Tourist Spot Recognition Using Machine Learning Algorithms

Chapter · January 2023

DOI: 10.1007/978-981-19-1844-5_9

5 authors, including:

Jahanggir Hossain Setu
Daffodil International University
5 PUBLICATIONS **10** CITATIONS

SEE PROFILE

Nusrat Jahan
Daffodil International University
27 PUBLICATIONS **173** CITATIONS

SEE PROFILE

Tourist Spot Recognition using Machine Learning Algorithms

*Pranta Roy[1], Jahanggir Hossain Setu[1], Afrin Nahar Binti[1], Farjana Yeasmin Koly[1], and *Nusrat Jahan[2]
[1]Daffodil International University
[1](pranta15-11056, jahanggir15-10533, afrin15-11341, farjana15-11047)@diu.edu.bd
[2]Daffodil International University
[2*]nusratjahan.cse@diu.edu.bd

Abstract. Tourism plays significant role for enhancing economic potential worldwide. The natural beauty and historical interests of Bangladesh remarked as a major tourist destination for the international tourists. In this study, we target to propose a deep learning based application to recognize historical interests and tourist spots from an images. Making use of on-device Neural Engine comes with modern devices makes the application robust and internet free user experience. One of the difficult tasks to collect real images from tourist sites. Our collected images were in different sizes because of using different smartphones. We used following deep learning algorithms– Convolution Neural Network (CNN), Support Vector Machine (SVM), Long Short-Term Memory (LSTM), K-Nearest Neighbor (KNN) and Recurrent Neural Network (RNN). In this proposed framework, tourists can effortlessly detect their targeted places that can boost the tourism sector of Bangladesh. For this regard, Convolutional Neural Network (CNN) achieved best accuracy of 97%.

Keywords: Tourism, Deep Learning, Convolutional Neural Network, Recurrent Neural Network, Tourist Spot.

1 Introduction

Tourism is one of the most remarkable and rising sector in global economy. It has effect on the economic growth of a country. Moreover, this sector provides approximately 1.47 trillion U.S dollars in 2019 worldwide [1]. Developing countries can be benefited greatly from this sector. Apart from gaining foreign currencies, it is also augmenting the economic development for those countries. However, tourism revenue of Bangladesh reached 391 million USD in December 2019 [2].

Natural beauty and charming historical sites of Bangladesh attract a huge number

of tourists from all over the world. Hills, waterfalls, rivers, tea gardens, archaeological sites, religious places, forests, coasts and beaches increase the magnificence of Bangladesh. This enormous beauty convince tourists to visit here. As a result, tourism sector contributes 4.4% in total GDP for Bangladesh [3]. In this digital era, people observe many social media post about tour but sometimes there are no details about that beautiful tour or scenario. Sometimes, it is difficult to find out that tourist spot by seeing only the images or photos. It is a problem that have been faced by tourists from home and aboard. Considering this problem, we are proposing a deep learning based application to eradicate this issue and make a safe system for tourists where they can search tourist's places by photos.

Modern technology has helped tourism industry to speed up the travelling process where deep learning techniques and computer vision can provide sophisticated solutions. Researcher from worldwide trying to develop this tourism situation where many deep learning algorithms have constructed to deal with complex task. Travel time prediction, tourist behavior analysis, tourist place recommendation system, travel guide system (app and web based) and tourist spot detection are the key components where researchers have worked on. In general, most of the tourism based research work are associated with image analysis where image processing algorithms have used extensively. In deep neural network, Convolution neural network (CNN) is a kind of Artificial Neural Network (ANN) which conducted in image processing and recognition. Along with CNN, Long Short Term Memory (LSTM), Recurrent Neural Network (RNN) are used in image classification tasks whereas, popular machine learning classifiers such as KNN, SVM and Random Forest.

In this study, we proposed a deep learning based system to recognize historical interests and tourist spots from an image. Several deep neural network algorithms (CNN, KNN, SVM, RNN and LSTM) have applied to train the model. The photos taken by different smartphones and pre-processed to achieve the more accurate results. The proposed model shows 97% accuracy.

The rest of the paper is organized as follows. Section II for presenting few previous related studies, section III will describe methodology, experimental results will be discussed in section IV and finally, we will conclude our paper work including future plan in section V.

