Heritage Identification of Monuments using Deep Learning Techniques

Sowjanya Jindam, Jaimini Keerthan Mannem, Meena Nenavath, Vineela Munigala

***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 google earth images. We have applied various pre-processing techniques and from pre-processed images we extracted features using feature extraction techniques such as Local Binary Patterns(LBP), 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 gives the accuracy value as well as displays the monument image along with information of the monument.*

***Keywords**: Convolutional Neural Networks (CNN), Heritage Identification, Image Classification, Local Binary Pattern (LBP), 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;

Manuscript received on 02 May 2023 | Revised Manuscript received on 12 June 2023 | Manuscript Accepted on 15 June 2023 | Manuscript published on 30 June 2023.
***Correspondence Author(s)**
Sowjanya Jindam*, Assistant Professor, Department of Information Technology, Maturi Venkata Subba Rao (MVSR) Engineering College, Osmania University, Hyderabad (Telangana), India. E-mail: sowjanya_it@mvsrec.edu.in, ORCID ID: 0000-0001-6959-2110
Jaimini Keerthan Mannem, Student, Department of Information Technology, Maturi Venkata Subba Rao (MVSR) Engineering College, Osmania University, Hyderabad (Telangana), India. E-mail: mannem.jk2002@gmail.com
Meena Nenavath, Student, Department of Information Technology, Maturi Venkata Subba Rao (MVSR) Engineering College, Osmania University, Hyderabad (Telangana), India. E-mail: meenaonmail31@gmail.com
Vineela Munigala, Student, Department of Information Technology, Maturi Venkata Subba Rao (MVSR) Engineering College, Osmania University, Hyderabad (Telangana), India. E-mail: vishmam2002@gmail.com

(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. LITERATURE REVIEW

1) Image based Indian Monument Recognition using Convoluted Neural Networks.

AUTHORS: Aradhya Saini T, Tanu Guptha Panwar, Rajat Kumar, Akshay Kumar Gupta, Ankrush Mittal.

This paper proposes an approach for classification of various monuments based on the features of monument images. Deep convoluted neural networks is used for extracting representations. This paper considered hundred monuments in the dataset for classification with 90% accuracy. They used GBVS (Graph Based Visual Saliency) method for monument recognition to find out saliency in monument images so that better image recognition algorithm work. The images are previously processed according to the GBVS method, which is in order to either keep the SURF or SIFT features , which are corresponding to the present actual monuments while the background “noise” which has been minimized [3].

2) A Monument Recognition mobile app using Deep Learning.

AUTHORS: Chollet, F.,Omran, M.,Ramos, S., Rehfeld M., Benenson

This project introduces a project aimed at studying CNN techniques in the field of architectural heritage, a still to be developed research stream. This paper introduces the work of amulti disciplinary team to exploit AI technologies for image recognition in the architectural heritage field. A role is proposed for automatic image recognition in localization techniques for sites of architectural interest. It helps in making the system more scalable, storing online large amounts of data that can be retrieved when needed. This paper developed a mobile app that allows to access the data related to building or work of art just by pointing the camera at the object. The result is capable of connecting the real city to set the documents such as images, texts, 3D results [4].

3) Monument Recognition using Deep Neural Networks

AUTHORS: Nithish Srivasthav A, Vinod Nair, Kajal Dhumal P.

The monuments or the landmarks can be accurately identified using the classification model. Using the concept of Transfer learning on the InceptionV3 architecture, this model achieves commendable performance on esoteric visual recognition objects and possesses in the ability to classify monuments who have striking resemblance in their appearance with considerate accuracy. Any user without access to a Graphic Processing unit (GPU) can train their dataset of a relatively Substantial size within a considerable frame of time. This project uses SVM and works efficiently for high definition images. When given a large dataset, this model lags. A model of hundred images was run on the SVM model which returned an accuracy of 70%. Larger images are trimmed to multiple overlapping cells with identical aspect ratios. Image dataset is trained for 4000 iterations. Label.txt files were generated which will just list down the labels of all the classes[5].

