Using Deep Learning and Deepfake Techniques in Tourism (Interactive Statues Application)

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***Abstract*— The preservation and promotion of ancient civilizations have always been of great importance in the field of cultural heritage. When searching in this field, the main problem is the difficulty of providing a tour guide for each visitor at a museum or historical site who wants information about a specific statue. It is not feasible to have a personal tour guide for every individual, especially considering the cost implications.**

By leveraging deep learning models to address this problem, specifically convolutional neural networks (CNN) specially VGG-19 Architecture with 97% accuracy. The application allows users to capture or select images of statues and engage in interactive conversations with virtual representations of the statues. Additionally, a desktop application is provided for administrators and database managers to create fake videos of statues talking about themselves using the first-order motion model. The created videos are then incorporated into the application's database, expanding the range of available content. This approach aims to provide an alternative and easy-to-access way for tourists to obtain information about specific statues without the need for a physical tour guide. The use of deepfake technology, which is typically associated with entertainment purposes, is repurposed to serve as a useful tool and virtual tour guide for visitors. Overall, the application aims to provide an interactive and immersive experience for tourists, researchers, and students interested in ancient Egyptian civilization.

Keywords—Deepfake, Image Classification, Deep learning, Tkinter, Flutter, Firebase, Statues Recognition.

I. INTRODUCTION

The ancient Egyptian civilization stands as one of the world's greatest civilizations, attracting many tourists every year who are eager to witness the awe-inspiring statues of kings and queens and delve into their remarkable history. In 2022 alone, Egypt welcomed an impressive 12 million tourists (as shown in Figure 1), and all indicators point towards a significant increase in visitor numbers in the coming years. However, an ongoing concern revolves around the scarcity of available tourist guides, leading to several challenges faced by tourists. These challenges include long wait times for suitable tour guides who can communicate in the tourists' language and the excessive pricing of tourist and exploratory trips by tourism companies [1] [2].

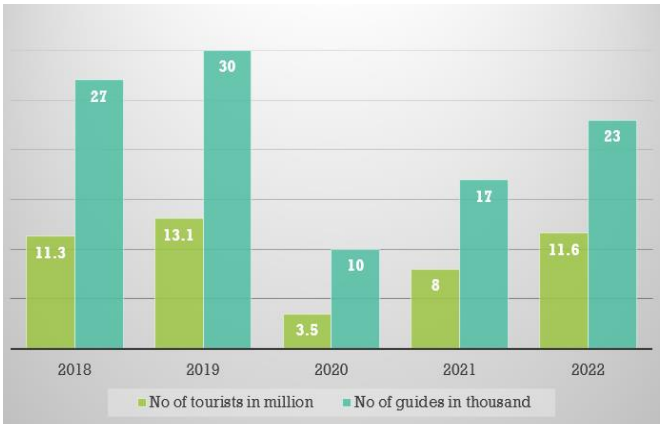

Fig. 1. Statistics between the number of tourists and tour guides in Egypt

Considering these challenges, the design of a mobile application has been undertaken, aimed at assisting tourists, researchers, and students in obtaining easy, comprehensive, and interactive information about all kings and queens, regardless of their location, be it within Egypt or abroad. The primary objective is to replace the traditional manual guidance approach with an automated guidance system, making the tourist journey more accessible, enjoyable, and cost-effective. By supporting tourism in Egypt and expanding global knowledge of the ancient civilization, the efforts seek to provide a truly immersive and interactive experience centered around historical and cultural exploration.

To achieve the goal, deep learning and machine language techniques will be employed to implement the ideas, creating models that leverage the power of technology. The Flutter Framework will be utilized for the mobile application, as it offers a versatile and user-friendly platform that can cater to

both iOS and Android operating systems, providing a seamless user interface, exceptional performance, and the ability to easily update and enhance the application.

Moreover, the envisioned application holds great potential to not only enhance the tourist experience but also serve as a pivotal guide for the future development of tourism applications. By studying how to design and implement an application that resonates with the public, the aim is to increase tourist numbers and facilitate the widespread dissemination of Egyptian culture worldwide. With the sights set on the future, the goal is to evolve the application into a universal platform that encompasses the statues and artifacts of various ancient civilizations, transcending its current Egyptian focus.