2 Literature Review

Lack of information about destinations suffered tourists while they visiting historical places. To detect historical places in Iran M. Etaati et al., [4] proposed a web based cross platform mobile framework which based on deep learning

approach. Firstly, Speeded Robust Feature (SURF), Scale Invariant Feature Transform (SIFT) and Oriented FAST and Rotated BRIEF (ORB) have been used for doing this work. But in high level visual features, they have used Support Vector Machine (SVM) and Random Forest where VGGNet model with 19 layers. They have achieved 95% accuracy by using Random forest algorithm. S Mikhailov et al., [5] have reported an ontology defines tourists' behavior analysis system which based on digital pattern of life concept. For doing this work, they build a dataset about the movement of tourists while working from data lake. They have collected 4000 trips data. They have taken route data from movement dataset for classification. For clustering, they grouped the tourists on the basis on their point of interest reviews. Finally, they used time series model to predict human behavior to predict travel time.

To develop traffic system, traffic managers are interested in understanding travel time. From this point of view M Abdollahi et al., [6] manifested an algorithm to predict travel time. They have collected 1.5 million Taxi and Limousine Commission trip records from New York City. To boost the feature space, they have applied statistical learning methods, geospatial features analysis and unsupervised learning algorithm (K-Means). Finally, they have trained a deep multilayer perception to predict travel time. However, their proposed method failed to get good accuracy. C. Siripanpornchana et al., [7] proposed a Deep networks concept to predict travel time. They have used Caltrans Performance Measurement System dataset which is one of the most used dataset.

F Goudarzi et al., presented a model to predict travel time. Where they have used Google Maps API for collecting data. They have used several machine learning algorithm like Nearest Neighbor, Windowed Nearest Neighbor, Linear Regression, Artificial Neural Network etc. where a shallow ANN achieve highest accuracy [8]. V Parikh et al., [9] proposed a mobile application where a user can find their desirable tourist place. This application recommended tourist spots, restaurants and hotels by user's interest. To recognize places they have used the CNN algorithm. Their proposed application showed good accuracy. X Su et al., [10] reported a big data architecture for supporting cultural heritage. For cultural item suggestions, they proposed a novel user-centered recommendation technique. An application of the Android devices called "Smart Search Museum" was created to test their system. G LI et al., [11] focused to design a recommendation system for tourist spots. HSS model and SVD++ algorithm have used to design the model. DSSM and CNN are also used to develop the performance of recommendation. For more robustness, they have used IRGAN model.

To detect tourist's activity patterns from Twitter data, F Hu et al., [12] inaugurated a graph based method. They have collected tweets with geo-tags. For building tourist graphs comprising of the tourist attraction edges and vertices, they have adapted a clustering method (DBSCAN). They have also used the Markov

Clustering Method and Network Analytical Method for detecting tourist movement patterns. Their work achieved 94% accuracy. N. Nezamuddin and M. Manoj [13] presented an application which assign machine learning techniques for experimental exploration and modelling. They used support vector machine (SVM), Decision Tree (DT), Neural Network (NN), Bayesian Network (BN). They also used Ensemble Learner method, K-means clustering method. They got 93.11% accuracy.

Faizan Ali et al., [14] provided a general way of Virtual reality and Augmented Reality technologies, conviction and base. They used CTM (correlated topic model) that extract the semantic structure on a hierarchical Bayesian analysis. Hien T. Nguyen et al., [15] investigate how mobile technologies are effect on tourism site and also give many information for tourist. They resolved the developing importance of mobile technologies in tourism diligence by reviewing and examining.