4) Machine Learning Advances aiding Recognition and Classification of Indian Monuments and Landmarks.

AUTHORS: Aditya Jyoti paul, Smaranjith Ghose, Kanishka Agarwal, Shivam Pal, Niketha Nethaji.

Monument classification can be broadly described as the task of identifying and classifying images of monuments into sub - categories based on their architectural style. Monument recognition and classification comes under the broader domain of landmark recognition.

Retrieval Number: 100.1/ijipr.D1022063423
DOI: 10.54105/ijipr.D1022.063423
Journal Website: www.ijipr.latticescipub.com

Published By:
Lattice Science Publication (LSP)

Though landmark recognition comes is a well – researched area in computer vision, monument recognition still remains challenging due to various factors such as the lack of sufficient annotated datasets of monuments. This paper presented a survey on previous work done in the field of monument recognition and classification [6].

III. 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 labeled 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].

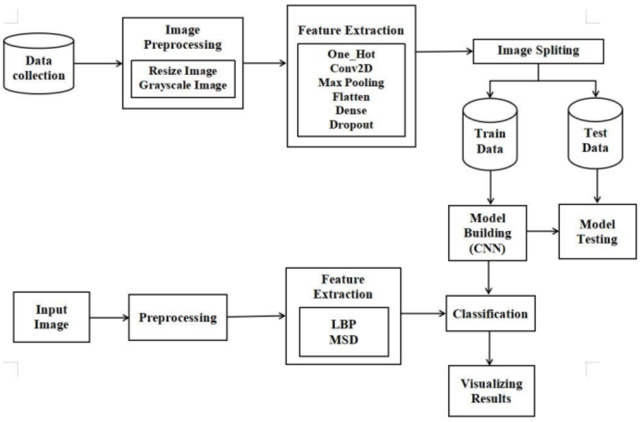


Fig. 1.Architectural Diagram

A. Creation of Satellite dataset:

The success of deep learning models depends heavily on the quality and quantity of data used for training. In the case of heritage identification, we obtained satellite imagery of 15 monuments from various sources, including public open source such as Google Earth. In-order to create the dataset with the aid of google earth first we need to visit the site and search for the required then capturing screenshots of monuments by zooming in and out and moving them about the screen in different locations. Since we used the satellite dataset, size will be larger, so we have collected the sample set of 300 images for each monument to fit the system configuration.

Fig. 2.Sample of Satellite dataset

B. Working of Convolutional Neural Network:

CNNs are successful for tasks like object recognition, picture classification, and image segmentation since they are built to automatically learn characteristics from images. Convolution involves applying a set of learnable filters (also known as convolutional kernels) to the input image, which results in feature maps that highlight patterns in the image. Here, the convolutional layers can learn to detect edges, corners, textures, and other local features. Non-linearity is important for recognizing the subtle variations and nuances in images, such as differences in lighting, scale, and viewpoint, which are often present in monument images taken from different angles or under different lighting conditions [8]. To add non-linearity to the model, CNNs often include activation functions (such as ReLU, sigmoid, or tanh).

Retrieval Number: 100.1/ijipr.D1022063423
DOI: 10.54105/ijipr.D1022.063423
Journal Website: www.ijipr.latticescipub.com

Published By:
Lattice Science Publication (LSP)

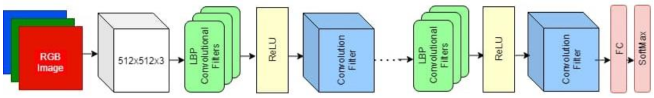


Fig. 3.Overview of CNN

Pooling can help the model to recognize monuments of different sizes and orientations, making it more adaptable to variations in image scale and view point. CNNs commonly use pooling layers (such as max pooling or average pooling) to down sample the feature maps, reducing their spatial dimensions while preserving important features. Computational complexity of the model can be reduced and spatial location of the features can be changed efficiently. The feature maps learned from lower layers are combined and fused in higher layers. CNNs use fully connected layers (also known as dense layers) at the end of the model to perform classification. The flattened and fused features from the previous layers are fed into these dense layers, which learn to map the features to specific monument classes. The output of the dense layers is usually passed through a softmax activation function to obtain class probabilities, which indicate the likelihood of the input image belonging to different monument classes.

