Image-based Archaeological Object Detection Using Machine Learning

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September 23, 2021

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***Abstract-* This paper presents the image dataset of archaeological objects of different categories, which are found in Bangladesh. This dataset contains 24 number of statues named Aghora,Vishu, Uma-Mahesvara, Kalayana Sundara, Mahapratisara, Vishnu (Narasimha Avatara), Surya, Ganesha, Mahamaya, Gauri, Durga, Gajalaksmi, Manjuvara, Avalokitesvara, Chamunda, Akshobhya (Tathagata Buddha), Nilkhantha, Garuda, Sivalinga, Manjusri, Votiva Stupa, Ventilator, Lintel Yaksha. The dataset also contains four types of all-stone named Black Basalt, Black Stone, Sand Stone, and Granite Stone. As Bangladesh National Museum is the national museum of the country, so we have gotten various kinds of archaeological statues here. These statues are the historical view of the country. People can find the culture, which were used to follow by the people long time ago. People can use this paper for gathering knowledge, getting information for experiments. In our dataset, the camera of smart phone having enough image pixel information for applying image-processing tools captures all the pictures. We have created an image dataset consisting of 39385 sample images. The dataset can be considered as the basic ground-truth dataset for building any mobile application based on archaeological object.**

***Index Terms-* Statue classification, stone type, archeologya, machine learning, image Processing.**

I. INTRODUCTION

We are going to work on the archaeological object. Our main perpose is analysis the structure of the archaeological object and develop a system by combining data of objects.Archaeological objects consist of three-dimensional materials that have been removed from a burial environment. Burial environments include terrestrial sites (terrestrial sites mean archaeological sites on land) or waterlogged sites (waterlogged means the objects that are found under water). All archaeological materials can be grouped into four main categories: (1) artifacts, (2) ecofacts, (3) structures and (4) features associated with human activity [1]. Artifacts and ecofacts are portable and thus can be removed from the site to be analyzed by specialists. The type structures are non-portable architectural elements, usually made of durable materials as soil, stone, or wood etc. These include imprints of posts in the ground, deliberate alignments of stone, burners, and structures carved in the bedrock (pits, cists, etc.). A feature in archaeology and especially excavation is a collection of one or more contexts representing some human non-portable activity that generally has a vertical characteristic to it in relation to site stratigraphy. Examples of features are pits, walls, and ditches [2].

It is important to learn about archaeological monuments as they play a key role in helping us understand human history and their accomplishments for times with no or little written sources. The main step for this purpose is an efficient method for collecting and documenting information about objects of interest for historiacal knowledge [3].

In many countries, there are so many advanced technologies and various systems that the blind or visual impaired people can easily learn and get the knowledge of archaeological objects in the museum. Like- audio guides, 3D printing & multi-sensory device to sight etc [4].

In Bangladesh 750,000 people are visually impaired and approximately 1.1 million are blind, where there are 164.7 million people live in this country. According to official estimate, approximately 120,000 cataract patients are added every year [5].

However, in the museums of Bangladesh, there are no facilities for visually impaired people. Here, a visit to a museum has the potential to make them feel excluded. The traditional museum experience of objects behind glass does not offer much to a person who is blind or partially sighted. In that situation, a visually impaired people cannot recognize or detect the objects if they do not get the help from any able people. We want to do something for those people who are visually impaired. Therefore, we will try to make a solution and figure out the way for the visually impaired people through this research [6].

We are going to guide the visually impaired people that they can independent with themselves to gather knowledge about archaeological objects and make them sense that they know how to approach. Audio descriptive guide can be a great tool for the visually impaired people. Therefore, we are going to represent the method of recognizing and describing the archaeological objects.Our methods will detect the archaeological object, recognize the object, find the exact details of that object, and give audio descriptive guide such as text-to-speech.

II. Literature Review

In the previous years, many papers have been published on detecting objects and finding measurements. In 2020, a paper was published on thermal and visible aerial images for multi-modal and multi-spectral image registration and fusion. In that paper, the writter has shown the method of detecting Weather Condition Temperature (C), Wind speed (km/h) and Atmospheric Pressure (hPa) [7]. Jianglin Fu et al. have shown a paper on face and object detection in fisheye images by Equation of Generic Transformation [8]. A paper on 3D-printed prototypes and non-3D-printed prototypes has been written by Matthew Li et al. in 2019. They have shown about six types of image formate, which have been used for training [9]. Soyoung Park and Alicia Carriquiry have written a paper on detecting two-dimensional images of footwear outsole impressions [10].