To obtain visual image there are three terms: scene recognition, landmark recognition and food image recognition and lexical analysis is fruitful to attain semantic image. Yang Zhang focused here on deep learning method [16]. Smart Tourism Technologies (STTs), a travel related website which is designed by Jahyun Goo and C. Derrick Huang [17] to know the mechanism of the real conduct of STTs in tour plan and travel experience and the ultimate result. This method helps to set the progress of our understanding of STTs in tour planning. They used Bias model and partial least square (PLS) Model. Sun-Yun Kim, Kyung young Lee et al., [18] proposed a strategy which avail a knowledge on tourism report quality on internet by showing exploratory record on destination image structure. This method also helps to attract more tourist through social media platform. They are using an online survey method, it has some limitations. Idir Benouaret, Dominique Lenne et al., [19] have designed a travel time website such as Trip Advisor and your tour for the traveler. They approaches different kind of packages which is constituted with a set of diverse POIs from the website. They used BOBO algorithm and PICK-Bundle algorithm. Angshuman guin et al., [20] invented a time series model that obtain to predicting future travel time by using historical travel time data (ITS data). They used seasonal ARIMA Model (sometimes referred as SARIMA Model). They gather some data which is available in 15 minutes aggregates in Georgia Navigates and from a 7.2 miles segment on I-285 over six months period .

Yen-Chiu Chen et al., [21] worked on tourist spot detection and recognition. Here, Hsinchu City, Taiwan is considered to collect pictures from smartphones and government open dataset. You Only Look Once version 3 is used to build the model and compared deep learning models using same dataset. To optimize tourist spot detection parameters in 2021 Xiaofei Huang and et al., reported a model. They used RBF neural network to predict tourist spot [22]. An online platform is

also proposed by Dongjun Yang [23] in 2021 to identify a tourist spot. Here, as an input considered different types of data: video, image, and text. Dr. J. S Manoharan et al. [24] narrated the variants of Elaboration Likelihood Model (ELM). They have compared its accuracy and executing time. They have used Deep Belief Networks, Intelligent Learning based method and Statistical Feature to compare with Elaboration Likelihood Model (ELM). Where Elaboration Likelihood Model achieved best accuracy of 94.1%. Dr. R Sharma et al. [25] proposed a method for the detection of abnormal conditions at video surveillance with the help of an image classification procedure with the combination of CNN and SVM architecture. Temporal feature extraction (TFE), background subtraction (BS) and single classifier classification methods are compared in this paper. Where, CNN+SVM architecture achieved better accuracy with higher efficiency and less loss than other combination and single classifiers.

Our proposed model is based on CNN which is simple in architecture but, yet very accurate in terms of accuracy. We achieved 97.43% using CNN model. Moreover, our model is intented to run on on-device neural engine which requires no internet connection.

3 Methodology

3.1 Dataset

In this research study, data sets were collected from onsite source. Various mobile phone cameras have used to take photos from several popular tourists spots from Bangladesh. Sundarbans (Khulna), Sompur Mohavihara in Paharpur (Rajshahi), Curzon Hall in Dhaka University (Dhaka), Rayer Bazar Boddho Bhumi (Dhaka) and Shaheed Minar (Dhaka) were chosen for collecting photos from different perspective, where a total 846 real images have stored in jpg format. Here, Table 1 represent the location wise data.

Table 1. Dataset Creation

Tourist Spots	No. of Images	No. of Images after Augmentation
1. Sundarbans	265	7916
2.Sompur Mohavihara	101	2997
3. Rayer Bazar Boddho Bhumi	124	3688
4. Shaheed Minar	264	7885
5. Curzon Hall	92	2728
	Total = 846	Total = 25214

3.2 Data Augmentation

Data Augmentation process plays an effective role while training a model. Several

image augmentation processes, such as Zoom in, Zoom out, Rotation, Gray scaling, Salt and Pepper Noise, Gaussian Noise we have used here to increase the data volume. Augmentation list is provided in Fig. 1. After applying data augmentation we got total 25204 images. As a result, this large volume of dataset has significance in terms of training a model to achieve promising result.