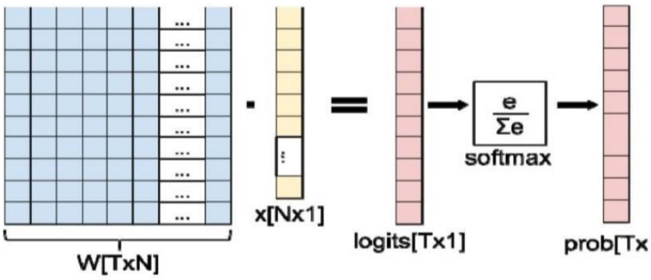


Fig. 4.A generic softmax layer diagram [9]

To train a CNN for monument recognition and classification, a large dataset of labeled monument images is typically used to optimize the model's parameters through a process called back propagation. During training, the model learns to automatically adjust the weights of the convolutional kernels and dense layers to minimize the error between its predicted outputs and the ground truth labels [10]. The model's performance is evaluated using metrics such as accuracy, precision and it is iteratively fine-tuned until satisfactory performance is achieved.

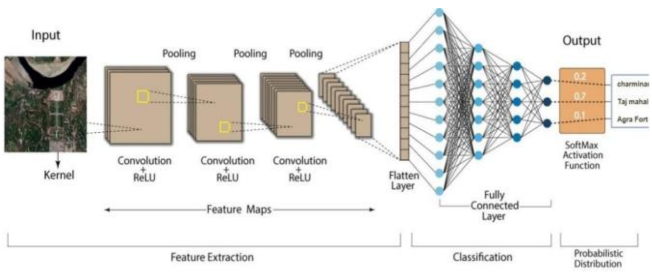


Fig. 5.Convolutional Neural Network Architecture

In conclusion, CNNs are powerful deep learning models that can automatically learn and extract relevant features from images, making them highly effective for image processing tasks. By leveraging convolution, non-linearity, pooling, feature fusion, and classification, CNNs can capture local and global contextual information from images, enabling them to recognize and classify monuments.

C. LBP (Local Binary Patterns):

Local Binary Pattern (LBP) is used to describe Convolutional Neural Networks (CNNs). A popular feature extraction technique in image processing and computer vision tasks, such as CNNs, is the local binary pattern. It is a method that is used to describe texture characteristics of the surfaces. By applying LBP, texture pattern probability can be summarised into a histogram. LBP values need to be determined for all of the image pixels [11]. A texture descriptor called Local Binary Pattern can be used in CNNs to identify local patterns in an image. It includes recording the outcomes as binary patterns after comparing the intensity levels of a core pixel with its surrounding pixels. Then, a CNN may learn and classify various visual patterns using these binary patterns as input characteristics.

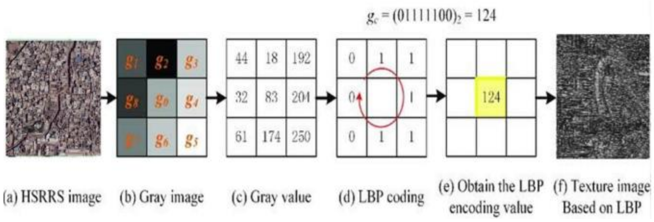


Fig. 6.LBP Feature extraction

D. MSD (Mean Standard Deviation):

Mean standard deviation, frequently employed as features in Convolutional Neural Networks (CNNs) during the pre-processing stage of the data. By adding up each pixel value in an image and dividing by the total number of pixels in the image, the mean is determined. The standard deviation is a measurement of how widely apart a group of numbers are from one another. Overall, mean standard deviation feature extraction is an important preprocessing step in CNNs that can help to improve the accuracy and robustness of the network. However, the term "mean standard deviation" refers to the average of the standard deviations of a set of variables in statistics. It is calculated by first figuring out the standard deviation of each number in the collection, and then averaging those results.

