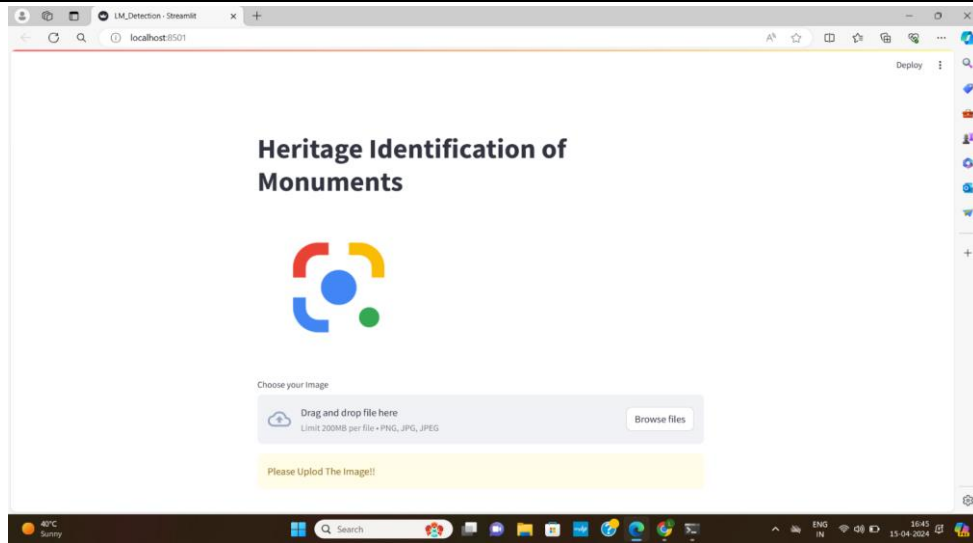
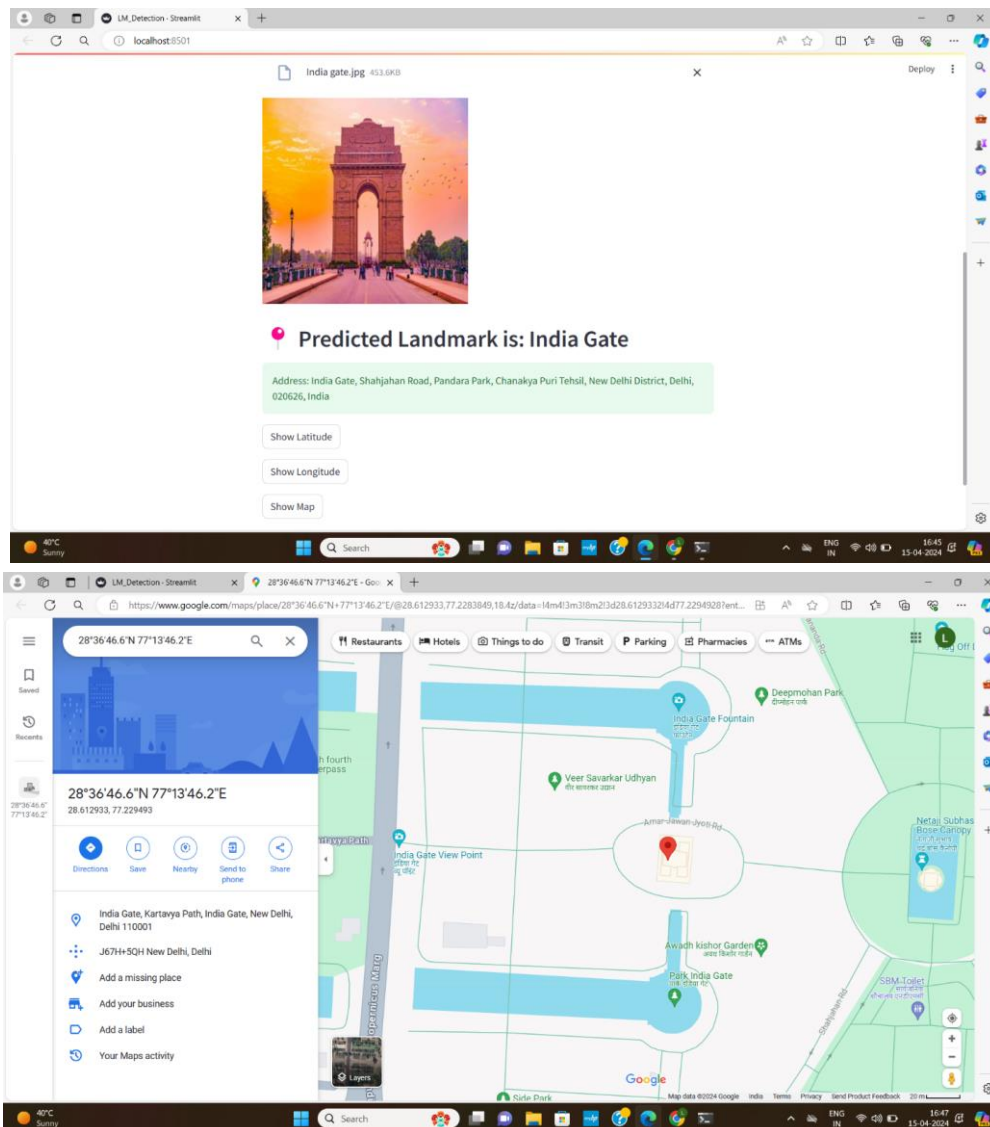


Figure 2: Name of Graph (Font size-10)



V. CONCLUSION

We have successfully developed a system to recognize and identify the heritage of the monument. A dataset of satellite imagery of monuments served as the foundation for the development of a deep learning algorithm

called Convolutional Neural Network. To do this, we first preprocessed the images in the dataset and then extracted the features from those preprocessed photos along with splitting of dataset, building and evaluating the model. Finally, the findings demonstrate the accuracy and ability to forecast the type of monuments and whether they are patrimony or not. Overall, this effort emphasises how critical it is to use contemporary technologies to preserve our cultural history.

The identification and preservation of our cultural legacy could be revolutionised by the use of deep learning in heritage identification, which is a promising area of research. Our heritage monuments can be preserved for future generations with the aid of cutting-edge technologies and deep learning algorithms. However, there are still a number of issues that must be resolved, including the need for more diverse datasets and a lack of adequate documentation.

Future developments in the field of heritage monument identification utilising CNN and satellite photos are likely to include a number of improvements. Like enhanced accuracy, greater resolution satellite imagery. Future research may focus on making CNN models more interpretable and explainable. This can help in understanding the decision-making process of the models and gaining insights into the features or patterns that contribute to the identification of heritage monuments from satellite images, making the results more transparent. We can identify any potential threats or changes to heritage sites in a timely manner, allowing for timely intervention and preservation efforts. Integration of CNN-based heritage identification models with other technologies, such as augmented reality (AR) or virtual reality (VR), may provide more immersive experiences for users and facilitate virtual heritage exploration and preservation efforts.

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