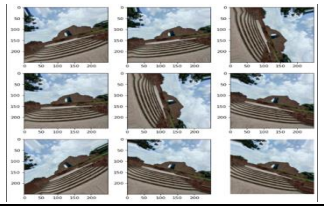
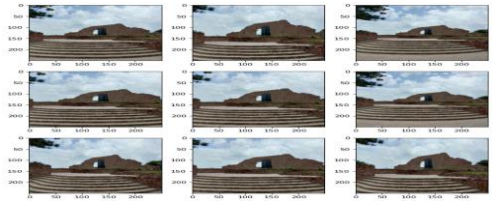
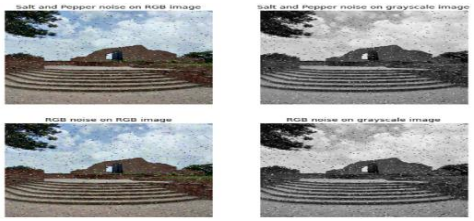
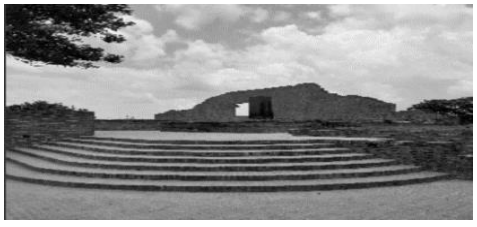
Rotation	
Zoom in/out	
Gaussian Noise	
Salt and Pepper	
Grayscale	

Fig. 1. Sample Data after Augmentation

3.3 Proposed Method

The architecture of the system introduced is entirely decentralized and based on cross-platform. The whole work flow shown in Fig. 2. Using the on-device camera modules, the user captures a photo of the tourist spot.
Most modern devices, such as smartphones, tablets, and laptops, include an on-board neural engine intended to effectively run deep learning or machine learning models. The images captured by users are transmitted to the neural engine on the device, which detects the tourist spot and extracts its labels and related information from the database. The result is then shown on the device's screen. The primary advantages of implementing the on-device neural engine is that image processing does not need an internet. Because many tourist spots in Bangladesh still lack access to high-speed internet. Furthermore, the neural engine outperforms the CPU and GPU in terms of Machine Learning and Deep Learning calculations. As a result, the time complexity issue is eliminated.

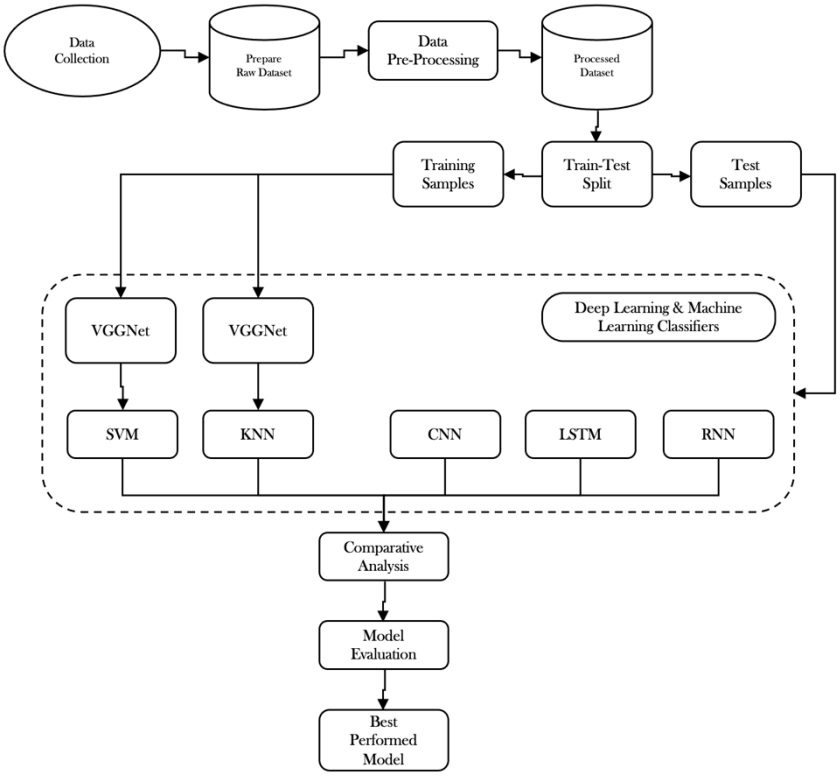


Fig. 2. Flow chart of proposed work

In addressing image classification problems, CNN has shown to be remarkably efficient. Many image datasets, including the MNIST database, the NORB

database, and the CIFAR10 dataset, have seen considerable improvements as a result of research based on CNN. It specializes in detecting local and global structures in image data. In landscape photos containing things such as monuments or hills, which also have visible local and global structures. Local features of an image, like, edges and curves can be integrated to produce more complex features, and eventually the whole scene. When training a complex neural network with many parameters, over-fitting could be a potential problem. Thus, in this study, we suggested a CNN network architecture that is particularly suited for texture-like multi-class image classification and aimed to mitigate the problem of over-fitting.