III. Research Methodology

Here is our data collection procedure, our dataset and the applied methodology for the dataset.

A. Dataset

TABLE I: Dataset of the Archaeological

No	Name	Media	Measurement	Period	Place where found	No of Images
1	Aghora	Black Basalt	Ht. 93 cm	C. 11th Century AD.	Abdullahpur, Munshiganj	1723
2	Vishnu	Black Basalt	Ht. 119 cm.	C. 12th Century AD.	Munshiganj	1399
3	Uma-Mahesvara	Black Basalt	Ht. 67 cm.	C. 10th Century AD.	Comilla	1580
4	Kalayana Sundara	Black Basalt	Ht. 67 cm.	C. 11th Century AD.	Sankarbandha, Munshiganj	1389
5	Mahapratisara	Black Basalt	Ht. 67 cm.	C. 10th Century AD.	Munshiganj	1302
6	Vishnu (Narasimha Avatara)	Black Basalt	Ht. 76 cm.	C. 11th Century AD.	Munshiganj	1401
7	Surya	Black Basalt	Ht. 122 cm.	C. 11th Century AD.	Nasirkot Comilla	1301
8	Ganesha	Black Basalt	Ht. 61 cm.	C. 11th Century AD.	Dhanuka, Faridpur	1301
9	Mahamaya	Black Basalt	Ht. 142 cm.	C. 12th Century AD.	Kagajipara, Munshiganj	1064
10	Gauri	Black Basalt	Ht. 161 cm.	C. 12th Century AD.	Paikpara, Munshiganj	2101
11	Durga	Black Basalt	Ht. 66 cm.	C. 10th Century AD.	Jatrabari, Rajshahi	1304
12	Gajalaksmi	Black Basalt	Ht. 103 cm.	C. 10th Century AD.	Joradeul, Munshiganj	1372
13	Manjuvara	Black Basalt	Ht. 63.5cm.	C. 11th Century AD.	Niamatpur, Naogaon	1898
14	Avalokitesvara	Black Basalt	Ht. 76cm.	C. 10th Century AD	Shibpur, Rajshahi	1782
15	Chamunda	Black Basalt	Ht. 75cm.	C. 11th Century AD.	Rampal, Munshiganj	1783
16	Akshobhya(Tathagata Buddha)	Black Basalt	Ht. 105cm.	C. 11th Century AD.	Munshiganj	1546
17	Nilkhantha	Black Basalt	Ht. 132cm.	C. 11th Century AD.	Munshiganj	2151
18	Garuda	Black Basalt	Ht. 63.5 cm.	C. 11th Century AD.	Chakhar, Barishal	1675
19	Sivalinga	Black Basalt	Ht. 68.5 cm.	C. 10th Century AD	Unknown, (bangladesh)	1366
20	Manjusri	Black Basalt	Ht. 65 cm.	C. 11th Century AD	Jalakundi, Narayanganj	1554
21	Votiva Stupa	Black Stone	Height- 1meter 7cm.	C. 10th Century AD.	Bangarh, West Dinajpur	2401
22	Ventilator	Sand Stone	Ht. 79 cm.	C. 13th Century AD.	Mahisantosh, Naogaon	2914
23	Lintel	Sand Stone	Length-1.48meter, Width -32cn	C. 13th Century AD.	Unknown (Bangladesh)	2741
24	Yaksha	Granite Stone	Ht. 41cm.	C. 12th Century AD.	Patharghata, Joypurhat	1407

Courtesy: Bangladesh National Museum

Here are some samples of object from our dataset

Vishnu Uma-Mahesvara Ganesha Mahamaya

Fig. 1. Sample images from our dataset

B. Data collection procedure

We have set up a proper environment for better implementation. The used devices were Redmi 5 Plus (Camera: Rare 8MP), One Plus 3T (Camera: 16MP), Redmi K30 (Camera: 64MP). We have used hard disk for storing data. A display monitor was used for handeling implementation. We also used a soft-core processor.