By embarking on this endeavor, it is anticipated that the mobile application will greatly enrich the tourist experience, offering invaluable guidance and fostering a deeper appreciation for Egypt's ancient heritage. Furthermore, it is expected to serve as a blueprint for the development of similar applications and pave the way for future advancements in the field of technology-enabled tourism.

II. RELATED WORK

- *Deep Learning Survey*

After reviewing and studying the papers and conducting a search to select the best model to identify and classify images, we came to this comparison shown in Table No.1 [3] [4].

TABLE I. DEEP LEARNING SURVEY (IMAGE CLASSIFICATION)

Paper Name	Model/Tech	Data set	Accuracy
Study of Face Recognition Techniques	MS-HMM	UMIST	90.66%
	NN Based SOM for Face recognition	IIT-Dehli	85.25%
Convolutional Neural Network CNN for Image Detection and Recognition	RNN	CIFAR-10	80.17%
	CNN		78.90%
A Study on CNN Transfer Learning	CNN	Caltech Faces	92.85%
Data-specific Adaptive Threshold for Face Recognition	DCNN	Adience 19,339 Images 2,284 Classes	84.30%

We conclude that the best technique to use to identify and classify images is CNN Transfer Learning [5].

- *Deep Fake Survey*

After reviewing and studying the papers and conducting a search to select the best model for Create Faked Videos, we came to the results shown in Table No. 2. [6] [7]

TABLE II. *DEEP FAKE SURVEY (CREATE VIDEOS)*

Paper Name	Model/Tech	Data set	Accuracy
First Order Motion Model for Image Animation	First Order Motion / X2Face	Vox Celeb 1	90.8%
		Tai-Chi-HD	88.0%
	First Order Motion / Monkey-Net	Vox Celeb 1	68.4%
		Tai-Chi-HD	80.6%
A large -scale Challenging Dataset for deep fake Forensics	Convolutional neural network (CNN)	Face Forensics	85%
Make It Talk: Speaker-Aware Talking-Head Animation	Make It Talk Model	VoxCeleb2	88%
Deep Learning for Deepfakes Creation and Detection	VGG16 – ResNet50	5,000 real images from Celeb A and 5,000 fake images.	83.3%

We conclude that the best technique to use for Creating deep fake Videos is First Order Motion Model which has 90.8% accuracy. [8] [9]

III. PROPOSED METHODOLOGY

The system architecture we have designed is a comprehensive framework that encompasses multiple layers (as shown in Figure 2) to facilitate a rich and interactive user experience. Each layer of the architecture serves a specific purpose and contributes to the overall functionality of the system.

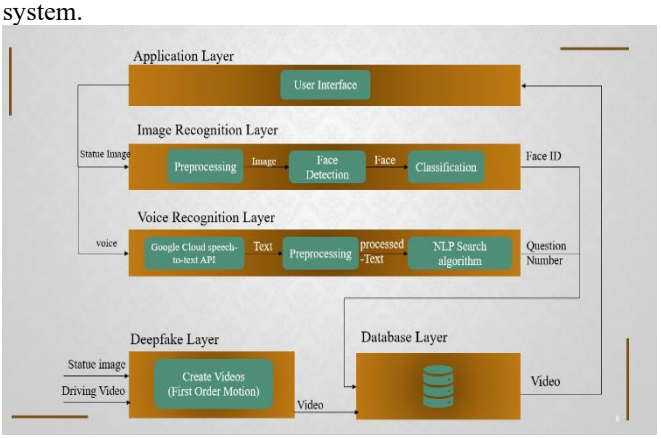

Fig. 2. System Architecture

Let's delve into the key layers that comprise this system architecture:

A. Image Recognition and Classification Layer

It serves as the backbone of the system's visual processing capabilities. It utilizes advanced image recognition algorithms and deep learning techniques, such as convolutional neural networks (CNN), to accurately identify and classify statues and other visual elements. This layer plays a crucial role in recognizing statues from user-captured photos. [10] [11] [12]

there are architectural models of deep convolutional neural networks (CNN) such as the VGG19, Res-Net (residential Network), Inception (GoogLe-Net), Alex-Net, and Custom CNN, We tried them all and concluded that the best architectural model in terms of results, speed, and

accuracy is VGG-19, which is a model of a deep neural network convolutional (CNN) is used in the field of computer vision. Developed by the research team at the University of Oxford (figure 3), it is a development of the original VGG-16 model. The number 19 in VGG-19 indicates the number of layers in the model. [13] [14] [15]

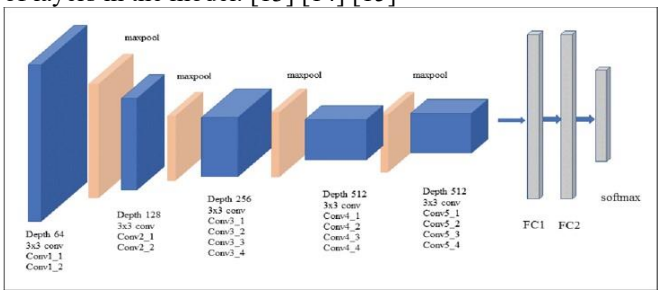

Fig. 3. VGG-19 Architecture

The Image Recognition Layer of our system encompasses various preprocessing techniques to enhance the accuracy and efficiency of image analysis. First, we resize the images to a standardized format, ensuring consistency and optimal processing performance, To ensure high-quality input data, we employ noise removal techniques to eliminate unwanted artifacts or disturbances present in the images. By applying denoising algorithms, we enhance the clarity and integrity of the images, we address the challenge of limited training data for certain classes by employing augmentation techniques. These methods involve generating additional training samples by applying transformations such as rotations, translations, and flips to existing images. [16] [17]

To further optimize the performance of our image recognition model, we leverage the knowledge and features extracted from a previously trained model on a large-scale dataset like ImageNet. By transferring this knowledge to our VGG-19 model, we can capitalize on the learned representations and benefit from their effectiveness in handling a wide range of visual features. Additionally, we employ the Early Stopping technique to prevent overfitting and improve the model's generalization capabilities. This technique halts the training process when the model's performance on validation data starts to deteriorate, thereby ensuring optimal model performance and reducing training time. [18] [19]

By implementing these preprocessing techniques and leveraging pre-trained models, we significantly enhance the accuracy and efficiency of our image recognition system.

B. Deepfake Model Layer

The Deepfake Layer is a distinctive component of the system architecture, responsible for creating realistic and captivating videos. We Use The first-order motion model (Figure 4), which is the deep fake model, as an example of changing a video clip or photograph to contain the likeness of another person. For example, the existing video sequences are used and faked by replacing the faces in the video with another person, the purpose of which is to look as realistic as possible, and we chose this model because it fully serves our project, and we also made some adjustments to it so that it becomes suitable for our purposes and use. It consists of two main units. [20] [21] [22]

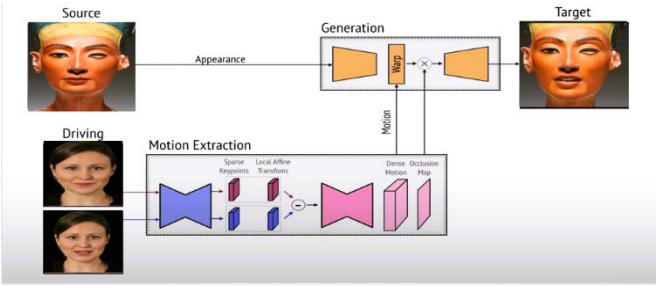

Fig. 4. First-Order-Motion Architecture

- Unity of movement: The motion module consists of a cryptograph that learns a hidden representation that contains scattered key points of high importance in relation to the movement of the object. The movement of these key points across the different frames of the driving video generates a field of motion. The dense field of motion predicts the movement of each individual pixel of the frame. The occlusion map highlights pixels in the frame that need internal painting. [21] [23]
- Image generation unit: The appearance module uses an encoder to encode the source image, which is then combined with the motion field and occlusion map to animate the source image. [21] [23]

C. Voice Recognition Layer

The Voice Recognition Layer within our system facilitates seamless and intuitive interaction between users and the platform. Leveraging advanced technologies, thereby enabling subsequent analysis and comprehension by the system.