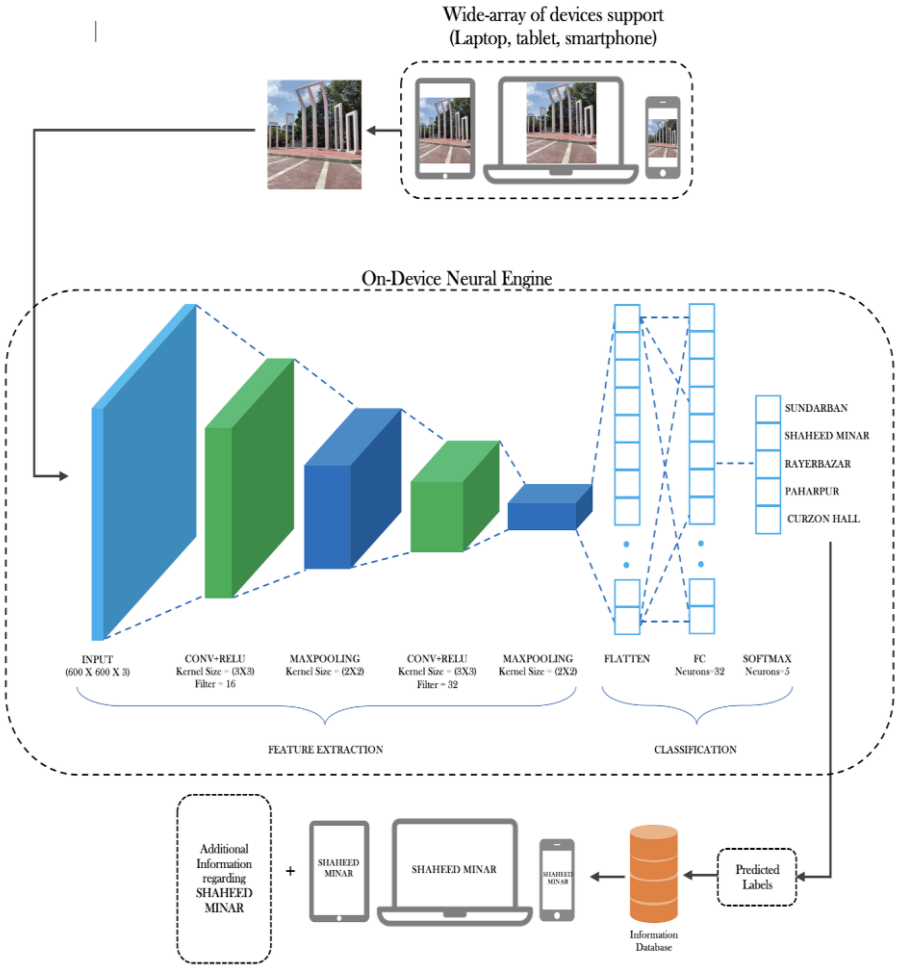


Fig. 3. System Architecture for Proposed CNN

The architecture of the proposed CNN model is illustrated in Fig. 3. Our proposed model is consisted of 7 layers. The network receives a normalized tourist location

image with a resolution of 600 by 600 pixels as input. A Conv2D layer with a kernel size of 3 X 3 pixels and 16 output channels is the first layer. The second layer, with a kernel size of 2 X 2, is a max pooling layer. Conv2D layer with kernel size of 3 X 3 pixels and 32 output channels and max pooling layer with 2 X 2 kernel size are the third and fourth layers, respectively. The following two layers are densely integrated neuronal layers, each containing 32-5 neurons. [Others architecture reference line like how many layers they are using]. The simplified network architecture also lowered the number of parameters that needed to be trained, reducing the risk of over-fitting.