In a certain situation, a CNN or machine learning programme might employ "mean standard deviation" as a feature or preprocessing method [12]. It might be applied, for instance, as a feature normalisation approach to scale the input data's standard deviations to a predictable range. However, it is impossible to give a more precise interpretation or instructions on how "mean standard deviation" may be employed without more context or specifics.

IV. IMPLEMENTATION

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.

Retrieval Number: 100.1/ijipr.D1022063423
DOI: 10.54105/ijipr.D1022.063423
Journal Website: www.ijipr.latticescipub.com

Published By:
Lattice Science Publication (LSP)

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 [13].

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

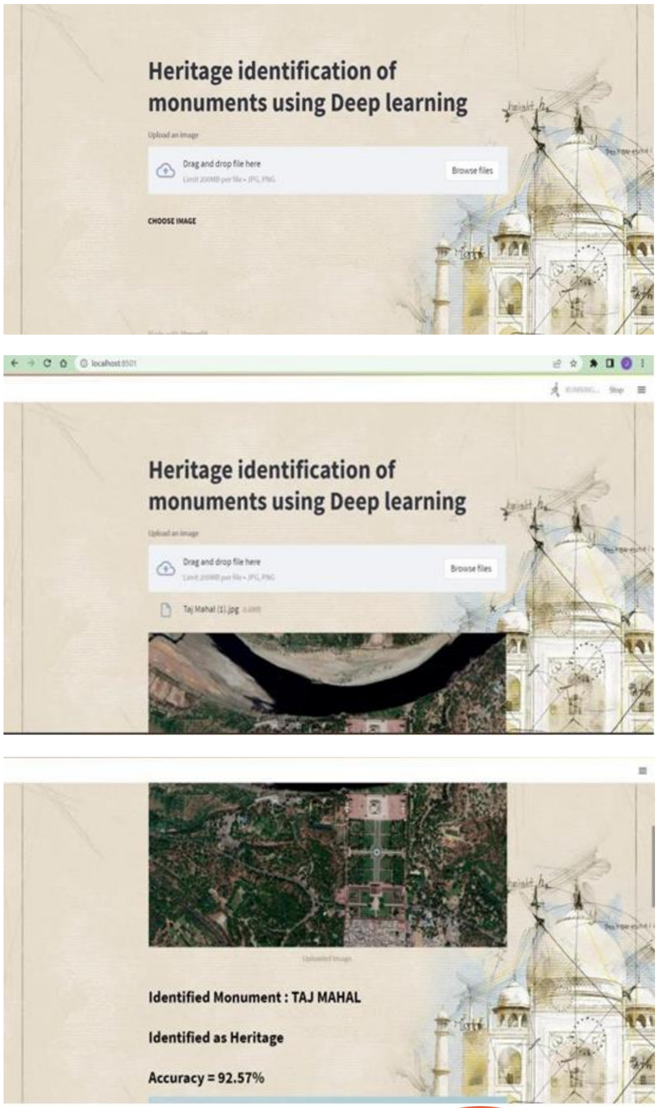
FN : Number of false negative predictions