Once the user enters the Conversation page and the User poses a voice question, the application captures the voice query and employs the Google Cloud speech-to-text API to convert it into text format (Figure 5). The resulting text undergoes further analysis and processing through techniques like tokenization, which involves dividing the text into smaller units such as individual words. Additionally, the text is subjected to text-cleaning procedures aimed at removing any unwanted elements or artifacts. These text manipulation operations utilize the available functions within the Dart language, enabling effective text manipulation and conversion. [24] [25]

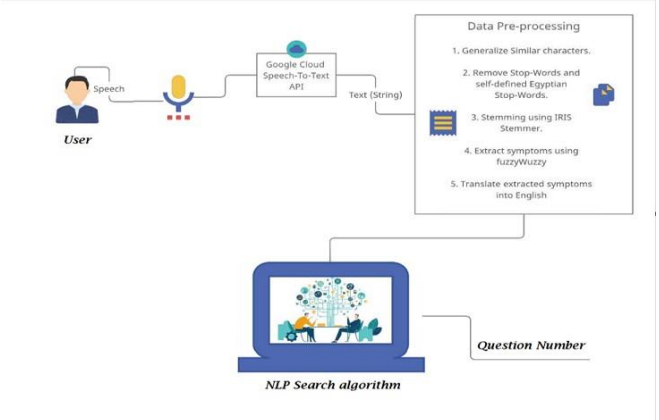

Fig. 5. Voice Recognition Architecture

To recognize the question from the processed text, a text search algorithm is executed, specifically the linear search algorithm (Linear Search). This straightforward method sequentially examines each element within the text set to

locate the desired question. The complexity of this algorithm is denoted as O(n), where 'n' represents the number of elements within the set. Upon successful recognition, the identified question is then forwarded to the database for retrieval of the response video. [26]

D. Database Layer

The Database Layer acts as a central repository for storing and managing system data. It provides the infrastructure for administrators and database managers to control and manipulate system resources. This layer is responsible for storing the generated videos, user queries, and other relevant data, ensuring efficient retrieval and management. The Database Layer supports functionalities such as video creation, editing, deletion, and addition, facilitating seamless integration with the other layers of the system.

the Firebase platform was used, which is characterized by ease, flexibility, the ability to expand, organize and store information in a logical and organized way, provides powerful data storage and synchronization capabilities in real-time, and provides strong security mechanisms to protect data, making it a suitable option for us to use in desktop, mobile and other applications. [27] [28]

E. Application Layer

The Application Layer comprises both a mobile application and a desktop application, serving as the user-facing interface of the system, visually appealing, and feature-rich, ensuring a seamless and engaging user experience.

- The Mobile Application:

It provides users with a convenient and intuitive platform to capture photos, record voice queries, and receive video responses from the statues, In the design of the application, we used the FLUTTER Framework that works in the Dart language developed by Google and is used to build multi-platform applications such as iOS and Android operating systems with a beautiful and smooth user interface and excellent performance. [29]

- The Desktop Application:

This application is dedicated to administrators and database managers, where they can create videos of Talking Statues, then inserts them into the database, and the application gives permission to the administrators so that they can edit, delete, or add to the database and control it, In the design of the application, we used the Tkinter library provided by the Python language, which is used to create graphical user interfaces (GUIs). Tkinter is used to build interactive desktop applications, which means that no additional installation is required when using Python, and therefore it can be easily used in the development environment. [30]

IV. RESULTS

The implementation of our proposed methodology yielded promising outcomes, showcasing the effectiveness and potential of the developed mobile application in revolutionizing the tourist experience and providing valuable information about the statues of ancient Egyptian kings and queens. Through the utilization of deep learning and machine learning techniques, we successfully created an interactive and immersive platform that offers a seamless and enjoyable journey.