4 Result Analysis

The results is discussed in this section. Several evaluation metrics used here to evaluate the performance of different deep learning and machine learning algorithms. The classifier algorithms were designed and tested using key metrics including Accuracy, Precision, Recall, and F1-Score. The key metrics were formulated as shown in the equations below, where Accuracy measures a classifier's overall efficiency. Precision measures the degree to which data labels coincide with the classifier's positive labels. The efficiency of a classifier in identifying positive labels is measured by Recall. The harmonic mean of Precision and Recall is the F1-score [26, 27].

$$Accuracy = \frac{(TP\ +\ TN)}{(TP + TN\ +\ FP\ +\ FN)}$$

$$Precision = \frac{TP}{TP\ +\ FP}$$

$$Recall = \frac{TP}{TP + FN}$$

$$F1 - score = \frac{2 \times (Recall \times Precision)}{Recall + Precision}$$

The performance results of VGG19 and deep other learning models (CNN, RNN, LSTM) are reported in the Table II. Where VGG19 model was built with machine learning classifiers (SVM and KNN). The five methods were implemented in Jupyter Notebook. We divided out dataset into 80:20 ration where 80% train and 20% test data. In Fig. 4, a normalized confusion matrix is presented for CNN model.

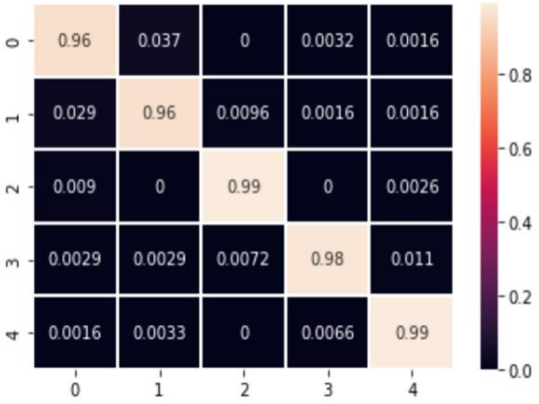


Fig. 4. Normalized Confusion Matrix for CNN

Table 2. Performance measurement

Methods	Accuracy (%)	Precision (%)	Recall (%)	F1-Measure (%)
CNN	97.40	96.95	97.91	97.43
LSTM	87.35	92.26	83.49	87.87
VGG19 + SVM	91.43	95.94	88.51	92.22
VGG19 + KNN	89.16	94.81	85.78	90.30
RNN	84.73	79.31	89.99	84.65

5 Conclusion and Future Work

While travelling, tourists face enormous problem about lack of information with the desired spot. In this paper, we proposed a deep learning algorithm based framework to detect historical interests and tourist spots from a collection of photos. The accuracy rate of several deep learning algorithms (CNN, RNN, LSTM, KNN, SVM) were compared, where Convolutional Neural Network (CNN) achieved best accuracy of 97%. Tourists would be able to easily find their desired destinations using this suggested framework, which will help Bangladesh's tourism industry grow.

References

1. Economic Impact Reports, [Online Available]: https://wttc.org/Research/Economic-Impact
2. Bangladesh Tourism Statistics 2002-2021, [Online Available]: https://www.macrotrends.net/countries/BGD/bangladesh/tourism-statistics