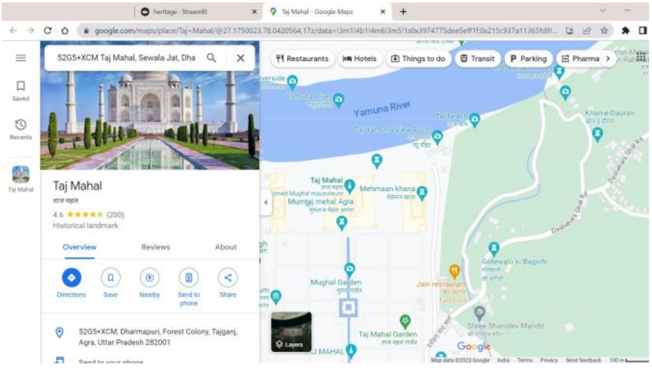
FP : Number of false positive predictions

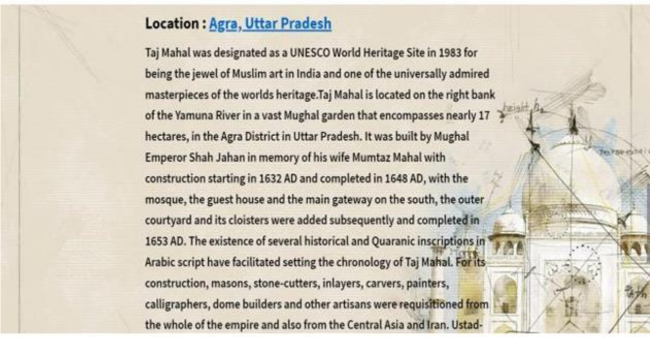
Steps for Implementation are given as follows:

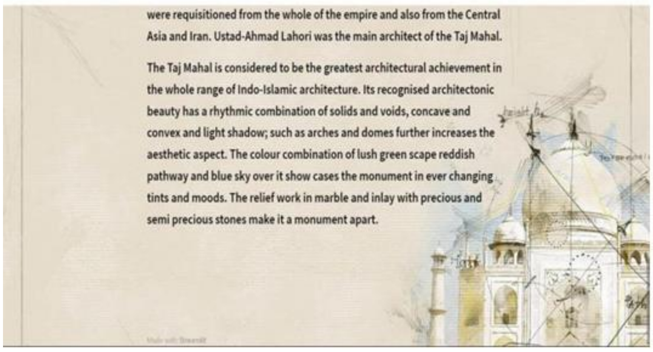
- Import all the required Libraries/packages (Numpy, Pandas, Tensorflow, Keras, CV2, Scikit learn, Matplotlib, streamlit).
- Create and Upload the dataset.
- Preprocess the dataset. In preprocessing we have to resize the image and convert the image into gray scale.To resize an image, we call the resize () 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 inorder 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.

V. RESULT AND DISCUSSION









VI. 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.

VII. FUTURE ENHANCEMENTS

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.

DECLARATION

Funding/ Grants/ Financial Support	No, I did not receive.
Conflicts of Interest/ Competing Interests	No conflicts of interest to the best of our knowledge.
Ethical Approval and Consent to Participate	No, the article does not require ethical approval and consent to participate with evidence.
Availability of Data and Material/ Data Access Statement	The dataset had been created using Google earth satellite images.
Authors Contributions	All authors have equal participation in this article.

REFERENCES

1. Official UNESCO site for Criteria of selecting a site for heritage declaration (https://whc.unesco.org/en/criteria/)
2. Long, Brian. “International Cultural Tourism Charter Managing Tourism at Places of Heritage Significance (1999).” Encyclopedia of Global Archaeology, 2014, pp. 3975–3979. [CrossRef]
3. Aradhya Saini T, Tanu Guptha Panwar, Rajat Kumar, Akshay Kumar Gupta, Ankrush Mittal., "Image based Indian Monument Recognition using Convoluted Neural Networks" 2017 International Conference, pp. 1-5, doi: 10.1109/LISS.2016.7854472. [CrossRef]
4. Chollet, F.,Omran, M.,Ramos, S., Rehfeld M., Benenson "A Monument Recognition mobile app using Deep Learning," 2017 IEEE 15th Student Conference on Research and Development (SCOReD) 2017, pp. 204-209, doi: 10.1109/SCORED.2017.8305393. [CrossRef]
5. Nithish Srivasthav A, Vinod Nair, Kajal Dhumal P., "Monument recognition using deep neural network," 2021 IEEE, pp. 0127-0131, doi: 10.1109/52608.2021.9454175.