1) Datasets

A data set is a set of structured and interconnected data, is considered an essential component for the development of machine learning and data learning models and is considered a powerful tool for understanding data and using it to achieve various goals in various fields and applications. The data set is mainly divided into two parts:

- The Textual dataset:

containing all the information on statues of kings and Queens collected (Figure 6), verified, and reviewed from documented historical sources and references such as "Egyptian Civilization" by John Romer and "History of Ancient Egypt: Egyptian Civilization from the Early Pharaonic to the Islamic conquest" by Ibrahim Fahmy and Hisham al-Laith and some academic research and articles published in recognized historical journals such as "Journal of Egyptian Archaeology" and "Bulletin of the Egyptian Museum" and "ancient Egypt magazine". [31] [32]

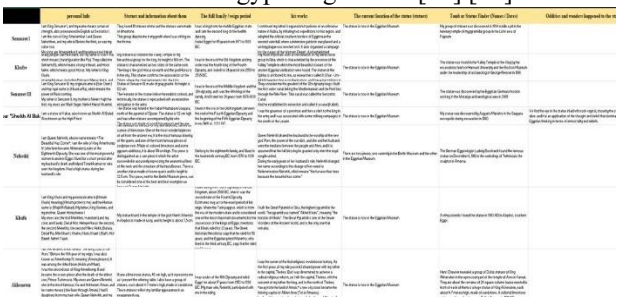

Fig. 6. Textual dataset

- images dataset:

Play a crucial role in neural network (CNN) models, they provide basic visual data for CNN models and help in pattern recognition, features, image analysis, and classification.

We faced a major problem, which is the lack of quality images and lack of the number of images that the model needs are freely available on the internet, where the image quality given to the model must be high so that it contains more information and details, allowing the model to take advantage of that information and details to improve the accuracy of analysis and classification, and it must be with a large number of high-quality images in the training process. So, we decided to visit Egyptian museums and take pictures of the statues that we need with standards We have considered that the photos should be of high quality and clear enough (Figure 7). we changed the angles, positions, and lighting as much as possible to reduce the contrast and noise caused by different lighting to get a variety of photos, and finally adjusted the size of the photos taken so that it is compatible with the requirements of the Model. conditions were set for the photos to contain only the statue's head and shoulders, and we decided after the end of our project to publish these photos for everyone to benefit.

Fig. 7. Images dataset

2) Experimental and Results

In this section, we present the key results obtained from our study. We highlight the recognition and classification accuracy achieved by the convolutional neural networks (CNN) model, the generation of realistic and high-quality videos using the deep fake model, the user-friendly mobile interface, and the desktop application and database management features.

Now, let us delve into the specific findings and outcomes obtained from our study, showcasing the achievements and capabilities of the developed mobile application and associated components.

A. Image Recognition and Classification

We will show the results of using various models in image recognition and classify them in Table No. 3.

TABLE III. TRIAL SUMMARY

Model	Augmentation	Accuracy
SVM	No	41.64%
SVM	Yes	59.09%
LeNet-5	No	37%
Custom CNN	No	52%
Custom CNN	Yes	69.5%
Alex Net	No	46%
Alex Net	Yes	66%
VGG-16	Yes	74%
VGG-19	No	92.76%
VGG-19	Yes	96.78%

From Table 3 we conclude that the CNN model, specifically the VGG-19 architecture, was employed to recognize and classify the images of statues. Through training the model on a large dataset of high-quality images, we achieved a remarkable accuracy rate of 97%. This high accuracy indicates the model's proficiency in identifying different statutes and extracting relevant features.

B. Deepfake Video Generation

The first-order motion model played a crucial role in the application by enabling the replacement of faces in the driving video with the likeness of the desired statue. The application was able to produce realistic and high-quality results (Figure 8), showcasing the power of deep fake technology.

Measuring the Quality of the first-order motion model typically involves evaluating the quality of the generated videos and assessing how well they align with the desired outcomes, there are factors that can influence the Quality of the model:

- Video Processing: The quality and characteristics of the input video can impact the accuracy of the model. Higher-quality videos with clear and consistent facial details are more likely to yield better results in terms of quality.
- Image Processing: The Quality of the first-order motion model can also be influenced by image processing techniques applied during the facial replacement process. These techniques may involve image enhancement, alignment, or blending to ensure seamless integration of the new face onto the original video frames.

