Heritage Building Era Detection using CNN

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Abstract. The Indian subcontinent is a southern area of Asia continent which includes India, Bangladesh, Pakistan, Nepal, Bhutan, Maldives, and Sri Lanka. In the different periods, different rulers had ruled in these territories such as the Sultanate period (1206–1526) and Mughal period (1526–1540, 1555–1857). In addition, various ancient and heritage structure patterns show the different historical and religious characteristics of the old civilizations. This research presents a computational method for identifying the construction period or era of old heritage building by using feature detection. We have done this experiment for the application aspect, where the tour guide is not available this application will help the tourists for knowing the construction period or era by detecting the features of old spectacular architecture. In this study, we have focused on the constructional characteristics of old architectural sites by using Canny Edge Detector method. After using the Canny Edge Detector method, we have categorized different types of features among the buildings such as Dome, Minaret or Tower, Ratna, and Front. The different eras old structure contains different characteristics of the Dome, Minaret or Tower, Ratna, and Front. Finally, we have developed a neural network based model which can identify the building's construction era of the Sultanate period and Mughal period.

1. Introduction
Detection of an object is currently an important research area in the field of computer vision and artificial intelligence. Building Detection is one of them [1]. The Indian subcontinent is a natural terrain in South Asia. There are many old tourist sites in this landmass such as Sona Mosque, Kusumba Mosque, Sixty Dome Mosque (Bangladesh), Taj Mahal, Qutub Minar (India), Tomb of Jahangir (Pakistan) etc. Day by day, many unknown and unexplored old structures are coming to the people's eye. For that, travelers are excited about seeing the recent revealed ancient structure [2]. Sometimes, foreign tourists cannot find a knowledgeable tour guide [3]. In this situation, it is hard for tourists for acquiring the knowledge of construction period of ancient buildings, mosque, temple, etc. In this point of view, we have explored this research where a software application helps the tourists knowing the construction period or era by detecting the old spectacular architecture. In recent years, some research papers have been published, where machine learning and computer vision approaches are used in ancient architecture and archaeology section [4]. A feature recognition technique is used in ancient architecture which is based on deep learning and computer vision [5]. In this paper, the researchers have proposed a method to identify the several features of the ancient structure by using an artificial neural network. Another recent method focuses on recognition and visualization for ancient Maya hieroglyph where the researchers utilized CNN technique [6]. Furthermore, these former
researchers have not expressed any method for identifying the construction period or era of ancient architectural structure like the ancient temple, mosque, and building. Due to this research gap, we have committed this research where an intelligent technique helps the tourists for knowing the construction period by detecting the old spectacular architecture.

2. Proposed system and process
In this research, presents an inquiry, field observation and an analytical study about the building detection of different eras. From many sources, we get the information of some mosques, temples, tombs, bridge, dispensary, schools, the palace of Zamindars, and the houses of general people. Some antiquities are fully destroyed and some are partly destroyed. This research will suggest taking an initiative of the preservation of all ancient structures due to insufficient resources.

Our research has illustrated an application based model which demonstrated how a computer program can identify the era of an ancient building. At first, an image was taken and sent to the Canny Edge Detector. After applying this method we have got two different types of dataset: a training set and test set. Then we created a CNN model to get the prediction result of old eras (Sultanate period and Mughal period). The steps and architecture of the proposed system have been shown in Figure 1.

![Proposed CNN model for building detection](image)

Figure 1. Proposed CNN model for building detection.

3. Building structure and feature identification
There are some computational methods for detecting the features and characteristics of buildings. Research has been narrated for identifying the damaged segment of a historical building [7]. In image processing perspectives, there are different types of pattern for feature recognition [8], such as edges, corners, points, etc. [9]. In our experiment, we have used some techniques for collecting the building features of the Sultanate and Mughal period.

The outcomes of the proposed model construct of realizing the old era and a machine provides probable data by learning the ancient building’s features. We have denoted how a programmable machine theoretically learns the different ancient buildings’ features such as Dome, Minaret or Tower, Ratna, and Front. By using the Canny Edge Detector method we got different Dome, Minaret or Tower, Ratna and Front structure of the Mughal and Sultanate architecture. The learning process is based on these characteristic structures. Figures 2-15 respectively, have been exhibited the feature detection of the Sultanate and Mughal period architectures for identifying the construction era. The training set was based on those characteristics and detected features. For detecting the edge, we used the Canny Edge Detector because this function has been utilized for detecting a wide range of edges from the image. Numerous researches agree with the Canny approach showing the best result [10].
The basic difference between two eras (Sultanate Period and Mughal Period) is its structure, decoration, and materials. In the Sultanate Mosques of Bengal have a unique exposition of surface decoration including stone-cut design, terracotta, color marble, and pleasing ornamentation, but the Mughal mosques are simply ornamented with plaster in different styles such as a rectangle, arched panel, flat, four-centered or multi-foiled arches. Due to lack of easy availability of architectural material like a stone within the short distance, the Mughal mosque continued to be dominated by brick masonry in its building art and the molded terracotta made out of the fine-textured alluvial clay for purposes of surface decoration. The plastered wall is some of the typical features of the Mughal architecture of Bengal.