6. Aditya Jyoti paul, Smaranjith Ghose, Kanishka Agarwal, Shivam Pal, Niketha Nethaji "Machine Learning Advances aiding Recognition and Classification of Indian Monuments and Landmarks.," 2022 6th International Conference on Computing Methodologies and Communication (ICCMC), Erode, India, 2022, pp. 1540-1545, doi: 10.1109/ICCMC53470.2022.9753715. [CrossRef]
7. Llamas, J.; Lerones, P.; Zalama, E.; Gómez García -Bermejo, J. Applying Deep Learning Techniques to Cultural Heritage Images within the INCEPTION Project. In EuroMed 2016: Digital Heritage. [CrossRef]
8. Andrew G. Howard, Menglong Zhu, Bo Chen, Dmitry Kalenichenko, Weijun Wang, Tobias Weyand, Marco Andreetto, Hartwig Adam, "MobileNets: Efficient Convolutional Neural Networks for Mobile Vision Applications".
9. Siddhant, Viraj Mehta, Karan Kanchan, Chahat Jain, Purva Raut, "Monument Recognition Using Deep Neural Networks" 2017 IEEE International Conference on Computational Intelligence and Computing Research (ICCIC), doi: 10.1109/ICCIC.2017.8524224. [CrossRef]
10. Lu, D., and Q. Weng. "A Survey of Image Classification Methods and Techniques for Improving Classification Performance." International Journal of Remote Sensing, vol. 28, no. 5, 2007, pp. 823–870. [CrossRef]
11. Calin, Mariana, et al. "3D Modeling for Digital Preservation of Romanian Heritage Monuments." Agriculture and Agricultural Science Procedia, vol. 6, 2015, pp. 421–428. [CrossRef]
12. Long, Brian. "International Cultural Tourism Charter Managing Tourism at Places of Heritage Significance (1999)." Encyclopedia of Global Archaeology, 2014, pp. 3975–3979, [CrossRef]
13. A. Crudge, W. Thomas and K. Zhu, "Landmark Recognition Using Machine Learning," CS229, Project 2017.

AUTHORS PROFILE

Sowjanya Jindam is an Assistant Professor from MVSR Engineering College with qualifications in MTech. Her research areas include Big Data Analytics, Machine Learning and the Internet of Things. Her recent works include an Prediction of software defects using ensemble machine learning techniques, Classify Authentic & Fraudulent Reviews Using Supervised Machine Learning, Social Distancing Detector using Deep Learning, Recognition of Traffic Sign Using CNN and Deep Learning.

Jaimini Keerthan Mannem, is a Bachelor of Engineering student, pursuing his final year in Information Technology at MVSR Engineering College, Osmania University. His research interests include in the field of Data Science, Machine Learning, and Artificial Intelligence. Recently, he worked on the projects, Classify Authentic & Fraudulent Reviews Using Supervised Machine Learning.

Meena Nenavath, a Bachelor of Engineering student, pursuing her final year in Information Technology at MVSR Engineering College, Osmania University. Her research interest comprehends in the fields of Machine Learning and Data Science. Recently she worked on the project, Heart Disease Prediction using Machine Learning.

Vineela Munigala, is a Bachelor of Engineering student, pursuing her final year in Information Technology at MVSR Engineering College, Osmania University. Her research interest comprehends in the field of Artificial Intelligence and DSA. Recently she worked on the project, Classify Authentic & Fraudulent Reviews Using Supervised Machine Learning.

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of the Lattice Science Publication (LSP)/ journal and/ or the editor(s). The Lattice Science Publication (LSP)/ journal and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.