C. Used methods

Here is the applied mechanism that, firstly, we have converted the image data into binary image data. Secondly, we have trainned the binary image data by three types of algorithm named SVM (Support Vector Machine), KNN (K-Nearest Neighbors), Navie bayas. We have converted the binary data into model data indevidually by these algorithms. At last, we have used these model data in testing. In this part, we have used scikit-learn library.

IV. EXPERIMENTAL EVALUATION

We have installed the software named "pip" and "python". We have used the programming language named Python. We have used sublime text as code editor

We also have used some library such as "NumPy" for array, "OpenCV" for managing images, "pickle" for utilize data, "scikit-learn" for the algorithms, "Matplotlib" for showing data and "random" for shuffing data.

We have used about three algorithms for implemention of our image data and getting the highest accuracy. Here is the table showing the measurements we have given and the results we have gotten.

TABLE II: the amount of trained data, tested data and the accuracy

No	Algorithm Name	For training	For testing	Accuracy
1	SVM	70%	30%	78%
2	KNN	70%	30%	99%
3	Naïve Bayas	70%	30%	97%

Here, the KNN algorithom shows the highest accuracy.

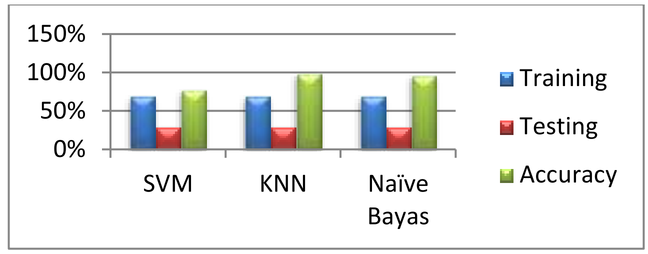

Fig. 2. Comparison chart of percentages of training, testing and accuracy

Here are the categories of images which can be detected and which cann't be detected.

TABLE III: Percentage of capabitily to detect objects

Type	Category Name	Percentage of detection
Can be detected	Aghora , Durga, Gajalaksmi, Gauri, Mahamaya, Mahapratisara, Surya, Votive Supta, Uma-Mahesvara, Kalayana Sundara, Vishnu (Narasimha Avatara), Vishnu (Narasimha Avatara), Yaksha, Ventilator, Lintel, Manjusri, Sivalinga, Garuda, Akshobhya (Tathagata Buddha), Nilkhantha, Chamunda, Avalokitesvara, Manjuvara	92%
Can not be detected	Vishnu, Ganesha	8%

Here is a pie chart of percentages of detection of objects.

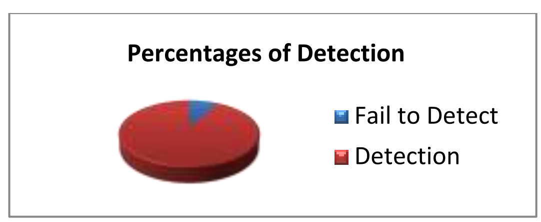

Fig. 3. Comparison chart of percentages of training, testing and accuracy

TABLE IV: Comparison of our proposed methodology with recent research papers

Works	**Name of the Object**	**Number of images**	**Classifier Model**	**Best Model**
This work	Archaeological Object	15040	SVM, KNN, Navie bayas	KNN
Lina M. García-Moreno et al.[7]	thermal and visible Aerial Area	110	MAtlab Function	NA
Jianglin Fu et al.[8]	Face and object	63,897	Equation of Generic Transformation	NA
Matthew Li et al.[9]	3D-printed prototypes and non-3D-printed prototypes	51,520	python script	NA
Soyoung Park and Alicia Carriquiry[10]	footwear outsole impressions	1500	footwear scanner	NA

VI. Conclusion

The research “Archaeological Object Detection” is for those people who are visually impaired and are unable to recognize materials by their own. There are many visually impaired people, who cannot recognize materials without anyone’s help. Our research will help them to know about archaeological materials by themselves. We are also going to provide a huge amount of data, information and research methodology through our research. All of these criterea are going to be the raw material for the researcher or students to want to study on this. Our work on archaeological objects is also going to help by giving valuable information to the archeologists. At the same time, our research also presents the archaeological objects from our country that tells the culture of previous centuries. We maintain the internal information of the museum secured. By this, we can help the visually impaired people without harming or publishing any national information.

Acknowledgments

This work was supported by Bangladesh National Museum, which has provided and given permission to get the images and data used in the preparation of the presented image database.

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