![Figure 2. Image of sultanate period.](image1)

![Figure 3. Image after using canny detection of sultanate period.](image2)

![Figure 4. Front image of sultanate period.](image3)

![Figure 5. Front image after using canny detection of sultanate period.](image4)

![Figure 6. Minaret image of sultanate period.](image5)

![Figure 7. Minaret image after using canny detection of sultanate period.](image6)

![Figure 8. Front image of mughal period.](image7)

![Figure 9. Front image after using canny detection of mughal period.](image8)
Figure. 10. Ratna image of mughal period.

Figure. 11. Ratna image after using canny detection of mughal period.

Figure. 12. Minaret image of mughal period.

Figure. 13. Minaret image after using canny detection of mughal period.

Figure. 14. Dome image of mughal period.

Figure. 15. Dome image after using canny detection of mughal period.

4. Proposed network architecture
We have created a Convolution neural network using 3 convolution layers 2 max pooling layers and 2 fully connected layers and a dropout (see Figure 16). Input image with size 64*64 and channel one is inserted into the first convolution layer.

Figure. 16. Diagram of CNN model.
5. Experimental result
The outcomes of the proposed model construct of realizing the old era where a machine provides data by learning the ancient building's features.

Confusion matrixes mainly describe the performance of a classifier model and it contains information about actual and predicted classifications which are done by a classification system [11]. For evaluating the performance of such systems, we used the data in the matrix. We trained our CNN model with our modified dataset and calculated the accuracy.

Test Dataset 1: Firstly, we made a single prediction in our CNN model using a single image which successfully predicted buildings of the Sultanate (see Figure 17) and Mughal (see Figure 18) period. Finally, we got a 100% accuracy rate for a single image.

| Name     | Type  | Size      | Value                        |
|----------|-------|-----------|------------------------------|
| edges    | uint8 | (800, 1200) | [0, 0, 0, ..., 0, 0, 0], [0, 0, 0, ..., 0, 0, 0], |
| i        | int   | 1         | 1                             |
| img      | uint8 | (800, 1200, 3) | [210, 186, 144], [215, 189, 147], |
| prediction | str  | 1         | Sultanate                    |
| result   | float32 | (1, 2)   | [[0., 1.]], dtype=float32    |
| test_image | float32 | (1, 64, 64, 3) | [[0., 0., 0.], [0., 0., 0.]] |

Figure 17. Predicted result of Sultanate period

| Name     | Type  | Size      | Value                        |
|----------|-------|-----------|------------------------------|
| edges    | uint8 | (800, 1200) | [0, 0, 0, ..., 0, 0, 0], [0, 0, 0, ..., 0, 0, 0], |
| i        | int   | 1         | 1                             |
| img      | uint8 | (800, 1200, 3) | [210, 186, 144], [215, 189, 147], |
| prediction | str  | 1         | Mughal                       |
| result   | float32 | (1, 2)   | [[1., 0.1]], dtype=float32   |
| test_image | float32 | (1, 64, 64, 3) | [[0., 0., 0.], [0., 0., 0.]] |

Figure 18. Predicted result of Mughal period.

Test Dataset 2: Total tested data 600. The Sultanate building contains data 350 & Mughal building 250 (see Table 1).

|          | SULTANATE | 337 | 13 |
|----------|-----------|-----|----|
| MUGHAL   | 33        | 217 |

From Table 1, we get TP = 337, TN = 217, FP = 33, FN = 13 and we know that,

\[
\text{Accuracy} = \frac{(TP+TN)}{(TP+FP+TN+FN)} \times 100\% 
\]

Following above formula (Eq. 3) for the raw data, we have achieved 92.33% accuracy.

Test Dataset 3: Total tested data 400. The Mughal building contains data 130 & Sultanate building 270.

|          | SULTANATE | 254 | 16 |
|----------|-----------|-----|----|
| MUGHAL   | 3         | 127 |

From Table 2, we get TP = 254, TN = 127, FP = 3, FN =16 and we know that,

Following above formula (Eq. 3) for the raw data we have achieved 95.25% accuracy.
6. Conclusion and future work
Our research has illustrated an application based model which demonstrates how a computer program can identify the era from an ancient building. This research is mainly focused on the period of building identification by using feature detection. Though we have achieved much better accuracy still there are somewhat limitations that we have put aside for our future work. Further, if we test the model with blurry or distortion picture, it cannot determine the target result of that specific picture. This drawback would also lead us to our future work to make our model more robust and more significant to recognize precise objects from the image. These issues will be looked forward to solve in proper research.

7. References
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