3. Bangladesh - Contribution of travel and tourism to GDP as a share of GDP, [Online Available]: https://knoema.com/atlas/Bangladesh/topics/Tourism/Travel-and-Tourism-Total-Contribution-to-GDP/Contribution-of-travel-and-tourism-to-GDP-percent-of-GDP
4. M. Etaati, B. Majidi, M. T. Manzuri.: Cross Platform Web-based Smart Tourism Using Deep Monument Mining. 4th International Conference on Pattern Recognition and Image Analysis (IPRIA), pp. 190-194, (2019)
5. S. Mikhailov, A. Kashevnik, A. Smirnov.: Tourist Behaviour Analysis Based on Digital Pattern of Life. 7th International Conference on Control, Decision and Information Technologies (CoDIT), pp. 622-627, (2020)
6. M Abdollahi, T Khalegi, K Yang.: An integrated feature learning approach using deep learning for travel time prediction. Expert Systems with Applications, Vol. 139, (2020)
7. C. Siripanpornchana, S. Panichpapiboon, P. Chaovalit.: Travel-time prediction with deep learning. IEEE Region 10 Conference (TENCON), pp. 1859-1862, (2016)
8. F. Goudarzi.: Travel Time Prediction: Comparison of Machine Learning Algorithms in a Case Study. IEEE 20th International Conference on High Performance Computing and Communications. IEEE 16th International Conference on Smart City; IEEE 4th International Conference on Data Science and Systems (HPCC/SmartCity/DSS), pp. 1404-1407, (2018)
9. V. Parikh, M. Keskar, D. Dharia, P. Gotmare.: A Tourist Place Recommendation and Recognition System. Second International Conference on Inventive Communication and Computational Technologies (ICICCT), Coimbatore, India, pp. 218-222, (2018)
10. X. Su, G. Sperlì, V. Moscato, A. Picariello, C. Esposito, C. Choi.: An Edge Intelligence Empowered Recommender System Enabling Cultural Heritage Applications. IEEE Transactions on Industrial Informatics, vol. 15, no. 7, pp. 4266-4275, (2019)
11. G Li, J Hua, T Yuan, J Wu, Z Jiang, H Zhang, T Li.: Novel Recommendation System for Tourist Spots Based on Hierarchical Sampling Statistics and SVD++. Mathematical Problems in Engineering, (2019)
12. F Hu., Z Li., C Yang, Y Jiang.: A graph-based approach to detecting tourist movement patterns using social media data. Cartography and Geographic Information Science, (2018)
13. Koushik, A. N., Manoj, M., Nezamuddin, N.: Machine learning applications in activity-travel behaviour research: a Review. Transport Reviews, pp. 288-311, (2020)
14. Loureiro, S. M. C., Guerreiro, J., Ali, F.: 20 years of research on virtual reality and augmented reality in tourism context:A text-mining approach. Tourism Management, (2020)
15. Guerreiro, C., Cambria, E., Nguyen, H. T.: New Avenues in Mobile Tourism. 2020 International Joint Conference on Neural Networks (IJCNN), pp. 1-8, (2020)
16. Sheng, F., Zhang, Y., Shi, C., Qiu, M., Yao, S.: Xi'an tourism destination image analysis via deep learning. Journal of Ambient Intelligence and Humanized Computing, (2020)
17. C. D. Huang, J. Goo, K. Nam, C. W. Yoo.: Smart tourism tech- nologies in travel planning: The role of exploration and exploitation. Information & Management,

vol. 54, no. 6, pp. 757 – 770, (2017)
18. Kim, S.-E., Lee, K. Y., Shin, S. I., Yang, S.-B.: Effects of tourism information quality in social media on destination image formation: The case of Sina Weibo. Information & Management, vol. 54, pp. 687–702, (2017)
19. Benouaret, I., Lenne, D.: A Package Recommendation Framework for Trip Planning Activities. 10th ACM Conference on Recommender Systems – RecSys, (2016).
20. Guin, A.: Travel Time Prediction Using a Seasonal Autoregressive Integrated Moving Average Time Series Model. IEEE Intelligent Transportation Systems Conference, (2006)
21. Chen Y-C, Yu K-M, Kao T-H, Hsieh H-L.: Deep learning based real-time tourist spots detection and recognition mechanism. Science Progress, (2021)
22. Huang, X., Jagota, V., Espinoza-Munoz, E.: Tourist hot spots prediction model based on optimized neural network algorithm. Int J Syst Assur Eng Manag, (2021)
23. Yang, D.: Online sports tourism platform based on FPGA and machine learning. Microprocessors and Microsystems, vol. 80, (2021)
24. Dr. J. S Manoharan.: Study of Variants of Extreme Learning Machine (ELM) Brands and its Performance Measure on Classification Algorithm. Journal of Soft Computing Paradigm (JSCP) no. 02 (2021)
25. Dr. R. Sharma, Dr. A. Sungheetha.: An Efficient Dimension Reduction based Fusion of CNN and SVM Model for Detection of Abnormal Incident in Video Surveillance. Journal of Soft Computing Paradigm (JSCP) 3, no. 02 (2021)
26. T. Saito, M. Rehmeismeier.: Basic evaluation measures from the confusion matrix. WordPress, (2017)
27. Vujović, Đ. Ž.: Classification model evaluation metrics. International Journal of Advanced Computer Science and Applications, Vol. 12, No. 6, (2021)