1) before generation 2) After generation

Fig. 8. Deepfake Video Generation

C. User-Friendly Mobile Interface

The mobile application's user interface, built using the Flutter framework, was designed with simplicity and ease of use in mind. The application offered smooth navigation, quick loading times, and responsiveness across different screen sizes and devices. The visually appealing interface, accompanied by intuitive symbols and a well-coordinated color palette, contributed to an enjoyable user experience.

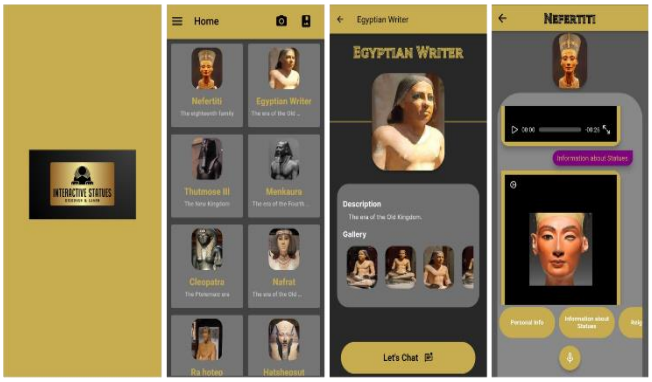

Fig. 9. Mobile App Screens

E. Desktop application and Database Management

The desktop application provided administrators with comprehensive control over the database. They could easily create, edit, delete, and add videos of Talking Statues. The application, developed using the Tkinter library, offered a user-friendly graphical interface with various elements and functions, enabling efficient management of the content.

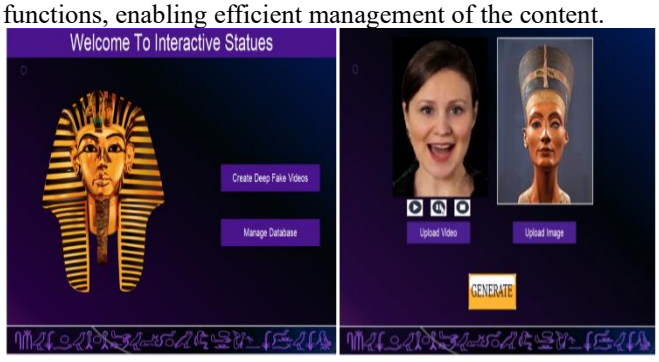

Fig. 10. Desktop App Screens

The implementation of our proposed methodology resulted in a successful mobile application that addressed the challenges faced by tourists in Egypt. By leveraging deep learning and machine learning techniques, we created an automated guidance system that replaced the traditional manual approach. The results indicated the potential of the application in enhancing the tourist experience, providing valuable information, and promoting Egyptian culture worldwide.

V. CONCLUSION

In conclusion, our research endeavors have led to the development of a mobile application that seeks to revolutionize the tourist experience in Egypt and beyond. By harnessing the power of deep learning and the Flutter Framework, we have created a comprehensive and interactive platform that provides tourists, researchers, and students with easy access to information about ancient Egyptian kings and queens. This application not only addresses the challenges faced by tourists, such as the scarcity of tourist guides and inflated trip prices but also aims to enhance cultural exploration, promote tourism, and increase awareness of the rich Egyptian civilization.

Through the implementation of deep learning models, including the VGG-19 convolutional neural network for image recognition and classification, as well as the first-order motion model for generating realistic Videos, our application offers users a unique and immersive experience. By engaging in conversations with the statues, users can gain in-depth knowledge, ask questions, and receive video responses, thus understanding their historical significance.

The proposed methodology encompasses a mobile application for users, a desktop application for administrators and database managers, a dataset comprising historical information and textual data from reputable sources, and robust deep-learning models for image recognition and video generation. Each component has been carefully designed and implemented to ensure a seamless and user-friendly experience, facilitating efficient interaction with the application.

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